NOA: AI-powered Travel Aids for Orientation and Mobility

Instructional strategies and illustrated examples

FIRST EDITION

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Content

Foreword

For people with vision impairments, being able to navigate the world on their own is essential to their quality of life, and **mobility and orientation aids like guide dogs and white canes play vital roles in promoting this independence.** The white cane is the most widely used assistive technology. It allows blind and visually impaired individuals to avoid collisions and be aware of their surroundings by detecting obstacles, changes in elevation and specific landmarks at ground level through tactile feedback. It is a cheap, reliable and accessible solution for many people. The white cane not only serves a practical use for mobility, it is also a recognized symbol of an individual's visual impairment and allows for other pedestrians or automobiles to be aware of this. However, the white cane does have certain limitations. **It does not protect users against obstacles at the upper body and head level, which can sometimes cause dangerous collisions.** Moreover, the white cane can rarely give a complete mobility coverage, even with optimal swiping techniques (Smith & Penrod, 2010).

The other most common assistive tool is the use of a guide dog. **Guide dogs are carefully trained to navigate obstacles, obey directional commands, alert for curbs and steps, and find crossings and doors.** They are also capable of making independent decisions to ensure their handler's safety, including sometimes disobeying unsafe commands. Guide dogs also provide companionship to their handlers, as well as a feeling of security and recognition of their disability by other pedestrians. However, they also come with certain disadvantages. Guide dogs require regular and scheduled care, whether it be feeding, relieving, playing or grooming. They also require occasional veterinarian visits. All these needs can cost a significant amount. The average cost of maintaining a healthy dog guide was estimated at about 70$ a month (Franck, 2010). Additionally, some locations or nations may demand additional preparation for travel. Last but not least, the help from a guide dog is limited by its lifespan, which is typically 6 to 8 years (Clovernook, 2020).

The shortcomings of conventional mobility aids have recently been addressed by electronic travel aids (ETAs). These aids typically improve spatial awareness and give BVI people real-time environmental feedback through tactile and/or auditory outputs. Tools such as the UltraCane and Sunu wristband, for instance, raise the bar for obstacle recognition and warn users of objects that conventional canes could overlook (UltraCane, n.d.; Alexiou, 2024). Similarly, GPS-based tools have emerged, such as Navibelt and BlindSquare, which act as navigators, giving complex directional instructions to help users to orient themselves in urban spaces and access sites of interest more independently (feelSpace, n.d.; BlindSquare, n.d.).

Introduction

At biped robotics, we are committed to enhancing mobility and independence for blind and visually impaired individuals through the use of artificial intelligence (AI) and new technology.

This guide serves as a comprehensive resource for Orientation and Mobility (O&M) specialists, educators, caregivers, and users, illustrating the effectiveness and multifaceted capabilities of AI and technology for O&M.

As technology continually reshapes the way we experience and navigate the world, it has become crucial to embrace the power of AI to advance mobility. For individuals with visual impairments, this shift is especially significant: modern AI-driven devices go beyond traditional orientation and mobility tools by unlocking unprecedented levels of situational awareness and safety.

AI's capabilities to interpret, analyze and respond to complex environments in real time represent an immense resource for ETAs.

This guide highlights the critical role of AI in next-generation mobility aids – introducing an experience that will soon set the standard in orientation & mobility.

NOA is an advanced assistive technology that offers real-time navigation assistance, obstacle detection, scene descriptions, and object-finding features to empower users.

NOA is tailored to meet the diverse needs of its users – ranging from active adults and children to individuals with mental disabilities – and promotes greater confidence and independence in orientation and mobility activities.

This freedom of movement can not only enhance daily interactions and activity, but also strengthen users' sense of belonging and connectedness in various environments.

At the heart of NOA is a sophisticated AI system developed by engineers at biped robotics, enabling a seamless experience for individuals with visual impairments. Through the integration of AI algorithms, NOA is able to accurately identify obstacles and landmarks, and thus provide real-time comprehensive assistance that traditional tools are incapable of providing. Additionally, NOA's AI-powered features give its customers flexible assistance, enabling them to move confidently across any environment, whether it be a busy city street, an indoor space, or a rural location.

This book highlights AI's potential in assistive technologies.

Moreover, it presents the NOA device, consolidates user testimonials, detailed descriptions of NOA's features, and practical applications in real-world settings. It aims to equip O&M professionals with valuable insights into the importance of AI, and how NOA can enhance orientation and mobility abilities, improve safety, and facilitate a more enriching experience for users.

We invite you to explore the information in this book and discover how the NOA device can make a significant difference in the lives of individuals with visual impairments, ensuring that they navigate their world with confidence and ease.

AI for Visual Impaired

Current Solutions

Advances in technology, and more specifically AI, are rapidly transforming the world we live in. These advancements present major opportunities for the visually impaired. Indeed, AI is transforming accessibility, offering new pathways to inclusivity for blind and visually impaired individuals.

This potential is being noticed and recognized in the field of vision rehabilitation and education. For example, the latest version of both volumes of the **Foundation of Orientation and Mobility now include detailed chapters about the use of technology for the visually impaired** (Giudice & Long, 2024, pp. 25-34; Penrod et al., 2024) demonstrating the importance and role technology and AI can play in assisting individuals.

Many AI-based tools have been developed in the past years to address the visually impaired community's necessities. **ChatGPT**, despite it being developed for the general population, is being used by many visually impaired people to provide information, answer questions, and help with different tasks (OpenAI, n.d.).

Beyond general-purpose AI tools like ChatGPT, specialized applications have emerged to meet the unique needs of the visually impaired community. For example, **Be My AI, a collaboration between Be My Eyes and ChatGPT,** allows users to send photos to the AI and receive descriptions and explanations about the information in the image (Paris, 2023).

Similar accessibility apps are also available, such as **Seeing AI and the Envision App** (Microsoft Garage, n.d.; Envision, n.d.).

Moreover, **wearable AI-based technologies** are also entering the market for accessibility, such as smart glasses equipped with a camera and AI capabilities. **OrCam smart glasses** enable users to read text and recognize faces, colors, coins, and objects.

Furthermore, they have developed an AI assistant with whom you can interact and ask questions about objects and text (OrCam Technologies, n.d.). **Envision** has also designed similar glasses which can read text, identify light sources, cash notes, and colors. The device is also capable of finding objects and familiar faces, as well as describing environments. Similarly to the OrCam glasses, Envision developed an AI feature to directly ask questions about text-based content to the device (Envision, n.d.).

While these applications are extremely promising and offer great assistance, they are **primarily tailored to indoor daily tasks and are often limited in outdoor settings where O&M needs are most complex**. Nonetheless, they demonstrate AI's potential to support orientation and navigation needs too. **Extending similar AI capabilities to outdoor environments could revolutionize O&M by addressing the challenges of navigation, spatial awareness, and obstacle avoidance** that visually impaired individuals face when navigating independently.

An AI-based smartphone application, **OKO AI Copilot**, is aiming to bring AI-based solutions to navigation. Indeed, the app is able to recognize pedestrian walk signs at intersections and inform users when the street is safe to cross (Ayes, n.d.). However, even though the technology can be extremely useful for street crossing, a challenging task for the visually impaired individuals, it is limited to only one specific task.

Orientation and Mobility

Traditional ETAs have long aimed to assist visually impaired individuals with O&M task. However, despite their potential, many of these tools have faced challenges in achieving widespread adoption.

For example, the Sunu wristband or the UltraCane cited in the latest version of the Foundations of

Orientation and Mobility have unfortunately gone out of business or have limited availability due to usability constraints, high costs and limited adaptability (UltraCane, n.d.; Alexiou, 2024). These challenges highlight a significant gap in tools that meet the full range of O&M needs. **Recent advancements in AI present unique opportunities to address these gaps and offer tools that assist users in all aspects of O&M and are intuitive to use.**

For a person who is visually impaired, **orientation means having an awareness of one's spatial position and surroundings, essentially answering, "Where am I, and where am I going?"** Traditional tools assist individuals to a certain degree, but AI can offer a much richer understanding of the surroundings.

GPS technology can be augmented by AI to pinpoint a user's exact location and direction in real time to provide spatial localization and a sense of place. In addition, **AI-powered object recognition can offer verbal descriptions of the environment, identify landmarks which can be helpful for orientation and develop spatial maps.**

Moreover, **optical character recognition and text-to-speech** can allow blind individuals to access otherwise unavailable information such as street names, safety notifications or shop signage. These advanced real-time features can significantly **enhance independence and situational awareness of visually impaired individuals, by providing a detailed environmental layout.**

The second major aspect, **mobility, involves safe movement, often with the question of "how do I get to my destination safely?"** Mobility is more than just moving; it is moving with a degree of safety, confidence, and ease. Navigation usually requires extensive memorization and path planning on the part of the user which is extremely exhausting.

Moreover, many situations, such as intersections, are very tricky and require advanced instructions to help individuals. By contrast, **AI-driven tools can eliminate much of the cognitive load and uncertainty associated with navigating** by offering real-time, detailed and personalized route instructions, confirmation and reassurance during navigation, as well as an overview of the journey before starting.

Furthermore, **obstacle detection and avoidance can be enhanced by AI-algorithms and ensure better safety**. AI can assess the type, proximity and trajectory of objects. Such systems may recognize and differentiate stationary objects, moving objects, or holes, and anticipate which obstacles will be on the user's travel path to warn them of this hazard. These developments in AI are particularly beneficial to handle potentially dangerous and complex situations at intersections or in crowded places.

In essence, AI offers remarkable opportunities to complement traditional O&M tools, enriching the resources available to blind individuals and specialists. **AI is particularly powerful, as it can be customized to provide real-time, dynamic and complex information, allowing users to better understand where they are and how to get to their destination**. Notably, AI can be trained to deliver instructions based on the real needs of the visually impaired community and grounded in O&M best practices and scientific evidence.

While not a replacement for the expertise of O&M specialists, **AI can act as a customizable personal assistant to obtain information about obstacles, landmarks, and paths during independent travel and on unfamiliar routes**, providing the kind of immediate environmental information that a specialist might offer in person.

Thoughts from Specialists

To explore the potential of AI in O&M further, it is essential to **understand the perspectives of those who work directly with visually impaired individuals — O&M specialists.** These professionals are uniquely positioned to evaluate the effectiveness of current mobility solutions, such as traditional aids and newer technologies like NOA, and to offer insights into how AI could

improve the O&M experience.

In this section, we present the thoughts of two key O&M specialists, **Vickie Anderson** and **Pedro Pessoa**, who bring extensive experience to the field.

Vickie Anderson is a vision rehabilitation therapist and O&M specialist with over 20 years of experience working with individuals who are blind or visually impaired. Vickie works with people of all ages, but has developed a strong focus on supporting children.

She is also actively involved in mentoring new O&M specialists and advocating for high standards in service provision through her role on the Professional Standards Committee of the Orientation and Mobility Association of Australasia (OMAA).

Pedro Pessoa is a seasoned occupational therapist with seven years of experience, specializing in low vision. Over the course of his career, he spent four years contributing to research and development, focusing on innovative solutions for visually impaired individuals.

For the past two years, Pedro has been working as a team manager in a healthcare center, where he continues to advance care in the field of low vision rehabilitation while supporting his own team.

Their insights explore the strengths and shortcomings of current mobility aids, the transformative potential of AI and technology, and the challenges of integrating these tools effectively. Together, they provide a professional perspective on how innovation can reshape the O&M experience for visually impaired individuals.

Current O&M Tools

Traditional O&M tools, such as canes or guide dogs, provide invaluable support to visually impaired individuals. Vickie highlights their reliability and the independence they offer, explaining, "With the cane, you can get up and go at any time. There's lots of freedom that comes with it. With the dog, you have a faster pace because you don't have that constant stopping, but you might not know exactly where you are all the time." For her, these traditional tools remain foundational despite their imperfections.

In contrast, Pedro brings a strong appreciation for newer technological tools, praising their ability to complement traditional aids by replicating many functions of vision. "***We're in an era where we've really succeeded in replacing just about all the activities of the eye, or at least replacing the eye's possibilities with devices,***" he notes, highlighting advancements like OCR. These innovations, he argues, provide users with tools that extend beyond what traditional aids can achieve.

However, both specialists identify limitations in today's electronic tools. Pedro critiques the lack of hands-free functionality, which restricts their usability in daily life: "**The majority of the devices that exist today don't allow you to do two-handed activities. The majority are things that you have to hold in one hand, to carry out an activity. It's extremely complicated.**"

Vickie, on the other hand, focuses on design flaws and the unreliability of many secondary aids. She reflects, "**I really struggle with electronic travel aids because I haven't found too many that are very reliable. Their idea is great and the possibility of it is great, but the wearability of it could be considered a flaw depending on the person.**" While she acknowledges their potential, she emphasizes the supplemental nature of these tools, rather than being replacements for traditional aids.

Future Trends

One of the most promising aspects of advancing technology in O&M is the potential for personalization, an area where current tools often fall short. Pedro explains, "***What's missing now is the ability to personalize these solutions, and I think that's where the introduction of artificial intelligence comes in. Not by having new functions, but by personalizing the experience according to the user's habits and needs.***" This capability could address cultural resistance and professional hesitancy, which Pedro attributes to skepticism about the effectiveness of new tools: "***We know today that around 70 to 80% of devices given to visually impaired people end up in a drawer after 3 months. They're useless, and professionals know this. O&M professionals are still waiting for miracle solutions...and it's often this personalization that we haven't yet managed to achieve.***"

Equally important is introducing technology earlier in education and rehabilitation, a strategy that Pedro believes could unlock greater potential for visually impaired individuals. He stresses, "***You have to introduce technology a little earlier in their education. For example, children learning Braille should also be exposed to tools that develop other skills, like AI-powered devices.***" By integrating technology at formative stages, individuals can build confidence, expand their capabilities, and develop a stronger sense of autonomy. Pedro adds that this approach could also help address societal biases: "***I think people with disabilities have skills. They can be included in our society, without being on the margins. And I think technology can help. We have people who are extremely competent. We have people who can be entrepreneurs, who can develop their own business. But to get people to do that, you have to introduce technology a little earlier in their education.***"

Additionally, AI-based solutions like smartphone applications are becoming more broadly available, reasonably priced, and accessible. Vickie observes, "***I believe that there's going to be more and more apps. Even when you just go in and search on the App Store, and search for vision loss, the amount of things that come up.***" These apps are becoming more effective and suited to the requirements of people with visual impairments thanks to developments in AI, which could help make everyday activities more manageable, and develop greater autonomy.

NOA's Potential

Building on the transformative possibilities of AI, NOA represents a concrete application of these advancements, offering a device tailored to address the diverse needs of visually impaired individuals. Vickie highlights its vast potential, stating, "***There's lots of ways that NOA can improve and complement O&M. I think it's probably limitless.***"

One of NOA's most significant advantages is its all-in-one design, which consolidates multiple functionalities into a single device. Pedro emphasizes the importance of this approach: "***NOA's advantage is that it's an all-in-one solution. In fact, every activity, whether it's reading, writing, developing, getting around, eating, cooking, etc., all these activities today require a solution. What's new about NOA is that it brings all this together in a single device.***" He

explains that this integration reduces the need for multiple tools and the corresponding learning processes, which can be time-consuming and overwhelming. "***Having several devices also means several learning processes, and that's very, very time-consuming. And it takes a lot of energy and organization,***" he adds, highlighting the device's potential to streamline O&M strategies.

Vickie shares Pedro's enthusiasm for NOA, but offers a note of caution about overloading its functionality. While she sees limitless potential, she warns against trying to address too many problems at once: "***What I found in the past with devices that try to do a lot is that nothing is done 100% anymore. It's not what it was created to do in the beginning; You want this stellar, amazing thing, but then we think, 'Oh, we can do this, and we can do this.' And so maybe everything's done 95% instead of 100%.***"

Strengthening Collaboration and Training

Collaboration between technology developers and O&M professionals plays an important role in creating tools that are not only innovative but also practical for visually impaired individuals. Pedro emphasizes that trust and hands-on experience are key to making these collaborations successful: "***To develop a device, you can be a great engineer, you can have great ideas, but there's no substitute for hands-on experience. It's really important to develop a bond of trust, to be able to create things, by going out into the field, and understanding the difficulties of users, but also of people in the field.***" He stresses that developers need to be spending more time with O&M specialists to understand the real-world challenges they face: "***It's extremely time-consuming, but if you want to be successful, I think it's the best thing to do.***"

Introducing technology earlier in education and rehabilitation is another essential step. Pedro points out that many professionals are already stretched thin and don't always have the time to assess how new tools could benefit their clients. "***That's where we need experts to explain, particularly to professionals in the field, who are in most cases already outnumbered and have a lot of requests, 'What's the point of this tool? Do I want to meet the demand, or do I want to increase my patient's skills?***'" he says. Structured training programs can bridge this gap, helping professionals understand the tool, its purpose, which clients could benefit from it, and how to effectively teach its use.

Pedro also highlights the importance of a clear roadmap for introducing technology to help guide rehabilitation efforts. "***We know that, like a child learning to walk, there are crucial stages. We can develop a taxonomy of skills, rather than saying we'll go by need,***" he explains. He sees this as part of two different approaches: one focused on long-term skill-building through rehabilitation and the other on quickly meeting specific demands. Both approaches require thoughtful and distinct planning and support to ensure success.

Vickie adds that accessible training materials are crucial, praising NOA's efforts to support both self-learners and those working with O&M specialists. "***I like how it's talking about someone who's self-onboarding and then someone who's with an O&M. So it differentiates the two different situations, and then, with the six lessons plus there's all the demos. You know, even the weekly newsletter helps people get up to date.***" Tailored training helps ensure that both professionals and their clients can use the technology effectively and confidently.

Both specialists agree that collaboration is not a one-time effort but an ongoing process. Vickie commends biped's commitment to seeking feedback and refining NOA: "***To me, networking and collaboration is how you succeed. What biped is already doing with NOA, I think, is already above and beyond what most places do. Seeking the information and seeking that feedback...that's only gonna make you bigger and stronger.***"

By building trust, offering structured training, and fostering open collaboration, the gap between innovation and real-world implementation can be

bridged. These efforts empower O&M professionals to better serve their clients while ensuring that tools like NOA reach their full potential.

Conclusion

This chapter examines Vickie Anderson and Pedro Pessoa's perspectives and shows how AI and technology have the ability to significantly improve O&M for those with visual impairments.

While traditional tools like canes and guide dogs remain essential, technological advancements like NOA exemplify how these aids can be enhanced by technology by customizing the experience and making daily activities easier. But for this potential to be fully realized, it's critical that devices are more than just gadgets—they must become practical, reliable tools that support and enhance people's existing O&M skills and primary mobility aids.

To achieve this, collaboration between developers and professionals should be the main focus, alongside thoughtful training programs that give specialists the confidence and knowledge to teach users the ability to benefit from these tools. By fostering partnerships, introducing tools early, and tailoring solutions to individuals, the O&M field can move toward a future where visually impaired individuals enjoy greater independence, confidence, and inclusion in their daily lives.

What Is NOA?

NOA stands for **Navigation, Obstacle and AI.** The device features sophisticated navigation, obstacle avoidance, and scene description capabilities using AI, enabling users to **move safely and independently in various environments.**

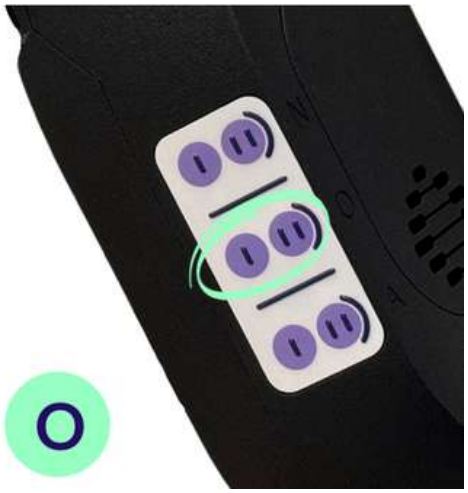
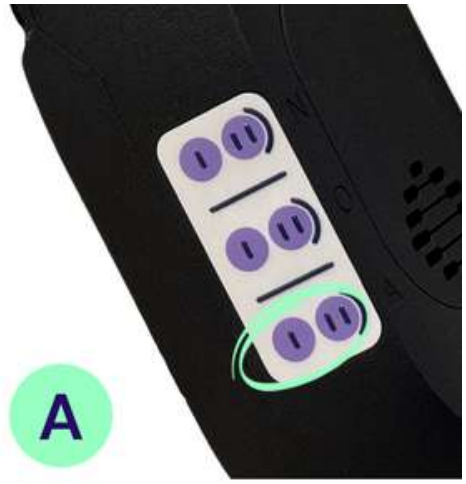
How Does It Work?

NOA is worn on the shoulders and is **composed of a small computer** with buttons on the right, **wide-angle cameras** on the left and **a battery behind the neck**. On the computer side, the **10 buttons** allow you to use the features and interact with the user interface when traveling. The main button on the bottom corner enables users to pause/resume the device (short press) and turn it on/off (long press).

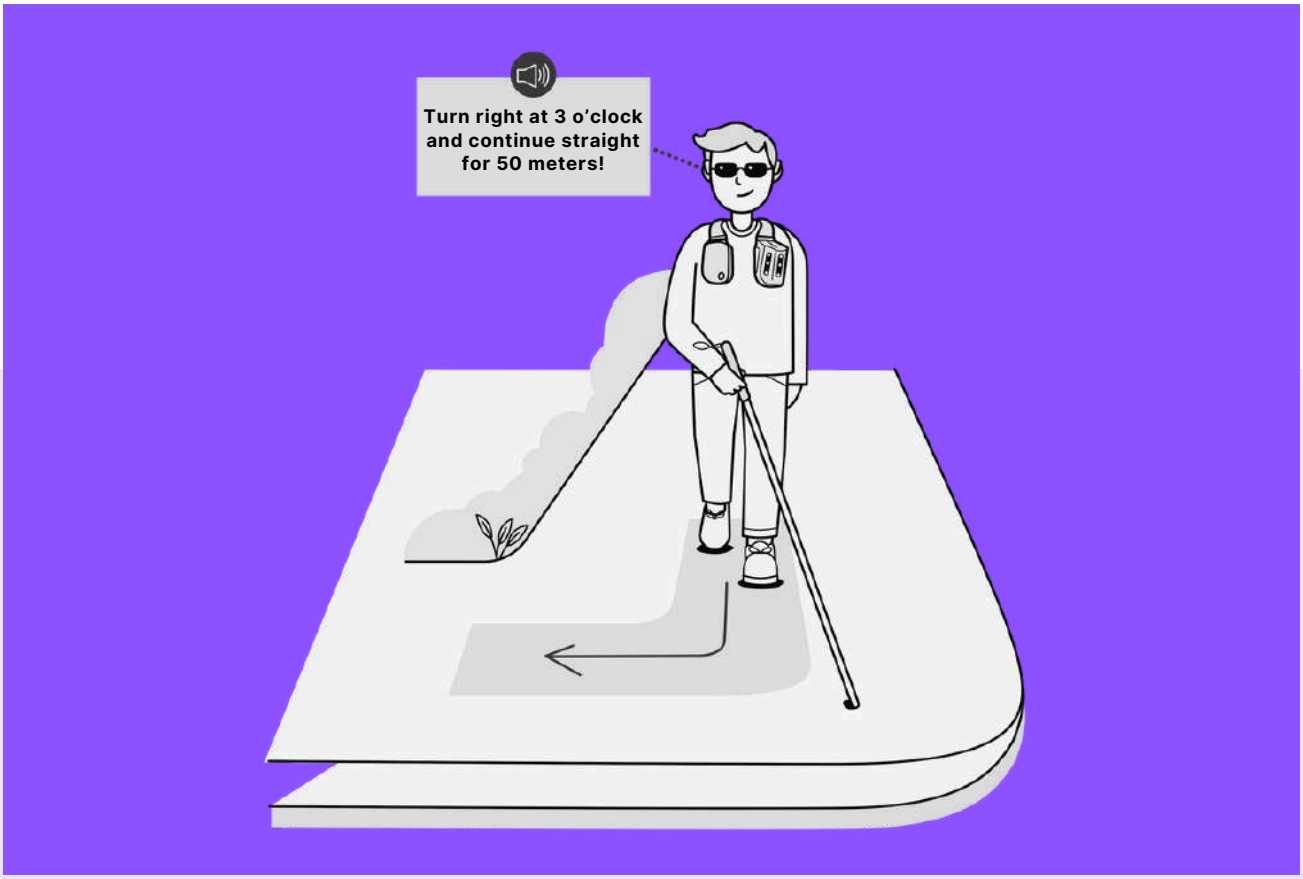
6 buttons on the right outer side compose the Features panel which trigger the navigation, obstacle detection and AI functionalities. **On the left inner side, there are 3 buttons.** The first one at the top, the Select button, allows you to select features from the Features panel. The two other buttons below can be used to skip or repeat instructions.

NOA also comes with a smartphone app, which is used to set up the device and learn how to use it. Most of the features are controlled directly by the buttons on the device so users do not have to worry about taking their smartphone out when traveling.

Buttons Summary

Position	Feature
	**NAVIGATION:** The first upper row consists of Navigation buttons: • **N1 (Left):** Select destination (1 to 10) and **press the select button** to confirm selection to start GPS navigation. • **N2 (Right):** Short press for navigation progress with details on your location and time until arrival. Long press for itinerary description.
	**OBSTACLE:** The middle row consists of Obstacle buttons: • **O1 (Left):** Change range between 1, 1.5, 2, 2.5, 3, and 4 meters. **Press the select button** to confirm selection and set the new range. • **O2 (Right):** Obstacle scanning will scan your surroundings and generate “beeps” for all obstacles around you.
	**SCENE DESCRIPTION WITH AI:** The last row consists of AI buttons: • **A1 (Left):** Find objects (1 to 8) such as doors, exits, crosswalks, or text. **Press the select button** to validate your choice. • **A2 (Right):** Short scene description with quick hints for a brief overview.

Navigation



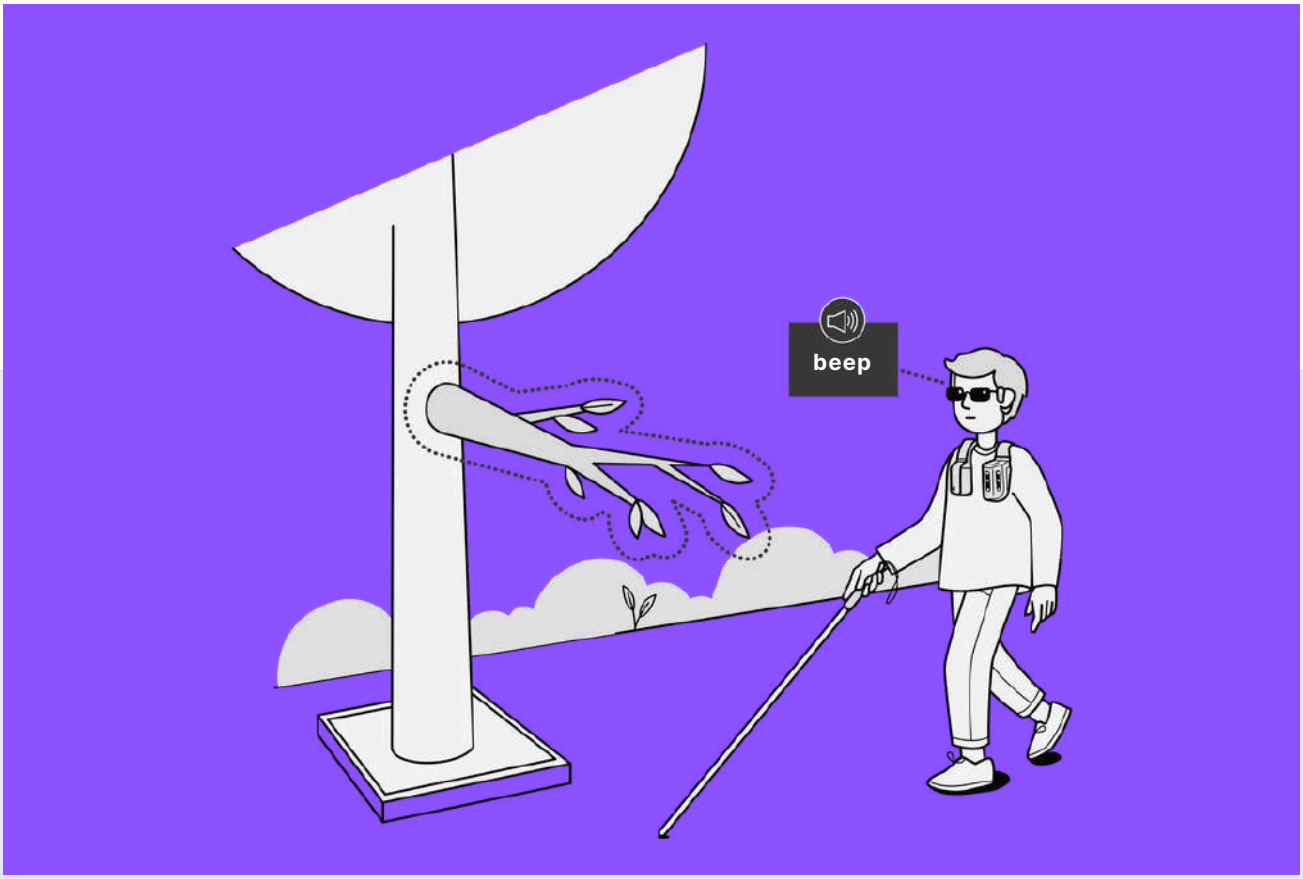
NOA provides turn-by-turn GPS instructions, identifying crosswalks, confirming directions, indicating turns, and rerouting users as needed. These instructions are delivered through bone-conducting headphones, leaving users' ears free to remain aware of their environment. Users can choose their route on the app, and save three destinations which can be directly selected from the buttons on the device.

The navigation features can be directly accessed with the first row of buttons on the Features panel. N1, the button closest to the chest, can be used to select a destination. Ten destinations can be saved from the app during the setup and directly accessed from the device. When a destination is chosen, the user will get turn-by-turn indications to follow the route efficiently. **15 meters before a turn, they will receive a warning : "Upcoming sharp left / left / slight left turn, heading East"**. **5 meters before the turn, NOA will announce "Turn left at 10 o'clock".** Crossings and intersections constitute complex navigation challenges for individuals with visual impairments. They have to be announced explicitly and described if needed to users. Therefore, NOA announces in advance **"Upcoming intersection on your left. Use the AI feature to find a crosswalk"** and shortly before the intersection **"Cross the street on your left."** More details on the AI feature and how NOA can help assist users at intersections can be found below.

The menu buttons, **N1, O1, and A1**, require you to confirm your choice by clicking on the Select button, located at top left of the case. The second button, N2, will give you your navigation progress, including time and distance until arrival (short press) and the itinerary description (long press). A double click on N2 will turn off GPS. Action buttons, such as N2, O2 and A2, do not need any press on the Select button; they directly trigger an action.

The timing and type of instructions given by **NOA have been developed based on O&M research studying the needs of blind and visually impaired individuals for verbal guidance** (Hoogsteen et al., 2022; Gaunet & Briffault, 2005), as well as based on knowledge from the Foundations of Orientation and Mobility (Wiener et al., 2024).

Obstacle Avoidance



NOA continuously scans the user's surroundings, detecting ground and head-level obstacles in real time. Using spatialized 'beeps', it guides users to avoid hazards such as low-hanging branches, electric scooters, or stairways, significantly minimizing the risk of accidents. NOA is equipped with wide-angle cameras, allowing for a 90 degrees vertical and 170 degrees horizontal field of view, as well as a range of view of 30 centimeters to up to 10 meters, by day and by night.

A perceptual interface was preferred with spatialized "beeps" or clicks representing the presence of obstacles. Indeed, spatialized audio is considered as a better solution than speech indications for obstacle detection, reducing the cognitive load for users (Giudice & Long, 2024, p. 27). The sound is of higher pitch for obstacles at head level, or lower pitch if the obstacle is at ground level. The beeps' speed increases when obstacles approaches, conveying information on distance. Furthermore, distinct sounds are used for walls, holes and stairs, and obstacles, to give users a better understanding of what surrounds them. Users can personalize in the settings the lateral detection range (narrow, regular, and wide), as well as the detection zone (full body, upper body, head level) based on their preferences and environment.

The second row of buttons on the Features panel enable the use of the obstacle features. The first button closest to the chest, O1, controls the range of detection. If you click once on O1, it will say "Obstacle detection range: 1 meter". If you click on O1 again, the distance will increase to 1.5, 2, 2.5, 3 or even 4 meters. The range of detection can be modulated directly from the device, so users can quickly tailor the device to different environments. Once the desired range is selected, you then confirm the choice by clicking on the Select button on the left inner side, and you will hear: "Obstacle detection range selected: 4 meters". The second button, O2, is used as a gridline search (Giudice & Long, 2024, p. 42-44). It allows you to spatialize an unfamiliar place by scanning your surroundings and generating beeps for all the obstacles around you, one at the time. Double clicks on O2 turns off/on the obstacle detection as well.

AI Features

NOA offers detailed scene descriptions and object-finding capabilities to assist users in navigating their environment. If a user is stuck, disorientated, or simply wants a description of their surroundings, they can use the buttons on the device to receive a full, precise description delivered directly to the headphones. Additionally, NOA can highlight specific elements such as crosswalks, doors, exits, elevators, stairs, open seats, bus stops and text, providing targeted assistance for various situations, without giving a full description. This list is based on the most recurrent visual elements that are typically hard to find for people and described by O&M specialists.

Scene description and object finding features are enabled with the last row of the Features panel. A1, the first button, selects the object you wish to find. Click once to find pedestrians, twice to find doors and exits, three times to find crosswalks, four times to find stairs and elevators, five times to find free seats, six times to find bus stops, seven times to find reception desks and counters, and eight times to read text. The Select button has to be pressed to confirm the choice. A2 is used to trigger a short AI description of the surroundings, highlighting the key elements on the user's path. NOA will specify what the user is facing (e.g. a road or a sidewalk), describe the ground (e.g. holes, stairs, or uneven ground), and any important point of interest. Alternatively, a double click on the Main button will trigger a longer and more detailed scene description which can be useful in some contexts. The extensive description will describe the landmarks around the user, from close to far, and left to right.

NOA's environmental descriptions are designed to provide users with different layers and types of verbal assistance. The features offered and type of visual landmarks described were designed based on several studies researching the environmental information required by blind and visually impaired individuals (Hoogsteen et al., 2022; Gaunet & Briffault, 2005; Papadopoulos et al., 2020). The object-finding function enables quick and efficient detection and location of elements most commonly searched for. The short description feature supports on-the-go orientation by giving important information about the path users are taking, while the long description is designed to describe all the visual landmarks O&M specialists would typically describe.

Target Audience for NOA

NOA is designed to **support individuals from various demographics** seeking independent navigation with confidence. **The device enhances security** and situational awareness, tailored to meet the unique needs of each group.

Active Adults

Active adults who wish to maintain or enhance their independence in navigating benefit from NOA's support.

NOA can help them explore new places and feel more confident on their usual paths, by giving them reliable guidance to avoid obstacles, find their way and assess their surroundings.

Gustavo is a regular NOA user diagnosed with keratoconus and retinal detachment. He has worked in marketing for most of his life and now enjoys retirement between Lisbon and New York, where he continues to assist companies and foundations.

Passionate about traveling and exploring his cities, **Gustavo uses NOA to navigate parks and visit his favorite stores and coffee shops in Lisbon**, New York, and even traveled to New Zealand with NOA.

"For me, NOA provides the extra independence and security I seek in my active lifestyle."

Older Adults

NOA can also be used by older users, who might not seek an extremely active daily life.

They can for instance decide to use **a simplified version of NOA**, by only activating the obstacle detection feature. Using NOA this way does not require the use of a smartphone or of an internet connection. The experience can be more accessible and straightforward for older users.

NOA can also be used by most people with hearing impairments. Indeed, the device can be connected over bluetooth to cochlear implants and to most modern hearing devices, just like it does with the bone-conducting headphones.

Children

NOA has been tested as a **support for children taller than 130cm in learning safe navigation, fostering confidence in their mobility.**

Through its intuitive audio cues and guidance, NOA assists children in developing essential skills for independent movement, such as **spatial awareness, distance estimation and orientation skills.** The device's simple beeps and spoken instructions are easy for young users to follow, making **it a practical companion for learning safe, confident navigation.**

Individuals with Mental Disabilities

Individuals facing cognitive challenges benefit from NOA's structured guidance and continuous navigation support, which **reduce the cognitive burden and level of decision making** associated with orientation and mobility. NOA simplifies directional choices and highlights obstacles which **promotes a sense of independence in all sorts of situations and environments.**

Individuals with cognitive impairments often learn to travel a familiar path using a series of landmarks as reference points to situate themselves. However, this can sometimes be difficult and unimportant objects may distract individuals from those landmarks making mobility complicated (Bozeman & McCulley, 2024). **NOA allows to separate the navigation task into smaller sections, by giving users turn-by-turn instructions and confirmations to simplify traveling.** Moreover, the verbal prompts from NOA can facilitate the learning and memorization of routes.

Individuals with Low Vision

NOA's features are designed to address the specific challenges faced by individuals with low vision, **enhancing their existing O&M skills by maximizing the effective use of their residual vision.** People with low vision often struggle with light adaptation, detecting changes in terrain, street crossing, and avoiding obstacles. NOA helps by providing real-time support to overcome these issues (Geruschast et al, 2024).

It aids in **adapting to varying light conditions**, even in low-light or dark environments, allowing users to navigate at any time. NOA also **detects changes in terrain**, such as stairs or curbs, and alerts users to potential hazards. Additionally, it enhances safety by **helping with street crossing, alerting users to oncoming traffic, and preventing collisions with obstacles or pedestrians in crowded areas.** Finally, NOA supports **reading signs and text,** making wayfinding easier when traveling.

By addressing these challenges, NOA improves the mobility and independence of individuals with low vision in diverse settings.

Testimonials

NOA has been tested and used by many. See what people are saying about it!

SightCity 2024

SWOMA 2024 - Mobility Trainer

Vista Center San Jose 2024

Explore more testimonials here!

Key Facts

Suitable for

- Anyone who has a visual impairment, from partially sighted to blind people
- White cane and guide dog users
- Users with mental disabilities
- Wheelchair users

Not Suitable for

- Users under 130cm
- People with hearing impairments who do not have Bluetooth hearing aids or implants
- For full use of NOA features, a smartphone is required

Augmenting White Canes & Guide Dogs

NOA is designed to work seamlessly alongside traditional mobility aids, providing additional support **without replacing or interfering with the cane or guide dog.** NOA's aim is to offer information that the user's main tool does not provide. For instance, it can guide the user, detect and communicate undetected hazards, such as overhead or side obstacles, or provide valuable insights into the environment thanks to its AI features.

NOA was designed to be a hands-free device. This is particularly important for white cane and guide dog users, who have one hand unavailable at all times. The smartphone rarely has to be used after being set up and the buttons on the device are easily reachable with one hand. Indeed, **the Features panel can be handled intuitively with three fingers and the Interaction panel with the thumb.**

The device in itself is designed to be ergonomic and modulable for any user. It is light (about 1kg) and the straps of NOA can be bent to match the shape of the torso and shoulders, as well as the clothes worn. NOA comes with a bag which can hold the device, a spare battery and the headphones when not using it.

During the initial setup, **users specify whether they will use NOA with a cane, a guide dog, or no mobility aid.** This enables the system to differentiate between the mobility aid and obstacles, thus preventing unnecessary alerts while users are on the move. Moreover, NOA's features work slightly differently based on which tool is used. Guide dog owners can use the object finding feature to find grass patches for their dog, and, if their dog stops unexpectedly, the short description feature will also attempt to explain the reason. Moreover, **users can easily change the obstacle detection range (full body, upper body, head level) based on their preferences**. This is helpful for many users, as they may not want to get warnings for obstacles that their dog or cane already detect.

Intended Use

NOA empowers users to travel from one point to another while applying their O&M skills and using their primary mobility aid. NOA's adaptability makes it suitable for various environments, enabling users to navigate confidently on various travels. Let's follow Sofia, a regular NOA user, as she navigates her way to a doctor's appointment.

Sofia begins her journey by preparing NOA for the trip. She inserts the battery, places the device on her shoulder, and selects her destination. She can do this either by pressing the N1 button directly on the device if her destination has been saved, or by opening the NOA Companion App on her phone to quickly enter the destination. Once set, Sofia tucks her phone into her pocket, grabs her white cane, and leaves her house.

NOA uses its built-in compass to determine Sofia's orientation and provide precise, step-by-step instructions. Without needing to take out her phone, Sofia receives clear, spoken directions, including the angle and direction of each turn. This allows her to focus on her environment and O&M skills while NOA ensures she stays on track.

As she approaches her first turn, 15 meters before it, NOA announces, "Upcoming sharp left turn, heading East." 5 meters before the turn, NOA provides more specific guidance, "Turn left at 9 o'clock." After completing the turn, Sofia hears a simple confirmation: "Keep going."

After a few meters, she hears a lower-pitch sound slightly to her left. There is a trashcan on the sidewalk, but Sofia is informed of the potential obstacle and moves easily around it by rotating her shoulders and confirming that the path is free. After successfully navigating this obstacle, Sofia continues her path without any further issues.

15 meters before her next turn, NOA warns, "Upcoming left turn, heading North." 5 meters before the turn, Sofia is told, "Turn left at 9 o'clock." After the turn, NOA reassures her again with "Keep going." Sofia receives similar instructions at her next right turn.

Now Sofia approaches the intersection. As she nears it, NOA announces, "Upcoming intersection slightly to your left. Use the AI feature to find a crosswalk." Shortly before the intersection, NOA adds, "Cross the street on your left."

Sofia turns to her left and presses the A1 button until she finds the "crosswalk" feature in the AI menu. NOA then specifies the intersection category: "There is a crosswalk straight ahead, crossing a 4-legged intersection with two lanes in each direction. The crosswalk has a length of 10 meters. There is a central island in the middle of the road."

NOA also informs Sofia about the presence of a pushbutton: "There is a push button to your slight right at about 2 meters." It continues to describe the other side of the crossing: "On the other side of the street, there is a subway station." With this detailed information, Sofia can confidently cross the street, knowing exactly what to expect at the intersection.

At the subway station, she hears a new sound with reverb, coming from from the ground on her left – NOA's way of indicating the nearby tracks – prompting her to move slightly to the right while waiting for her train. Sofia is warned by NOA that her subway is arriving. Once in the subway, Sofia puts NOA's obstacle detection feature on pause with a double click on the O2 button. She then presses the A1 button until she finds the "free seat" feature in the AI menu which guides her to a seat in the subway.

Upon exiting the subway, Sofia reactivates NOA's obstacle detection feature by double-clicking on the O2 button. She then presses on the A2 button to get a better understanding of her position on the platform. After a few seconds, NOA describes her surroundings. "You are on a train platform. There are stairs going down slightly to your left at about 3 meters with a sign "Exit" above." Sofia listens carefully and follows the path to the stairs. She then hears the same sound with reverb she heard earlier, indicating that the stairs are just in front of her. Sofia goes down the stairs and exits the station.

Once Sofia has exited the station, NOA's navigation feature instructs her to continue straight. Sofia is unsure of where she is, so she presses on the A2 button again to get a description of the path she is on. "You are facing an open space with a sidewalk about 15 meters ahead. The ground in front of you is flat. There is a group of people slightly to your right."

Sofia changes the detection range to 3 meters using the O1 button and crosses the station square. Before reaching the sidewalk, Sofia hears a high-pitch sound, warning her of a low-hanging branch ahead. She rotates her shoulders to find a path which is free and avoids the obstacle.

Once back on the street, Sofia presses the O1 button to set the obstacle detection range back to 1.5 meters, for a better experience on the more crowded street. She then takes a left turn following NOA's instructions and reaches her destination, the medical office building. "Your destination is on your right."

Sofia activates NOA's door-finding feature by pressing twice on the A1 button to locate the entrance quickly. "There is a closed door slightly to your right, at about 2 meters. On the door, it says "Medical Center.""

Once inside, she deactivates the obstacle detection with a double-click on the O2 button, and uses the seat-finding feature in the AI menu which guides her directly to a chair in the waiting area.

With NOA, Sofia completes her journey seamlessly, confidently navigating various environments using her O&M skills, her cane, and the enhanced guidance from NOA. This powerful combination ensures Sofia's independence throughout her travels.

Key Facts

NOA Features

- Navigation instructions with routes saved directly on the device
- Obstacle detection at all levels, including hole and stairs detection
- Obstacle detection without internet connection
- AI features to describe the user's surroundings and find typical landmarks
- Detailed intersection and street crossing description
- Works by day and by night

Limitations

- Navigation not available for indoor settings
- No curb detection
- Navigation requires internet connection
- AI features not suitable for small objects
- No traffic light color detection

Evaluating NOA's Impact

Understanding how NOA performs in real-world contexts is crucial for refining the device to better serve its users. This chapter presents **feedback from both O&M specialists and regular NOA users**, providing valuable insights into NOA's practical utility, perceived benefits, and areas for improvement.

O&M Specialists

Insights from eight O&M specialists was collected via an online survey. The survey was administered to professionals who had already tested the device. The survey gathered insights into NOA's advantages, limitations, and potential user profiles.

The respondents worked in diverse professional settings, including educational and rehabilitation organizations, private counseling, and other institutions around the world.

Appreciated Features

When asked about the features they appreciated most, **five out of the eight respondents highlighted NOA's AI-powered scene description functionality**, while one emphasized the **obstacle detection feature**.

Another specialist praised the device's **ability to promote independence**, and one cited additional strengths such as **potential wheelchair compatibility, the notification system, lightweight design, versatility in usage, and room-scanning functionality**.

Two respondents valued NOA's **all-in-one design**, which provides multiple functions for the user, is easy to handle, and represents a significant advancement over traditional sonar-only devices.

Noted Drawbacks

On the other hand, when asked what they liked least about NOA, **two respondents reported having no negative feedback**.

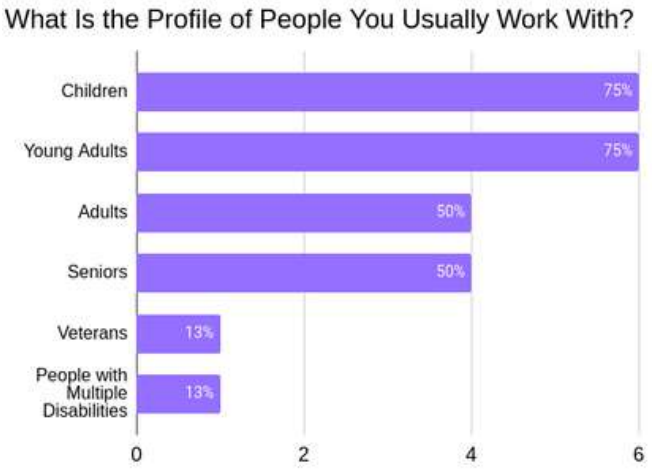
The other specialists noted limitations, including the **device's price, its ineffectiveness in areas with poor internet connectivity, its bulkiness, and its lack of usability for deaf-blind individuals.**

Two respondents emphasized that the device is still in a prototype stage and expressed anticipation for future improvements and additional features.

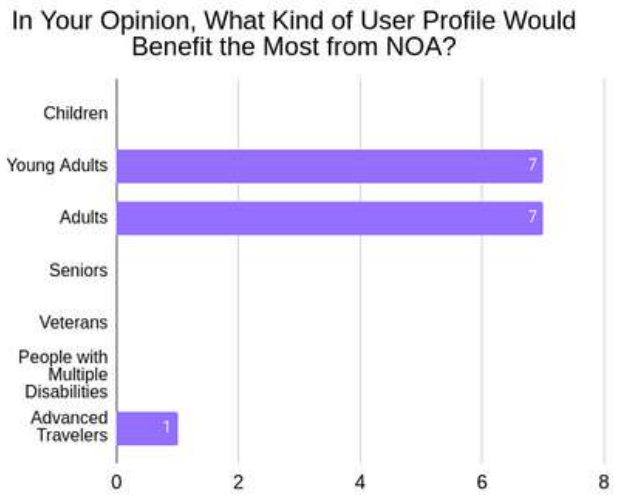
User Profiles

Regarding the profiles the specialists worked with, **75% of the specialists reported working with children, 75% with young adults, 50% with adults, 50% with seniors, one with veterans, and one with individuals with multiple disabilities**.

All specialists believed that NOA could benefit some of their trainees. Specific mentions included high-performance advanced travelers and high-school-aged students, though one respondent noted that the device's price could pose a barrier.



Young adults and adults were considered the best fit for NOA, with 88% of respondents selecting these groups as the most likely to benefit from the device. One specialist specifically identified advanced travelers as a key profile



Finally, **five of the eight specialists expressed interest in an ACVREP-certified training program** for teaching NOA, and all respondents requested updates about the device.

NOA users

Insights from four regular NOA users were gathered through semi-structured interviews conducted via phone or video calls.

The interviews combined **quantitative and qualitative approaches.** Participants rated their experiences on a 1-5 scale, with 1 being "Strongly Disagree" and 5 "Strongly Agree." Open-ended questions were included as well to provide opportunities for participants to elaborate on their experiences.

Training and Ease of Use

Participants rated the **ease of learning to use NOA with an average score of 4 out of 5**. While most found the learning process straightforward, Participant 1 noted that individuals unfamiliar with technology might face additional challenges. Participant 2 mentioned occasional difficulties due to internet connectivity, which impacted their initial experience.

All participants used the **training available in the NOA Companion App and the user manual** to learn how to operate the device. On average, the training phase lasted a few hours. When asked if they quickly became **comfortable using NOA** as part of their daily routine, participants gave an average score of **3.75 out of 5**.

Participant 1 and Participant 3 emphasized that, similarly to any new mobility tool, it took them several weeks to fully integrate NOA into their daily routines and become comfortable with its functionality.

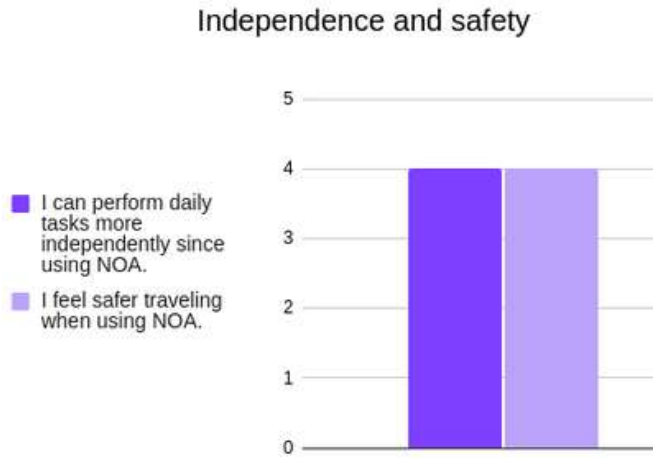
The **comfort of using and wearing the device received an average score of 3.125 out of 5**. Participant 2 and Participant 3 noted that the device's size and the back casing could sometimes feel cumbersome. In contrast, Participant 4 mentioned that while the device was not inherently uncomfortable, it required some time to get used to.

The **usability and intuitiveness of the NOA app were rated highly, with an average score of 4.125 out of 5.** Participants universally praised its accessibility, with no issues raised.

Independence and Safety

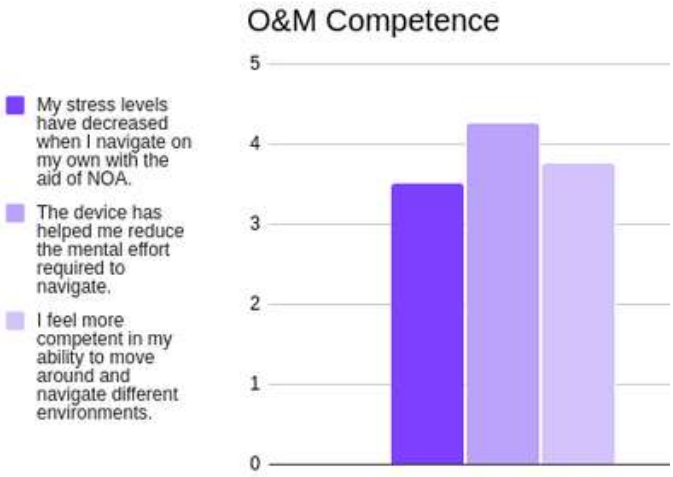
Participants reported a **strong sense of increased independence when using NOA, with an average score of 4 out of 5.** Participant 1 expressed a desire for greater independence, highlighting how **NOA enables him to explore new places confidently.**

Regarding safety, participants unanimously agreed that using **NOA made them feel safer while traveling, with an average score of 4 out of 5**. This was consistent across all participants.



O&M Competence

Participants reported a **decrease in stress levels when navigating independently with NOA, with an average rating of 3.5 out of 5**. Most participants found that using **NOA reduced the mental effort required to navigate, giving an average score of 4.25 out of 5.** Moreover, participants reported an **increase in O&M competence with an average score of 3.75 out of 5.**



When asked about **using NOA for crossing streets and intersections**, Participant 1, although he uses NOA in this context, continues to use traditional signals and remains cautious due to traffic concerns. Participant 2 noted using NOA but found it not always as effective as desired. Conversely, Participant 4 found it **extremely helpful and appreciated the intersection AI descriptions provided**, which aided in locating the push button when his guide dog could not.

Participants provided insights into their use of NOA in various outdoor environments. Participant 1 mainly uses NOA for **residential areas and local parks, appreciating its utility for exploring different paths and discovering new places**. Participant 2 uses it in **residential areas** with the navigation feature, while Participant 3 navigates **both rural and residential areas**. Participant 4 uses NOA **for specific routes, such as commuting to work**, and, due to current weather conditions, has not yet explored open areas like parks or the countryside.

For **indoor navigation**, Participants 1 and 2 found the **AI scene descriptions and object- or text-finding features particularly useful**. Participants 3 and 4 had not yet had the opportunity to use NOA in indoor spaces.

Discussion

These results highlight the positive impact of NOA on users' independence and mobility, particularly among adults, though there is potential to expand its accessibility to children and seniors. Recent updates, including a **smartphone-free version**, aim to address these gaps.

Most users found the device easy to learn and integrate into their routines, though challenges with technology familiarity and connectivity were noted. Biped has since improved these areas and developed professional training programs to support onboarding.

Users reported increased independence and safety, with NOA effectively **aiding obstacle detection and reducing mental effort** during navigation.

While feedback indicated that auditory outputs were generally adequate, some noted issues with

sound clarity, prompting refinements.

The device proved **versatile in both outdoor and indoor environments**, with features like AI-assisted navigation and object-finding receiving praise.

However, to guarantee that NOA continues evolving in line with the needs of users and O&M specialists, **constant improvements and cooperation with professionals and users remain necessary**.

For additional details on this impact study, including supporting scientific evidence and further resources, scan the QR code below or visit https://biped.ai/orientation-mobility#science.

Training with NOA

This chapter aims to present the training resources to learn how to use NOA. Users are able to self-onboard using the instructions and exercises presented in the user manual. It aims to give users the necessary information and experience to be able to use NOA in their daily life. However, we recommend our users to book training sessions with an O&M specialist for an assisted training. Below you will find an overview of the training resources found in the user manual, as well as three detailed lesson plans for O&M specialists to teach the use of NOA – for white cane users, guide dog owners, and for individuals transitioning from the cane to a guide dog.

Self-Onboarding

Our self-onboarding program found in the user manual is structured to be intuitive and accessible to new users. **The training at home can be done alone or with a caregiver or friend.** It offers a gradual exposure to the device's functionalities with practical lessons. Caregivers may use the **Companion Mode** found on the smartphone app provided with NOA to get a better understanding of the instructions and cues provided by the device (more details below).

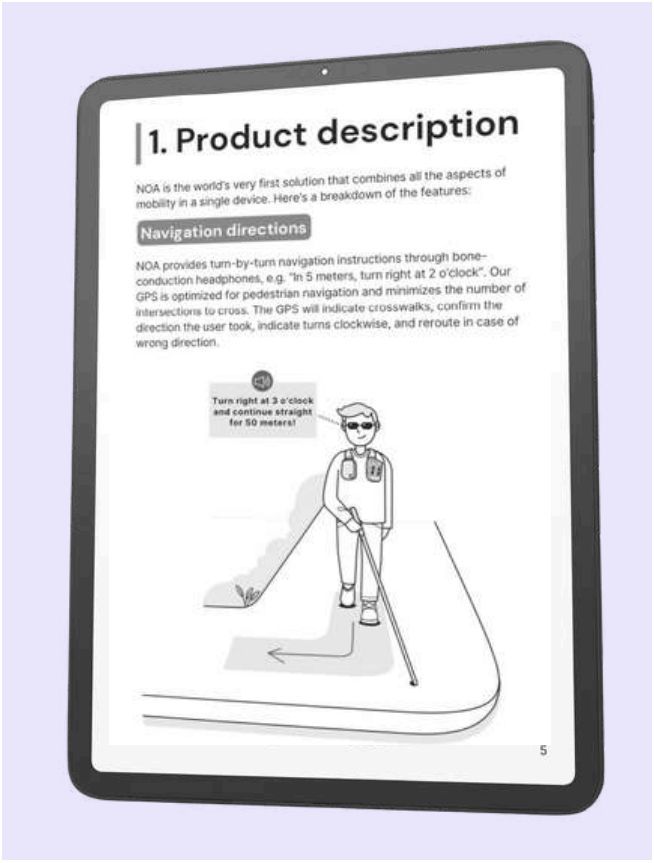
The training begins with an introduction to the device, its functionalities, and buttons, as well as the NOA Companion App. Detailed instructions help the user set up their device and app based on their mobility aid, profile, and preferences.

Users are then invited to discover the obstacle detection feature through static exercises to help them learn how to use the buttons, recognize the auditory cues, judge distances, and develop confidence with the feature. This approach progresses into interactive exercises where users can practice finding objects at different heights, move around and use the scene description features. Finally, users work through advanced exercises that introduce GPS navigation and hole detection.

The user manual training is complemented by a short training on the smartphone app, in the form of small quizzes to help users test and reinforce their understanding of the device.

The self-onboarding is estimated to last about 90 minutes based on our users feedback. On average, an additional 8 to 12 hours of use is expected for users to be able to exploit the full potential of NOA.

To access the manual, please refer to the QR code or find it directly on our website https://biped.ai/en/user-manual



O&M Training Plan

Users are recommended to book a training course with an O&M specialist when onboarding with NOA. The team at biped robotics has created three comprehensive training templates which can be used by O&M specialists to teach the use of the device in a detailed yet easy manner. This plan is **inspired by the valuable expertise found in the Foundations of Orientation and Mobility** (Lahav & Siegel, 2024; Penrod et al., 2024, pp. 559-576). The three templates are tailored to white cane users, guide dog owners, and to people transitioning from the cane to a guide dog who might benefit from NOA for this transition period. While the courses were designed specifically for NOA, they can also be valuable for the learning of other ETAs.

The training plan are separated into six lessons which are intended to gradually equip the learner with the necessary skills to use NOA effectively. **Practical exercises are designed to be done alongside the learner's primary mobility aid, as NOA was designed as a complement to the white cane and the guide dog.** We therefore believe the training should be done in conjunction with the learner's primary mobility aid to ensure seamless integration.

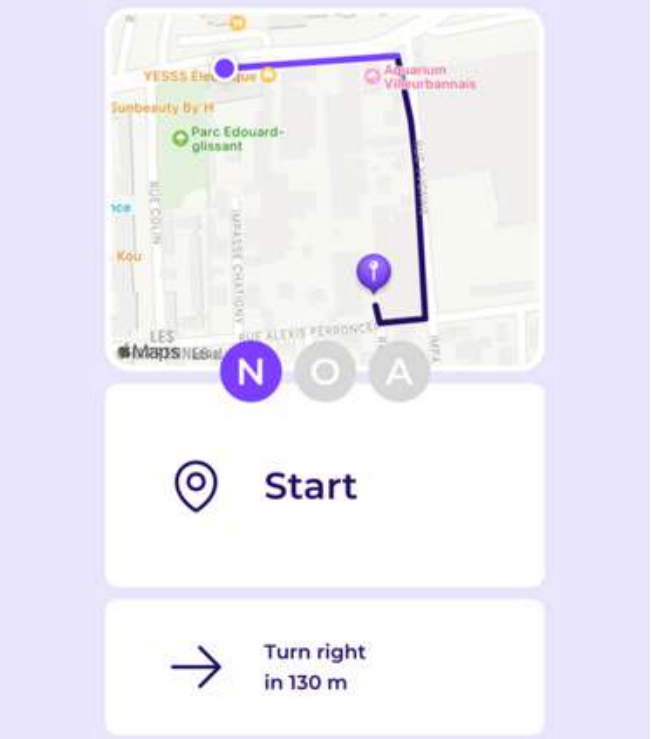
For indoor exercises, a large calm and mostly empty room should be preferred to minimize distractions, such as background noise or involuntary obstacle detection. While this training plan serves as a detailed template for NOA, O&M specialists are encouraged to adapt it based on the needs of their learners, the training location, and the specific device used.

Companion Mode

The NOA Companion App is designed to support the role of O&M specialists by providing a "Companion Mode".

The Companion Mode displays real-time visual feedback, allowing O&M specialists to monitor the learner's surroundings and the instructions they receive.

For the **Navigation feature**, a map with the itinerary is displayed as well as the instructions received by the learner.



For the **Obstacle Detection feature**, a map showing all the obstacles in the learner's surroundings is displayed, with the obstacle notified to the user highlighted in red and a short description of the object's location written below.

For the **AI features**, the app displays the descriptive text provided by the device.

Training with a White Cane

The first training plan is tailored for white cane users who wish to learn how to use NOA as a complement to their cane. Practical exercises should be done with the cane.

Prerequisite Lesson

The first lesson is recommended to be done **at home**, either independently by the user or with the help of a caregiver. The objective is to **familiarize learners with NOA's purpose and features before beginning practical training**.

This lesson involves following the first part of the user manual provided with NOA, excluding the training exercises at the end of the document.

The device's characteristics and functions, security instructions, and limitations are clearly explained to allow for a good understanding of NOA.

While the learner will have opportunities to revisit the device during subsequent lessons, it is important that they become familiar with its features by the end of the prerequisite lesson. They should have a clear understanding of the location of the buttons, the battery compartment, and the use of the NOA Companion App.

Lesson 1

Lesson 1 aims to teach the learner **how to set up the device**. Furthermore, learners will become comfortable with the **obstacle detection feature and sound spatialization.** This lesson is separated into four different exercises.

1) Setting Up the Device and App

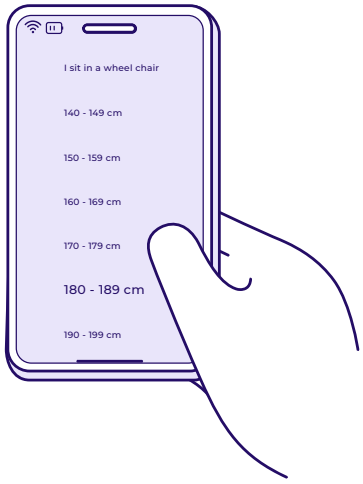
The first exercise aims to teach learners how to turn on, set up, and wear the device. The O&M specialist will first remind the user of the device's functions and buttons, and answer any questions the user may have.

The learner will then learn how to insert the battery, turn on the device, wear it on their shoulders, and locate the buttons on the right side of the device.

The O&M specialist will continue by teaching the learner how to change the settings in the NOA Companion App. The settings allow the user to tailor NOA to their preferences and use (e.g. primary mobility aid used, height, condition, sound volume, playback speed, unit system, etc.). They can be changed at any time.

The user must be able to turn the device on and off independently, insert and remove the battery and charge it. Furthermore, they need to be able to

change the settings in the smartphone app, connect the device to a Wi-Fi connection and to the headphones, as well as demonstrate a good understanding of the placement and use of the buttons on the device before starting with practical exercises.

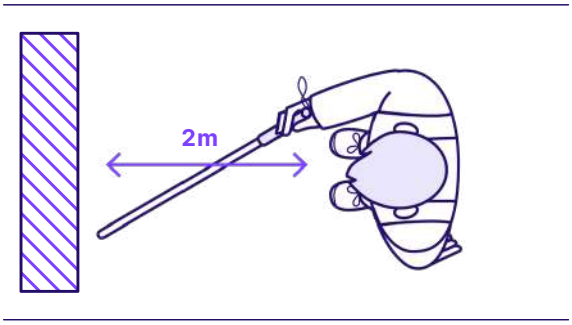


In the following exercises, the learner should be able to change the settings (e.g., pause object detection, change detection range) with minimal assistance.

2) Developing Awareness of Detection Ranges

The second exercise teaches the learner to develop awareness of distances using NOA and how to manipulate the obstacle detection feature.

The learner will wear the device and turn it on. The O&M specialist will then place the learner facing a wall at about 2 meters. The learner will be asked to set the detection range to 1.5 meters and walk towards the wall until contact with the cane tip is made. They will then turn off the obstacle detection mode by double-clicking the O2 button.



This exercise will be repeated with the different detection ranges and different initial distances, all outside the range selected. The exercise will be repeated until the user is able to distinguish the detection ranges and relate frequency to distance, as well as turn on and off the obstacle detection feature easily.

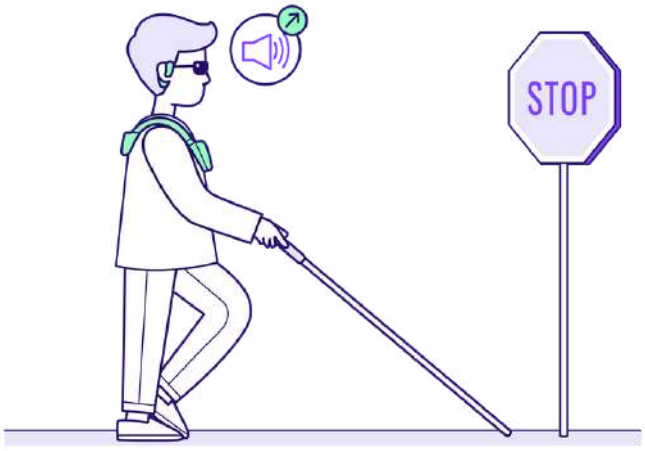
3) Developing Awareness of Vertical Spatialization

The third exercise aims at mastering the notion of vertical spatialization by detecting overhanging and ground-level obstacles.

The O&M specialist will teach the learner that vertical positioning is conveyed through a pitch gradient. Obstacles at ground-level have a low-pitch sound, while head-level obstacles have a higher pitch. The obstacle detection range can be fully customized in the settings depending on the user's preferences (full body, upper body, or head level).

To practice this concept, the O&M specialist will hold an object (e.g., a magazine opened and placed across a cane and held horizontally) at various heights and at various distances from the learner. The learner will then walk forward towards the obstacle, using NOA at the 1.5 meters detection range. They should be encouraged to use the upper-hand and forearm technique for overhanging obstacles, and make contact with the obstacle at first, either with their body or the white cane, and then move around it.

The exercise is repeated until the learner is capable of detecting the obstacle, stopping, determining its height, and moving around or under it without contact.

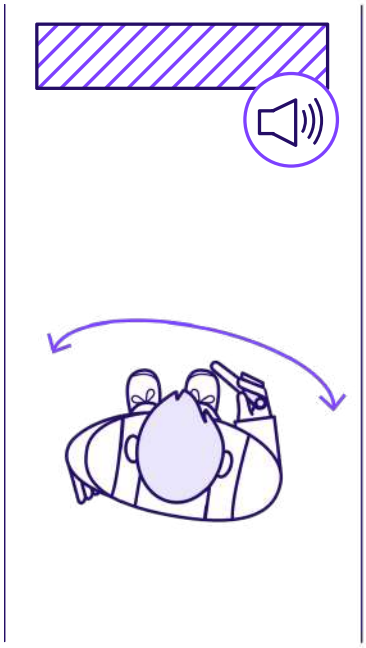


4) Developing Awareness of Horizontal Spatialization

The last exercise aims at teaching how to spatialize obstacles horizontally by learning to align perpendicularly to a wall using the device's sound spatialization.

The O&M specialist will place the learner at an angle and at 2 meters from the wall. The 3 meters range will be selected. The learner will scan side to side with their shoulders until the sound is located in front of them. The exercise will be repeated with different angles and distances, within the detection range.

The exercise will be completed once the learner is able to judge correctly when the sound is in front of them by rotating their shoulders.



Lesson 2

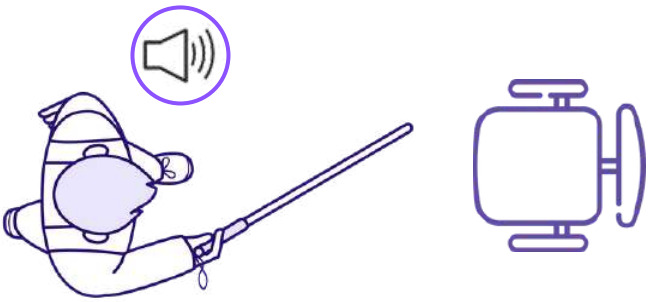
The second lesson aims to **further develop object spatialization and using different features of NOA** through three different exercises.

1) Detecting and Finding Visual Landmarks

The next exercise aims at detecting and finding visual landmarks.

Various objects should be placed around the room (e.g. chairs, tables or poles). The learner will scan the area using NOA with the 1.5 meters detection range, point to each object they find, approach the object, and make contact. The O&M specialist will return the learner to the center of the room and ask them to locate the farthest and nearest of two objects in the room.

The exercise is repeated until the learner demonstrates the ability to determine distances and directions to objects using NOA.



2) Gridline Exploration

The next exercise aims at teaching the learner to use the gridline obstacle detection feature of NOA.

The O&M specialist will place familiar objects (e.g., those used in the previous exercise but arranged differently). The learner will then first have to explore the room using a gridline exploration strategy. Once this is completed, they will use the obstacle scanning feature of NOA, using the button O2, to receive a spatial representation of the room.

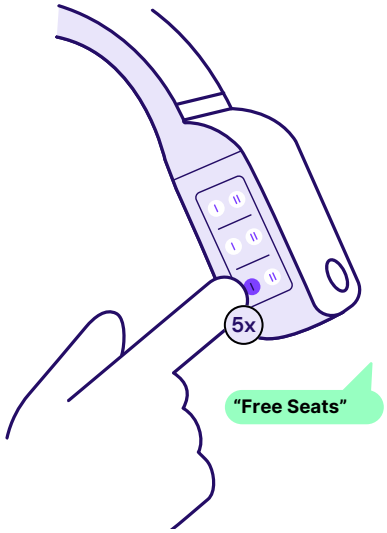
The exercise is repeated with different object placements until the learner is capable of representing the visual landmarks in their surroundings with the auditory cues of NOA.

3) Scene Description

The learner will learn how to use the scene description features of NOA to find objects. The O&M specialist will place familiar objects (e.g., those used in the previous exercises but arranged differently) and text displays in the room. The learner will use the long scene description to get an understanding of the room's configuration. They will be instructed to explain what the device told

them and approach one of the objects. Using the object-finding feature, the learner will locate an open seat and read the displayed text.

The exercise will be repeated until the O&M specialist is confident the learner is able to use the features comfortably and adequately.



Lesson 3

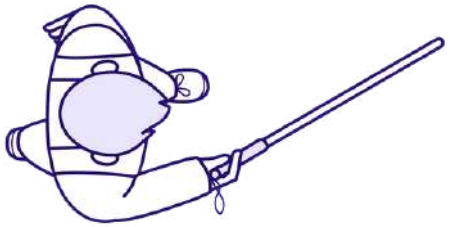
The third lesson consists of three exercises and allows the learner to **master trailing walls, differentiate between wall and obstacle detection, and finding doorways and stairs** with the aid of NOA.

1) Trailing Walls

This exercise teaches the learner to walk along a hallway without making contact with the walls.

The learner will be placed in a wide hallway, using the 1.5 meters detection range, and asked to trail the wall without making contact with obstacles or the walls with their cane or body. A few small obstacles should be placed along the hallway to allow users to differentiate between the buzzing sound signaling the presence of walls, and the "beeps" used for obstacles, and learn to move around an obstacle on their path.

The task will be completed when the learner can easily walk straight and avoid contact with obstacles and the walls of the hallway.



2) Detecting Doorways and Intersections

In this exercise, the learner will detect doorways and intersections in a hallway using NOA.

The learner will be asked to parallel a wall in a quiet wide hallway, using the 1.5 meters detection range, and verbally indicate any open doors or intersections detected with NOA. The O&M specialist should encourage the learner to use NOA by turning their shoulders side to side to detect these openings. Once detected, the O&M specialist will ask the learner to use the doors & exits object-finding feature in the AI menu to get confirmation and locate the visual landmark.

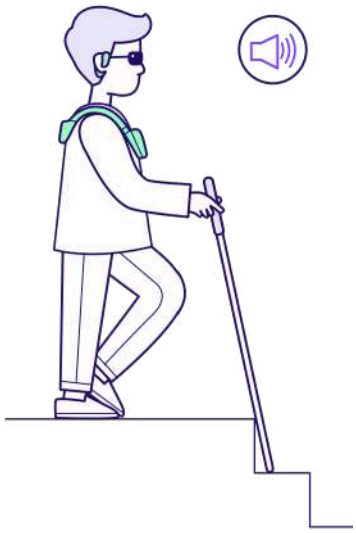
The exercise should be repeated until the learner masters the skill.

3) Identifying Stairs

Lastly, the learner will learn how to use NOA's hole detection feature by identifying stairs.

The O&M specialist will place the learner facing descending stairs at varying distances with the 2 meters detection range. The staircase should have at least three steps but not be too long. The learner should be asked to walk slowly forward until they identify the stairs by listening for the low-pitch sound signaling a drop in front of them. They should then stop, signal it verbally to the instructor, find the railing, and walk down the stairs. The learner should be asked to indicate verbally the end of the steps detected by NOA. The O&M specialist should make the learner aware that the hole detection only works for holes larger than 40cm and therefore does not detect sidewalk curbs for example.

This exercise should be repeated until the learner confidently identifies staircases and their endpoints using NOA.



During subsequent sessions, the learner will be introduced to using NOA in outdoor environments. It is essential that the indoor lessons are thoroughly mastered before progressing to Lesson 4. Outdoor settings present additional challenges and distractions, making it critical for the learner to be fully familiar with NOA's functionalities. They must also be able to recognize and interpret its auditory cues with confidence.

Lesson 4

During lesson 4, the learner will **practice obstacle avoidance and trailing with NOA along an outside wall.** These exercises are similar to those in Lesson 3, but take place in an outdoor setting.

1) Outdoor Wall Trailing in a Calm Area

In the first exercise, the learner will trail a building wall, fence, or hedge and verbally indicate gaps or open areas detected using NOA (e.g. alleys, open spaces, driveways). The learner can change the detection range, lateral detection range, and detection zone in the settings and on the device directly, depending on their preferences and environment.

This task should be performed on a sidewalk in a quiet area with minimal obstacles or pedestrians. The learner should be reminded to use their primary aid as usual, but avoid making contact with the wall.

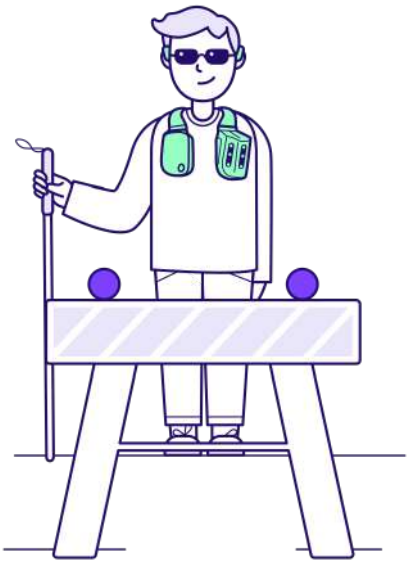
The exercise should continue until the learner demonstrates competence and comfort with the skill.

2) Navigating a Blocked Path

Once the learner is comfortable walking in a calm outdoor area, the O&M specialist will take them on a blocked path. This could be a sidewalk with construction work or a dead end.

The learner will hear the obstacle detection warning in front of them but will normally not find a solution to continue along the path. The O&M specialist should then introduce the short description feature, using the button A2, and instruct them to use it to get a description of their path and of the obstruction in front of them.

This short exercise will demonstrate to the learner how the feature can help them in certain situations.



3) Outdoor Wall Trailing in a Busy Area

To conclude the lesson, the first exercise should be repeated in a slightly busier area.

The learner should continue verbally indicating any gaps encountered when trailing the wall, while also avoiding any obstacle on the path. At one point during the navigation, the learner should be encouraged to compare the short and long scene description features to understand their respective uses. This will help the learner determine the most appropriate AI feature for different navigation scenarios.

The exercise should be repeated until the learner achieves mastery and confidence.

Lesson 5

The objective of this lesson is to **teach the learner to set up and use the Navigation functionality from NOA.**

In this training plan, it is assumed that the learner has **minimal knowledge of how GPS systems work and that they can be used to be guided to various points of interests.** If this is not the case, the O&M specialist must present the learner with sufficient knowledge to comprehend the utility of the Navigation feature.

1) Setting Up the Navigation Feature

The first part of the lesson will focus on mastering the Navigation and GPS functionality on the device and in the app.

The O&M specialist will remind the learner of the type of navigation instructions provided by NOA and how to use the feature with the NOA Companion App and buttons on the device.

The learner will learn how to navigate the app page, save and edit their five favorite destinations, enter a new destination, as well as turn on and off a route. Moreover, they will learn how to select a destination and access information about their position using the buttons on the device. The O&M specialist must remind the learner that GPS-based navigation systems are never fully reliable and furthermore they require internet connection. Therefore, it is important that the learner never entirely rely on their device and continue using their mobility tools and techniques alongside NOA.

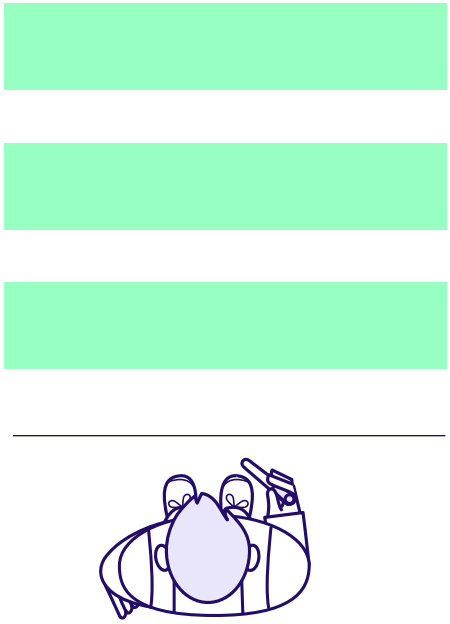
The exercise is mastered when the learner is comfortable describing and using the Navigation features on their own. They understand the assistance provided by the functionality, how it can be used with the other functionalities, but also the limitations of current GPS technologies.

2) Navigation with the Device

Once the learner is capable of setting up and understanding the navigation instructions, they will test them outdoors.

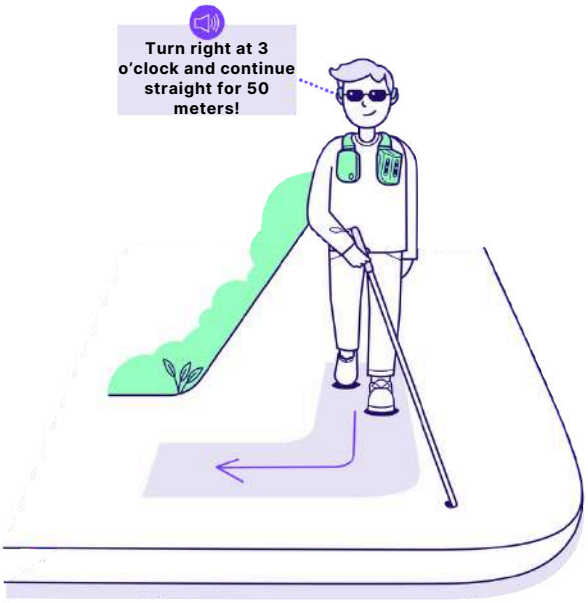
The O&M specialist will set up a short route in a quiet area. The itinerary should ideally contain an intersection with light traffic and a few turns. The learner will be asked to follow the instructions to the location.

At the intersection, the learner should be instructed to use the object-finding feature to get details about the intersection before crossing.



During the travel, the learner will be able to ask for any assistance from the O&M specialist, but should be encouraged to use NOA as much as possible.

Upon arrival at the final location, the learner should find the final objective (e.g., a building entrance, a bench) using their own O&M skills, but can also try using the various AI features from the device to locate the visual landmark. The exercise will be repeated for the return route.



At the end of the exercise, the learner should be comfortable with listening and following the navigation instructions on a calm route, in combination with the obstacle detection, and AI features when required.

Lesson 6

To finalize the training plan, the learner will **demonstrate their skills using the device by using it for one of their familiar routes.**

1) NOA on a Known Route

In this last exercise, the O&M specialist will accompany the learner on one of their typical trips (e.g., work, grocery shopping, school) using NOA.

The learner will prepare and set up the device, and start the navigation session independently. During the trip, they should demonstrate confidence in using NOA alongside their primary mobility aid, effectively interpreting auditory cues, and appropriately utilizing the different features.

The exercise will be complete when the O&M specialist is confident that the learner can navigate in their daily life independently, using NOA as a complement to their mobility aid.

A summary of the lessons and an evaluation sheet, designed as tools for the O&M specialist during training sessions, can be provided upon request. These resources include: A summary of the training plan for quick reference, and an evaluation sheet for assessing the learner's mastery of the device during Lesson 6.

For convenient access to these materials, scan the QR code below or visit https://biped.ai/orientation-mobility#training.

Training with a Guide Dog

The first training plan is tailored for guide dog owners who wish to learn how to use NOA as a complement to their dog. Practical exercises should be done with the guide dog. The template is similar to the white cane training, with certain adjustments and additional features useful for guide dog owners.

Prerequisite Lesson

The first lesson is recommended to be done **at home**, either independently by the user or with the help of a caregiver. The objective is to **familiarize learners with NOA's purpose and features before beginning practical training**.

This lesson involves following the first part of the user manual provided with NOA, excluding the training exercises at the end of the document.

The device's characteristics and functions, security instructions, and limitations are clearly explained to allow for a good understanding of NOA.

While the learner will have opportunities to revisit the device during subsequent lessons, it is important that they become familiar with its features by the end of the prerequisite lesson. They should have a clear understanding of the location of the buttons, the battery compartment, and the use of the NOA Companion App.

Lesson 1

Lesson 1 aims to teach the learner **how to set up the device**. Furthermore, learners will become comfortable with the **obstacle detection feature and sound spatialization**. This lesson is separated into four different exercises.

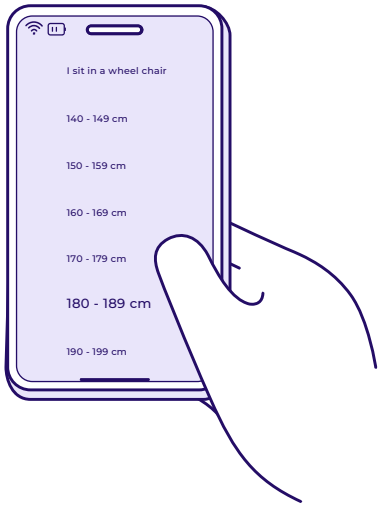
1) Setting Up the Device and App

The first exercise aims to teach learners how to turn on, set up, and wear the device. The O&M specialist will first remind the user of the device's functions and buttons, and answer any questions the user may have.

The learner will then learn how to insert the battery, turn on the device, wear it on their shoulders, and locate the buttons on the right side of the device.

The O&M specialist will continue by teaching the learner how to change the settings in the NOA Companion App. The settings allow the user to tailor NOA to their preferences and use (e.g. primary mobility aid used, height, condition, sound volume, playback speed, unit system, etc.). They can be changed at any time.

The user must be able to turn the device on and off independently, insert and remove the battery and charge it. Furthermore, they need to be able to change the settings in the smartphone app, connect the device to a Wi-Fi connection and to the headphones, as well as demonstrate a good understanding of the placement and use of the buttons on the device before starting with practical exercises.

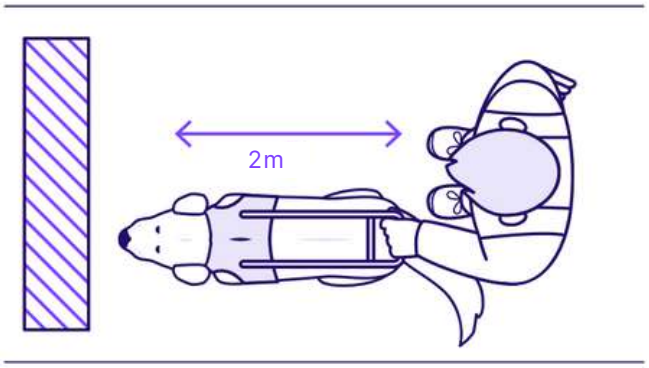


In the following exercises, the learner should be able to change the settings (e.g., pause object

detection, change detection range) with minimal assistance.

2) Developing Awareness of Detection Ranges

The second exercise teaches the learner to develop awareness of distances using NOA and how to manipulate the obstacle detection feature.
The learner will wear the device and turn it on. The O&M specialist will then place the learner facing a wall at about 2 meters. The learner will be asked to set the detection range to 1.5 meters and walk towards the wall until contact is made or the dog stops. They will then turn off the obstacle detection mode by double-clicking the O2 button.



This exercise will be repeated with the different detection ranges and different initial distances, all outside the range selected. The exercise will be repeated until the user is able to distinguish the detection ranges and relate frequency to distance, as well as turn on and off the obstacle detection feature easily.

3) Developing Awareness of Vertical Spatialization

The third exercise aims at mastering the notion of vertical spatialization by detecting obstacles at different heights.

The O&M specialist will teach the learner that vertical positioning is conveyed through a pitch gradient. Obstacles at ground-level have a low-pitch sound, while head-level obstacles have a higher pitch. The obstacle detection range can be fully customized in the settings depending on the user's preferences (full body, upper body, or head level).

To practice this concept, the O&M specialist will hold an object (e.g., a magazine opened and placed across a cane and held horizontally) at various heights and at various distances from the learner. The learner will then walk forward towards the obstacle, using NOA at the 1.5 meters detection range. They should be encouraged to use the upper-hand and forearm technique for overhanging obstacles, and at first make contact with the obstacle with their body, and then move around it.

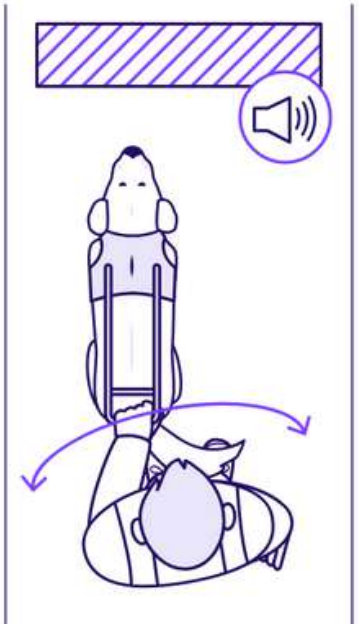
The exercise is repeated until the learner is capable of detecting the obstacle, stopping, determining its height, and moving around or under it without contact.

4) Developing Awareness of Horizontal Spatialization

The last exercise aims at teaching how to spatialize obstacles horizontally by learning to align perpendicularly to a wall using the device's sound spatialization.

The O&M specialist will place the learner at an angle and at 2 meters from the wall. The 3 meters range will be selected. The learner will scan side to side with their shoulders until the sound is located in front of them. The exercise will be repeated with different angles and distances, within the detection range.

The exercise will be completed once the learner is able to judge correctly when the sound is in front of them by rotating their shoulders.



Lesson 2

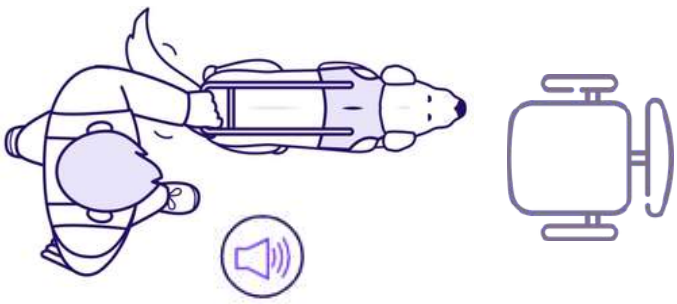
The second lesson aims to **further develop object spatialization and using different features of NOA** through three different exercises.

1) Detecting and Finding Visual Landmarks

The next exercise aims at detecting and finding visual landmarks.

Various objects should be placed around the room (e.g. chairs, tables or poles). The learner will scan the area using NOA with the 1.5 meters detection range, point to each object they find, approach the object, and make contact. The O&M specialist will return the learner to the center of the room and ask them to locate the farthest and nearest of two objects in the room.

The exercise is repeated until the learner demonstrates the ability to determine distances and directions to objects using NOA.



2) Gridline Exploration

The next exercise aims at teaching the learner to use the gridline obstacle detection feature of NOA.

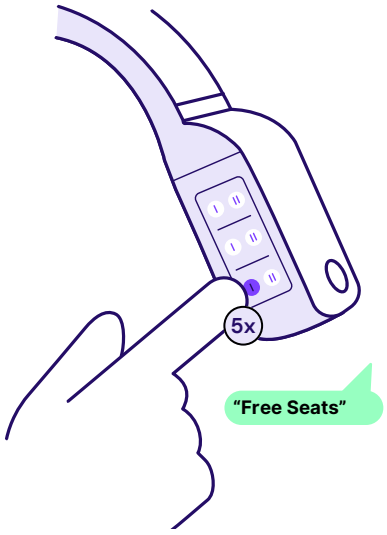
The O&M specialist will place familiar objects (e.g., those used in the previous exercise but arranged differently). The learner will then first have to explore the room using a gridline exploration strategy. Once this is completed, they will use the obstacle scanning feature of NOA, using the button O2, to receive a spatial representation of the room.

The exercise is repeated with different object placements until the learner is capable of representing the visual landmarks in their surroundings with the auditory cues of NOA.

3) Scene Description

The learner will learn how to use the scene description features of NOA to find objects. The O&M specialist will place familiar objects (e.g., those used in the previous exercises but arranged differently) and text displays in the room. The learner will use the long scene description to get an understanding of the room's configuration. They will be instructed to explain what the device told them and approach one of the objects. Using the object-finding feature, the learner will locate an open seat and read the displayed text.

The exercise will be repeated until the O&M specialist is confident the learner is able to use the features comfortably and adequately.



Lesson 3

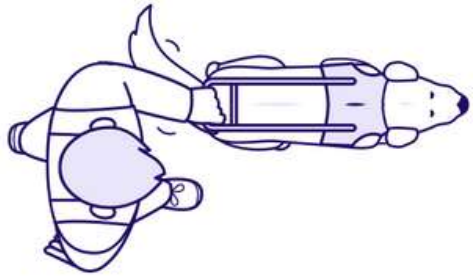
The third lesson consists of three exercises and allows the learner to **master trailing walls, differentiate between wall and obstacle detection, and finding doorways and stairs** with the aid of NOA.

1) Trailing Walls

This exercise teaches the learner to walk along a hallway without making contact with the walls.

The learner will be placed in a wide hallway, using the 1.5 meters detection range, and asked to trail the wall without making contact with obstacles or the walls. A few small obstacles should be placed along the hallway to allow users to differentiate between the buzzing sound signaling the presence of walls, and the "beeps" used for obstacles, and learn to move around an obstacle on their path.

The task will be completed when the learner can easily walk straight and avoid contact with obstacles and the walls of the hallway.



2) Detecting Doorways and Intersections

In this exercise, the learner will detect doorways and intersections in a hallway using NOA.

The learner will be asked to parallel a wall in a quiet wide hallway, using the 1.5 meters detection range, and verbally indicate any open doors or intersections detected with NOA. The O&M specialist should encourage the learner to use NOA by turning their shoulders side to side to detect these openings. Once detected, the O&M specialist will ask the learner to use the doors & exits object-finding feature in the AI menu to get confirmation and locate the visual landmark.

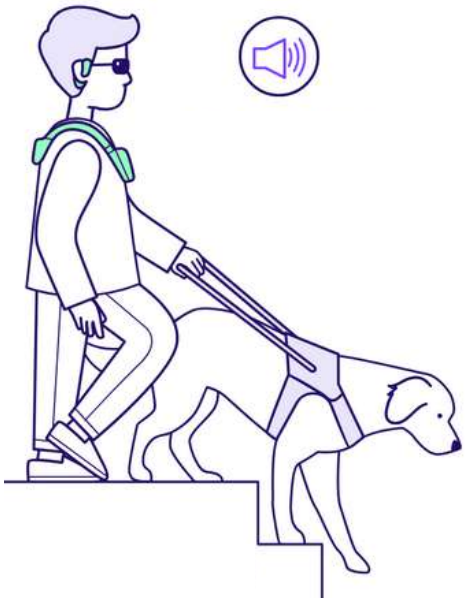
The exercise should be repeated until the learner masters the skill.

3) Identifying Stairs

Lastly, the learner will learn how to use NOA's hole detection feature by identifying stairs.

The O&M specialist will place the learner facing descending stairs at varying distances with the 2 meters detection range. The staircase should have at least three steps but not be too long. The learner should be asked to walk slowly forward until they identify the stairs by listening for the low-pitch sound signaling a drop in front of them. They should then stop, signal it verbally to the instructor, find the railing, and walk down the stairs. The learner should be asked to indicate verbally the end of the steps detected by NOA. The O&M specialist should make the learner aware that the hole detection only works for holes larger than 40cm and therefore does not detect sidewalk curbs for example.

This exercise should be repeated until the learner confidently identifies staircases and their endpoints using NOA.



During subsequent sessions, the learner will be introduced to using NOA in outdoor environments. It is essential that the indoor lessons are thoroughly mastered before progressing to Lesson 4. Outdoor settings present additional challenges

and distractions, making it critical for the learner to be fully familiar with NOA's functionalities. They must also be able to recognize and interpret its auditory cues with confidence.

Lesson 4

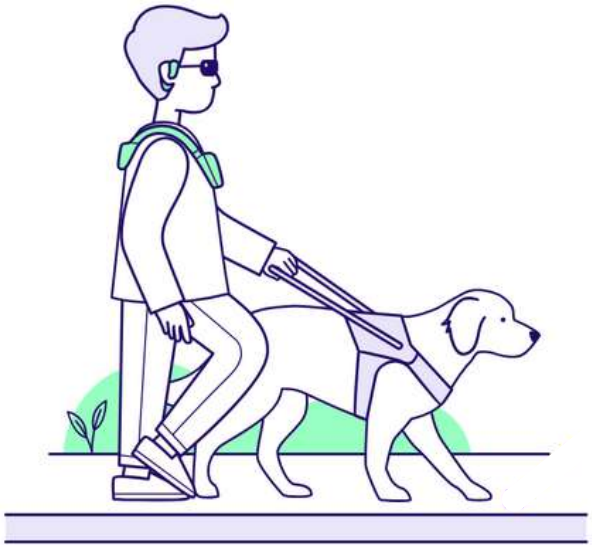
During lesson 4, the learner will **practice obstacle avoidance and trailing with NOA along an outside wall.** These exercises are similar to those in Lesson 3, but take place in an outdoor setting.

1) Outdoor Wall Trailing in a Calm Area

In the first exercise, the learner will trail a building wall, fence, or hedge and verbally indicate gaps or open areas detected using NOA (e.g. alleys, open spaces, driveways). The learner can change the detection range, lateral detection range, and detection zone in the settings and on the device directly, depending on their preferences and environment.

This task should be performed on a sidewalk in a quiet area with minimal obstacles or pedestrians. During the walk, the O&M specialist should encourage the learner to test the grass area finding feature, using the A1 button, that is available when setting the device on guide dog mode. This feature searches for a potential grassy area for their guide dog.

The exercise should continue until the learner demonstrates competence and comfort using NOA outdoors.

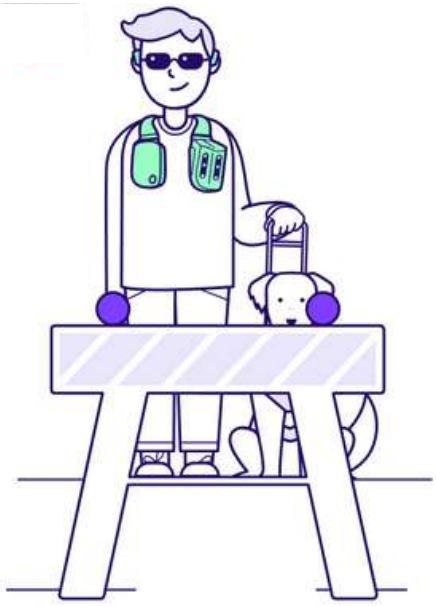


2) Navigating a Blocked Path

Once the learner is comfortable walking in a calm outdoor area, the O&M specialist will take them on a blocked path. This could be a sidewalk with construction work or a dead end.

The learner will hear the obstacle detection warning in front of them and their guide dog will stop. The O&M specialist should then introduce the short description feature, using the button A2, and instruct them to use it to get a description of the path in front of them, and the potential reason why their dog has stopped.

This short exercise will demonstrate to the learner how the feature can help them in certain situations.



3) Outdoor Wall Trailing in a Busy Area

To conclude the lesson, the first exercise should be repeated in a slightly busier area.

The learner should continue verbally indicating any gaps encountered when trailing the wall, while also avoiding any obstacle on the path. At one point during the navigation, the learner should be encouraged to compare the short and long scene description features to understand their respective uses. This will help the learner determine the most appropriate AI feature for different navigation scenarios.

The exercise should be repeated until the learner achieves mastery and confidence.

Lesson 5

The objective of this lesson is to **teach the learner to set up and use the Navigation functionality from NOA.**

In this training plan, it is assumed that the learner has **minimal knowledge of how GPS systems work and that they can be used to be guided to various points of interests.** If this is not the case, the O&M specialist must present the learner with sufficient knowledge to comprehend the utility of the Navigation feature.

1) Setting Up the Navigation Feature

The first part of the lesson will focus on mastering the Navigation and GPS functionality on the device and in the app.

The O&M specialist will remind the learner of the type of navigation instructions provided by NOA and how to use the feature with the NOA Companion App and buttons on the device.

The learner will learn how to navigate the app page, save and edit their five favorite destinations, enter a new destination, as well as turn on and off a route. Moreover, they will learn how to select a destination and access information about their position using the buttons on the device. The O&M specialist must remind the learner that GPS-based navigation systems are never fully reliable and furthermore they require internet connection. Therefore, it is important that the learner never entirely rely on their device and continue using their mobility tools and techniques alongside NOA.

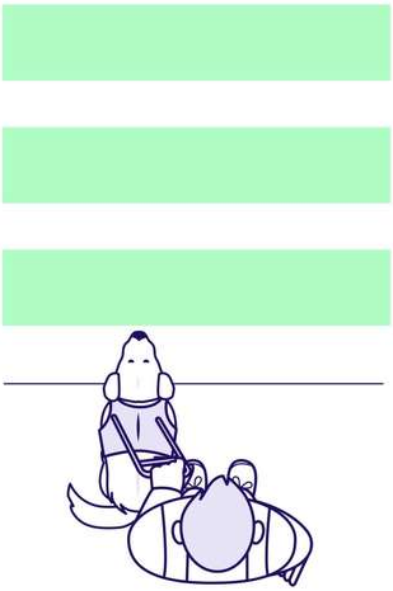
The exercise is mastered when the learner is comfortable describing and using the Navigation features on their own. They understand the assistance provided by the functionality, how it can be used with the other functionalities, but also the limitations of current GPS technologies.

2) Navigation with the Device

Once the learner is capable of setting up and understanding the navigation instructions, they will test them outdoors.

The O&M specialist will set up a short route in a quiet area. The itinerary should ideally contain an intersection with light traffic and a few turns. The learner will be asked to follow the instructions to the location.

At the intersection, the learner should be instructed to use the object-finding feature to get details about the intersection before crossing.



During the travel, the learner will be able to ask for any assistance from the O&M specialist, but should be encouraged to use NOA as much as possible.

Upon arrival at the final location, the learner should find the final objective (e.g., a building entrance, a bench) using their own O&M skills, but can also try using the various AI features from the device to locate the visual landmark. The exercise will be repeated for the return route.

At the end of the exercise, the learner should be comfortable with listening and following the navigation instructions on a calm route, in combination with the obstacle detection, and AI features when required.

Lesson 6

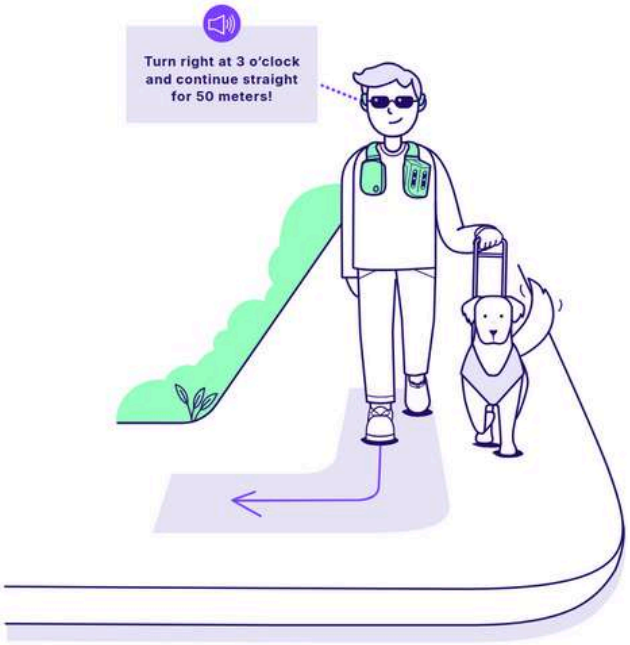
To finalize the training plan, the learner will **demonstrate their skills using the device by using it for one of their familiar routes.**

1) NOA on a Known Route

In this last exercise, the O&M specialist will accompany the learner on one of their typical trips (e.g., work, grocery shopping, school) using NOA.

The learner will prepare and set up the device, and start the navigation session independently. During the trip, they should demonstrate confidence in using NOA alongside their primary mobility aid, effectively interpreting auditory cues, and appropriately utilizing the different features.

The exercise will be complete when the O&M specialist is confident that the learner can navigate in their daily life independently, using NOA as a complement to their mobility aid.



A summary of the lessons and an evaluation sheet, designed as tools for the O&M specialist during training sessions, can be provided upon request. These resources include: A summary of the training plan for quick reference, and an evaluation sheet for assessing the learner's mastery of the device during Lesson 6.

For convenient access to these materials, scan the QR code below or visit https://biped.ai/orientation-mobility#training.

Training for Transition from White Cane to Guide Dog

The last training plan is aimed at teaching NOA to a learner who is transitioning from the white cane to a guide dog. Indeed, this transition period is often difficult and NOA can ease the process. The first three lessons in the training guide aim to teach the learner how to use NOA with the white cane indoors, similarly to the first training template. Starting in lesson 4, the learner will transition from using NOA with the white cane to using it with a guide dog.

Prerequisite Lesson

The first lesson is recommended to be done **at home**, either independently by the user or with the help of a caregiver. The objective is to **familiarize learners with NOA's purpose and features before beginning practical training**.

This lesson involves following the first part of the user manual provided with NOA, excluding the training exercises at the end of the document.

The device's characteristics and functions, security instructions, and limitations are clearly explained to allow for a good understanding of NOA.

While the learner will have opportunities to revisit the device during subsequent lessons, it is important that they become familiar with its features by the end of the prerequisite lesson. They should have a clear understanding of the location of the buttons, the battery compartment, and the use of the NOA Companion App.

Lesson 1

Lesson 1 aims to teach the learner how to set up the device. Furthermore, learners will become comfortable with the obstacle detection feature and sound spatialization. This lesson is separated into four different exercises.

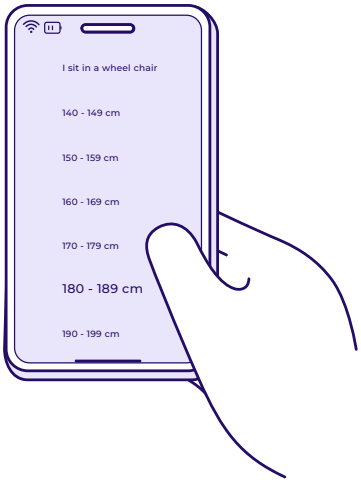
1) Setting Up the Device and App

The first exercise aims to teach learners how to turn on, set up, and wear the device. The O&M specialist will first remind the user of the device's functions and buttons, and answer any questions the user may have.

The learner will then learn how to insert the battery, turn on the device, wear it on their shoulders, and locate the buttons on the right side of the device.

The O&M specialist will continue by teaching the learner how to change the settings in the NOA Companion App. The settings allow the user to tailor NOA to their preferences and use (e.g. primary mobility aid used, height, condition, sound volume, playback speed, unit system, etc.). They can be changed at any time.

The user must be able to turn the device on and off independently, insert and remove the battery and charge it. Furthermore, they need to be able to change the settings in the smartphone app, connect the device to a Wi-Fi connection and to the headphones, as well as demonstrate a good understanding of the placement and use of the buttons on the device before starting with practical exercises.

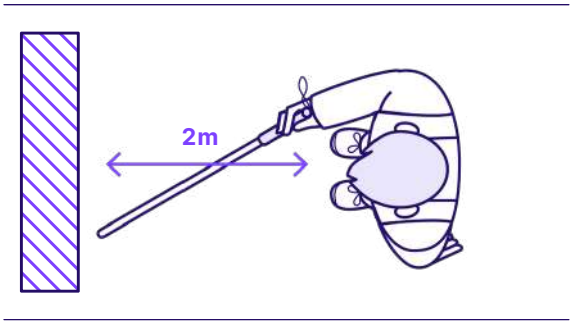


In the following exercises, the learner should be able to change the settings (e.g., pause object detection, change detection range) with minimal assistance.

2) Developing Awareness of Detection Ranges

The second exercise teaches the learner to develop awareness of distances using NOA and how to manipulate the obstacle detection feature.

The learner will wear the device and turn it on. The O&M specialist will then place the learner facing a wall at about 2 meters. The learner will be asked to set the detection range to 1.5 meters and walk towards the wall until contact with the cane tip is made. They will then turn off the obstacle detection mode by double-clicking the O2 button.



This exercise will be repeated with the different detection ranges and different initial distances, all outside the range selected. The exercise will be repeated until the user is able to distinguish the detection ranges and relate frequency to distance, as well as turn on and off the obstacle detection feature easily.

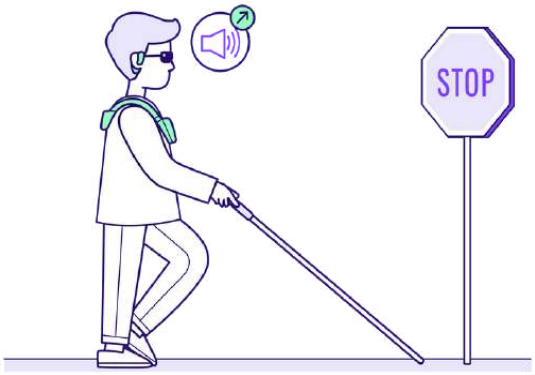
3) Developing Awareness of Vertical Spatialization

The third exercise aims at mastering the notion of vertical spatialization by detecting overhanging and ground-level obstacles.

The O&M specialist will teach the learner that vertical positioning is conveyed through a pitch gradient. Obstacles at ground-level have a low-pitch sound, while head-level obstacles have a higher pitch. The obstacle detection range can be fully customized in the settings depending on the user's preferences (full body, upper body, or head level).

To practice this concept, the O&M specialist will hold an object (e.g., a magazine opened and placed across a cane and held horizontally) at various heights and at various distances from the learner. The learner will then walk forward towards the obstacle, using NOA at the 1.5 meters detection range. They should be encouraged to use the upper-hand and forearm technique for overhanging obstacles, and make contact with the obstacle at first, either with their body or the white cane, and then move around it.

The exercise is repeated until the learner is capable of detecting the obstacle, stopping, determining its height, and moving around or under it without contact.

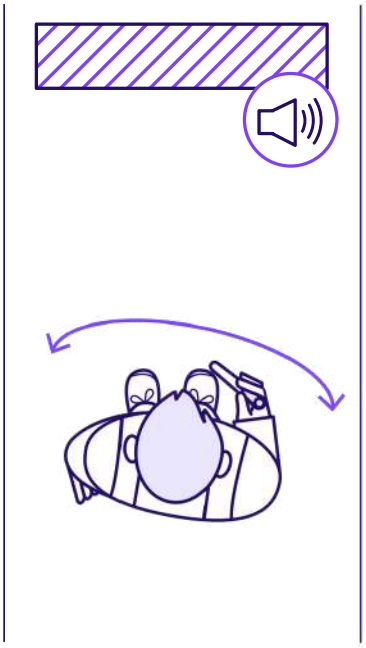


4) Developing Awareness of Horizontal Spatialization

The last exercise aims at teaching how to spatialize obstacles horizontally by learning to align perpendicularly to a wall using the device's sound spatialization.

The O&M specialist will place the learner at an angle and at 2 meters from the wall. The 3 meters range will be selected. The learner will scan side to side with their shoulders until the sound is located in front of them. The exercise will be repeated with different angles and distances, within the detection range.

The exercise will be completed once the learner is able to judge correctly when the sound is in front of them by rotating their shoulders.



Lesson 2

The second lesson aims to **further develop object spatialization and using different features of NOA** through three different exercises.

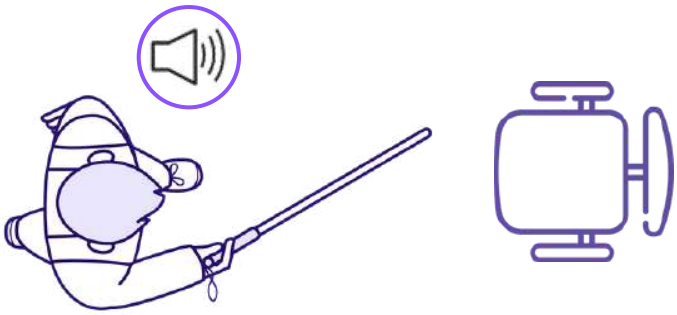
1) Detecting and Finding Visual Landmarks

The next exercise aims at detecting and finding visual landmarks.

Various objects should be placed around the room (e.g. chairs, tables or poles). The learner will scan

the area using NOA with the 1.5 meters detection range, point to each object they find, approach the object, and make contact. The O&M specialist will return the learner to the center of the room and ask them to locate the farthest and nearest of two objects in the room.

The exercise is repeated until the learner demonstrates the ability to determine distances and directions to objects using NOA.



2) Gridline Exploration

The next exercise aims at teaching the learner to use the gridline obstacle detection feature of NOA.

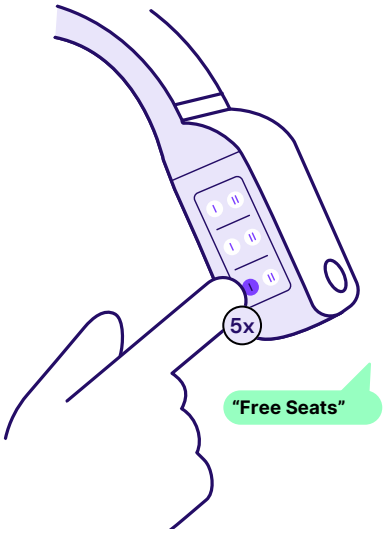
The O&M specialist will place familiar objects (e.g., those used in the previous exercise but arranged differently). The learner will then first have to explore the room using a gridline exploration strategy. Once this is completed, they will use the obstacle scanning feature of NOA, using the button O2, to receive a spatial representation of the room.

The exercise is repeated with different object placements until the learner is capable of representing the visual landmarks in their surroundings with the auditory cues of NOA.

3) Scene Description

The learner will learn how to use the scene description features of NOA to find objects. The O&M specialist will place familiar objects (e.g., those used in the previous exercises but arranged differently) and text displays in the room. The learner will use the long scene description to get an understanding of the room's configuration. They will be instructed to explain what the device told them and approach one of the objects. Using the object-finding feature, the learner will locate an open seat and read the displayed text.

The exercise will be repeated until the O&M specialist is confident the learner is able to use the features comfortably and adequately.



Lesson 3

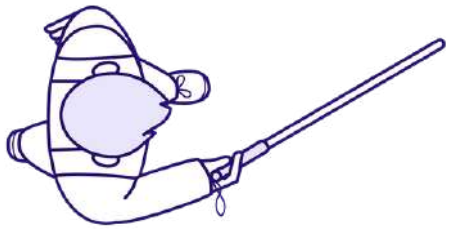
The third lesson consists of three exercises and allows the learner to **master trailing walls, differentiate between wall and obstacle detection, and finding doorways and stairs** with the aid of NOA.

1) Trailing Walls

This exercise teaches the learner to walk along a hallway without making contact with the walls.

The learner will be placed in a wide hallway, using the 1.5 meters detection range, and asked to trail the wall without making contact with obstacles or the walls with their cane or body. A few small obstacles should be placed along the hallway to allow users to differentiate between the buzzing sound signaling the presence of walls, and the "beeps" used for obstacles, and learn to move around an obstacle on their path.

The task will be completed when the learner can easily walk straight and avoid contact with obstacles and the walls of the hallway.



2) Detecting Doorways and Intersections

In this exercise, the learner will detect doorways and intersections in a hallway using NOA.

The learner will be asked to parallel a wall in a quiet wide hallway, using the 1.5 meters detection range, and verbally indicate any open doors or intersections detected with NOA. The O&M specialist should encourage the learner to use NOA by turning their shoulders side to side to detect these openings. Once detected, the O&M specialist will ask the learner to use the doors & exits object-finding feature in the AI menu to get confirmation and locate the visual landmark.

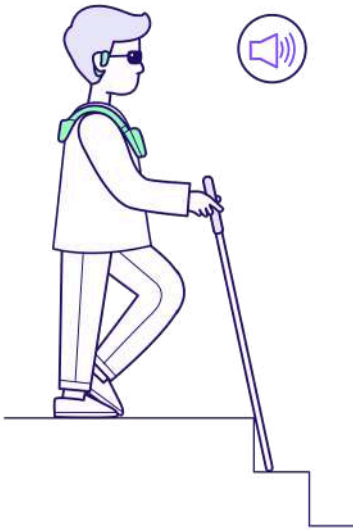
The exercise should be repeated until the learner masters the skill.

3) Identifying Stairs

Lastly, the learner will learn how to use NOA's hole detection feature by identifying stairs.

The O&M specialist will place the learner facing descending stairs at varying distances with the 2 meters detection range. The staircase should have at least three steps but not be too long. The learner should be asked to walk slowly forward until they identify the stairs by listening for the low-pitch sound signaling a drop in front of them. They should then stop, signal it verbally to the instructor, find the railing, and walk down the stairs. The learner should be asked to indicate verbally the end of the steps detected by NOA. The O&M specialist should make the learner aware that the hole detection only works for holes larger than 40cm and therefore does not detect sidewalk curbs for example.

This exercise should be repeated until the learner confidently identifies staircases and their endpoints using NOA.



During subsequent sessions, the learner will be introduced to using NOA in outdoor environments. It is essential that the indoor lessons are thoroughly mastered before progressing to Lesson 4. Outdoor settings present additional challenges and distractions, making it critical for the learner to be fully familiar with NOA's functionalities. They must also be able to recognize and interpret its auditory cues with confidence.

Lesson 4

During lesson 4, the learner will **practice obstacle avoidance and trailing with NOA along an outside wall**. The first part of this lesson will be done with the white cane. The learner will then transition to using NOA exclusively with the guide dog.

1) Outdoor Wall Trailing in a Calm Area

In the first exercise, the learner will trail a building wall, fence, or hedge and verbally indicate gaps or open areas detected using NOA (e.g. alleys, open spaces, driveways). The learner can change the detection range, lateral detection range, and detection zone in the settings and on the device directly, depending on their preferences and environment.

This task should be performed on a sidewalk in a

quiet area with minimal obstacles or pedestrians. The learner should be reminded to use the white cane as usual, but avoid making contact with the wall. The exercise should continue until the learner demonstrates competence and comfort with NOA and the white cane.

The learner will then change in the settings the device's mode from white cane to guide dog and perform the task again, with the guide dog as primary aid instead of the white cane. During the walk, the O&M specialist should encourage the learner to test the grass area finding feature, using the A1 button, that is available with the guide dog mode. This feature searches for a potential grassy area for their guide dog.

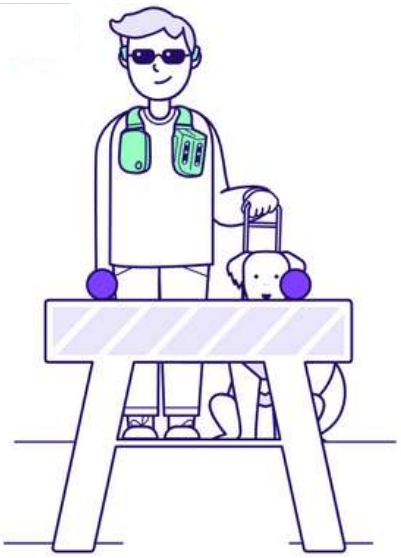
This crucial exercise should be performed until the learner is comfortable walking with a guide dog together with NOA.

2) Navigating a Blocked Path

Once the learner is comfortable walking in a calm outdoor area with NOA and the guide dog, the O&M specialist will take them on a blocked path. This could be a sidewalk with construction work or a dead end.

The learner will hear the obstacle detection warning in front of them and their guide dog will stop. The O&M specialist should then introduce the short description feature, using the button A2, and instruct them to use it to get a description of the path in front of them, and the potential reason why their dog has stopped.

This short exercise will demonstrate to the learner how the feature can help them in certain situations.



3) Outdoor Wall Trailing in a Busy Area

To conclude the lesson, the first exercise should be repeated with the guide dog in a slightly busier area.

The learner should continue verbally indicating any gaps encountered when trailing the wall, while also avoiding any obstacle on the path. At one point during the navigation, the learner should be encouraged to compare the short and long scene description features to understand their respective uses. This will help the learner determine the most appropriate AI feature for different navigation scenarios.

The exercise should be repeated until the learner achieves mastery and confidence.

Lesson 5

The objective of this lesson is to **teach the learner to set up and use the Navigation functionality from NOA.**

In this training plan, it is assumed that the learner has **minimal knowledge of how GPS systems work and that they can be used to be guided to various points of interests.** If this is not the case, the O&M specialist must present the learner with sufficient knowledge to comprehend the utility of the Navigation feature.

1) Setting Up the Navigation Feature

The first part of the lesson will focus on mastering the Navigation and GPS functionality on the device and in the app.

The O&M specialist will remind the learner of the type of navigation instructions provided by NOA and how to use the feature with the NOA Companion App and buttons on the device.

The learner will learn how to navigate the app page, save and edit their five favorite destinations, enter a new destination, as well as turn on and off a route. Moreover, they will learn how to select a destination and access information about their position using the buttons on the device. The O&M specialist must remind the learner that GPS-based navigation systems are never fully reliable and furthermore they require internet connection. Therefore, it is important that the learner never entirely rely on their device and continue using their mobility tools and techniques alongside NOA.

The exercise is mastered when the learner is comfortable describing and using the Navigation features on their own. They understand the assistance provided by the functionality, how it can be used with the other functionalities, but also the limitations of current GPS technologies.

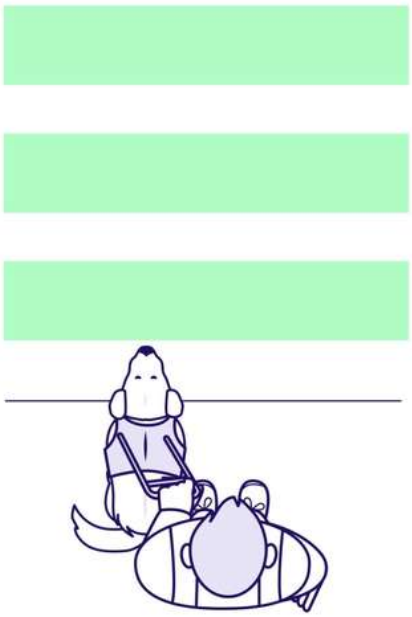
2) Navigation with the Device

Once the learner is capable of setting up and understanding the navigation instructions, they will test them outdoors.

The O&M specialist will set up a short route in a quiet area. The itinerary should ideally contain an intersection with light traffic and a few turns. The learner will be asked to follow the instructions to the location.

At the intersection, the learner should be instructed to use the object-finding feature to get details about the intersection before crossing.

During the travel, the learner will be able to ask for any assistance from the O&M specialist, but should be encouraged to use NOA as much as possible.



Upon arrival at the final location, the learner should find the final objective (e.g., a building entrance, a bench) using their own O&M skills, but can also try using the various AI features from the device to locate the visual landmark. The exercise will be repeated for the return route.

At the end of the exercise, the learner should be comfortable with listening and following the navigation instructions on a calm route, in combination with the obstacle detection, and AI features when required.

Lesson 6

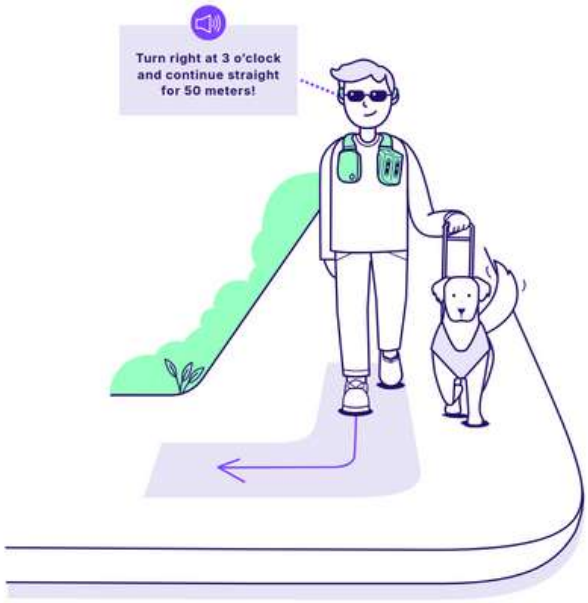
To finalize the training plan, the learner will **demonstrate their skills using the device by using it for one of their familiar routes.**

1) NOA on a Known Route

In this last exercise, the O&M specialist will accompany the learner on one of their typical trips (e.g., work, grocery shopping, school) using NOA.

The learner will prepare and set up the device, and start the navigation session independently. During the trip, they should demonstrate confidence in using NOA alongside their primary mobility aid, effectively interpreting auditory cues, and appropriately utilizing the different features.

The exercise will be complete when the O&M specialist is confident that the learner can navigate in their daily life independently, using NOA as a complement to their mobility aid.



A summary of the lessons and an evaluation sheet, designed as tools for the O&M specialist during training sessions, can be provided upon request. These resources include: A summary of the training plan for quick reference, and an evaluation sheet for assessing the learner's mastery of the device during Lesson 6.

For convenient access to these materials, scan the QR code below or visit https://biped.ai/orientation-mobility#training.

NOA for and with O&M Specialists and Users

Since the beginning, **the team at biped robotics has regularly organized demo days with NOA, creating opportunities to gather suggestions and feedback from O&M specialists and individuals with visual impairments.** We are also open to lending devices to organizations or associations, and prioritize collaborating with professionals as much as possible.

Our weekly newsletter and regular contacts with our users help us stay focused on the real-life needs of blind and visually impaired people while customizing our device accordingly. We also approach each case individually, recognizing that there is no “one-size-fits-all solution.” **We believe however that AI is on the verge of bringing change to accessibility and we want to be part of this revolution.**

Contact Us

We would love to hear from you! For inquiries or feedback, please

reach out to us:

- Phone: +41 78 909 14 25
- Email: hello@biped.ai

Stay Updated with Biped's Newsletter

FAQ

Features

What obstacles can NOA detect?

NOA can detect all sorts of obstacles in front of you: branches, traffic signs, holes, staircases going down, drop-offs... day and night.
But it goes beyond that. NOA can also detect moving obstacles, such as vehicles (cars, trucks, buses, motorcycles...) or pedestrians (walking, running, riding a bicycle...).

Can NOA detect holes?

NOA can detect holes and drop-offs of 30 cm and above. Users are warned with the same sound as for an obstacle, but with a lower pitch, to make it feel like the sound in coming from the floor. We advise users to navigate with a white cane, in order to identify the smaller changes of level and of texture.

Can NOA detect walls?

Yes, NOA can detect walls and help you follow them. When following a wall, NOA produces a distinct buzzing sound that changes in intensity based on your distance from the wall, helping you maintain a consistent path alongside it.

Can NOA detect doors?

Yes, NOA detects doors and doorways, both open and closed. It can also identify different types of doors like sliding doors, revolving doors, and elevator doors.

Can I ask NOA to only detect head level obstacles?

Yes, this is available as a setting in the NOA app. In this mode, NOA specifically focuses on detecting obstacles that hang at head height which a cane cannot detect, like low-hanging branches or protruding traffic signs. Ground-level obstacles and walls that your cane can detect will not trigger notifications, allowing you to focus solely on head-level hazards.

Can I ask NOA to only detect upper body obstacles?

Yes, similar to the head-level detection mode, NOA can be configured to detect obstacles from waist to head height. This setting is useful when you want to be alerted about obstacles that might impact your upper body while using your cane for ground-level detection. The device will warn you about obstacles like protruding mailboxes, hanging signs, or partially open windows, while ignoring ground-level obstacles that your cane can detect.

What kind of feedback does it provide?

NOA provides spatial audio feedback through headphones, preferably bone conduction headphones like the Shokz Open Run Pro that leave your ears free for ambient sounds. When detecting obstacles (e.g., a tree branch at head-level on your left), it generates directional "beeps" with pitch indicating height - high pitch for head-level, low pitch for ground-level obstacles.

How accurate is NOA with distances and angles?

NOA uses high-precision depth cameras that are accurate to the centimeter level for measuring distances and angles. We combine this precise hardware with advanced vision language models to create

AI that can accurately interpret spatial relationships. This allows NOA to provide highly reliable information about obstacle distances, intersection angles, and environmental layouts. The system continuously calibrates itself to maintain accuracy even with movement and different lighting conditions.

Does NOA have its own GPS?

No, NOA relies on your smartphone's GPS for navigation features. This allows for more accurate positioning and real-time updates to navigation instructions while keeping the device lighter and more energy efficient. However, NOA has its own compass, allowing you to safely store your smartphone while navigating accurately. The instructions are computed from your shoulders directly.

Can NOA help with crosswalks?

Yes, NOA describes the full intersection layout, including crosswalks, traffic lights, and pedestrian signals. It provides information about intersection type (T-junction, 4-way, etc.), traffic flow direction, and presence of pedestrian islands or refuge areas.

Can NOA describe the scene around me?

Yes, NOA can provide detailed descriptions of your surroundings through its AI scene description feature. It can identify buildings, landmarks, street furniture, and describe the general layout of the environment. This feature requires an internet connection.

Can NOA read text?

Yes, NOA can read text from signs, displays, and documents when using the text recognition feature in the NOA app. This includes street signs, store names, menus, and other text in your environment. This feature requires an internet connection.

Can I ask oral questions to NOA?

Not yet, but we're working on it.

Can NOA be used with a guide dog?

Yes, NOA works well with guide dogs. When used with a guide dog, NOA focuses on detecting obstacles that the dog might miss, like overhanging branches or obstacles at head height, complementing rather than interfering with your guide dog's work.

If I'm in guide dog mode, can NOA help me find grass areas?

Yes, NOA can detect and identify grass areas through its AI vision system. This is one of the environmental features specifically included in our AI classification system to help guide dog users locate relief areas for their dogs.

Do I need a smartphone to use NOA?

While obstacle avoidance works standalone, a smartphone provides GPS navigation instructions and network-dependent AI features.

Do I need the NOA app every time I use NOA?

No, you only need the NOA app for initial device setup. After that, the app is only required when you want

to set up a new GPS destination. All other features, including obstacle detection and navigation to saved destinations, work without needing to access the app.

Which languages does NOA support?
NOA supports English, French, German, Spanish, Polish, Czech, Italian, and many more languages to come.

Can I adjust the playback speed of NOA's AI voices?
Yes, you can adjust the playback speed of NOA's AI voices through the app settings. You can choose between normal speed (1x), moderately faster (1.5x), or double speed (2x) to match your listening preferences.

Does NOA support both metric and imperial units?
Yes, NOA supports both metric (meters) and imperial (feet) units. You can easily switch between measurement systems through the NOA app settings to receive distance information in your preferred format.

How can I learn to use NOA?
NOA comes with a comprehensive user manual that guides you through all features and settings. You can access the user manual. The manual covers everything from basic setup to advanced features, helping you get the most out of your device.

Technical Specs

How long does NOA's battery last?
NOA's battery lasts up to 3 hours of continuous use on a single charge, usually more than enough for a full day of walk. The device automatically enters deep sleep mode after 5 minutes of inactivity and wakes up when moved, so you can leave it on a table while grabbing a coffee and resume your walk later. The battery can be fully recharged in about 3 hours. 2 batteries are provided. You can swap the batteries and the device will restart in less than 12 seconds.

Does NOA work under the rain?
NOA is IP43 rated for light to medium rain. Performance may degrade in heavy rain, so we include a rainproof travel bag for quick protection.

Does NOA work at night?
Yes, most features including obstacle detection, hole detection, and GPS navigation work at night. AI description features might have limited functionality.

Does NOA work indoors?
All features except GPS navigation work reliably indoors. GPS navigation requires outdoor use for accurate performance

Can I wear NOA on a backpack?
Yes, NOA's flexible straps easily adapt to sit on top of a backpack.

How do I store NOA?
NOA comes with a protective travel bag. The device can be flattened and stored in the bag in about 10 seconds.

Component	Description
Acquisition sensors: Depth cameras, infrared cameras	
Frame rate	Up to 30 images per second
Light conditions	Day and Night
Range	30 centimeters, up to 10 meters (1 to 33ft)
Field of view	90 degrees vertical and 170 degrees horizontal field of view
Connectivity: WiFi, Bluetooth, BLE	
Device: Weight, battery, operational range	
Device weight	1044 grams (2.30 lbs)
Battery weight	224 grams (0.49 lbs)

Users & Accessibility

Can NOA be used with kids?
The current version requires users to be at least 1.40 meters tall for comfortable use.

Is NOA compatible with various conditions?
Yes! NOA works with users who have retinitis pigmentosa (with helpful infrared cameras for low light), age-related macular degeneration, glaucoma, diabetic retinopathy, cataracts, optic nerve damage, hemispatial neglects/field cuts (customizable through app settings), and other vision impairments. NOA is also compatible with wheelchair users through a specific mode in the NOA app.

Does it replace traditional mobility aids?
No, NOA complements rather than replaces white canes or guide dogs. We value these primary aids for protecting the immediate space in front of you and designed NOA to work alongside them.

Can NOA repeat instructions if I didn't hear them?
Yes, you can ask NOA to repeat any instruction by pressing the "repeat" button on the device. NOA will clearly repeat its last instruction.

Can I adjust NOA's volume?
Yes, you can easily adjust NOA's volume using the volume buttons on the device or through the NOA companion app.

Can I put NOA on pause?
Yes, you can pause NOA in two ways: Either press the large central button on the right chest module, or simply stop walking - NOA will automatically detect that you've stopped moving and pause itself. When paused, NOA will not provide any audio feedback until reactivated.

Maintenance & Updates

How will the product evolve?
NOA's AI is continuously developed and tested to enhance features based on user feedback. Regular updates ensure access to the latest improvements.

How often is NOA updated?
Updates occur every 3 months, with email notifications sent one week prior.

How do I update NOA?
With your device ON and connected to WiFi, open the NOA companion app, go to My NOA, and click Updates. Follow on-screen instructions for the 5-minute update process.

Are updates free?
Yes.

What if I break the device?
For hardware issues like broken glass, contact support@biped.ai for manufacturer repairs.

Pricing & Plans

What payment options are available?
NOA offers 2 payment plans: One-time purchase with no monthly fees, at 4950€, or a weekly plan at 24€. See our pricing page for more details.

What payment options are available?

NOA offers 2 payment plans: One-time purchase with no monthly fees, at 4950€, or a weekly plan at 24€. Both options come with a 30-day money back guarantee. Shipping fees are not included and must be covered by the customer. See our pricing page for more details.

What happens after 48 months?

Payments stop after 48 months. While warranty expires, customers can upgrade to newer models at a discount.

What's the cancellation policy?

Monthly payments are non-refundable. 75% of the initial downpayment may be refunded depending on device condition.

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Closing Words

We're convinced that we're going through a transformational era in O&M.

AI & robotics are bringing what GPS systems brought decades ago. A tool, that becomes an interal part of daily lives, and of O&M training.

We're also conviced that white canes and guide dogs are here to stay. Not because technology cannot be as "good".

But because fostering independence should not mean building technology dependency, especially in mobility.

Because technology can run out of battery in the middle of a walk. Because technology can be wrong.

And most importantly, because technology should not undo what O&M training skills teach. Cane technique. Walking with a guide dog. All of these fundamental learnings are here to stay.

But teaching O&M skills to millions of people around the world is a challenge. And continuous training with O&M practitioners over time is even harder to envision at scale. There are simply not enough O&M trainers.

This is where technology plays a role. We believe in continuous learning after O&M sessions. NOA users continue to use their cane, but gain the confidence walk more. The confidence to take a new route. The confindence to rely on their cane or dog, while accessing visual & safety information without having to walk with another person.

We observe, among our user base, that most users start by using NOA on know routes. And gradually feel empowered to discover new routes.

We minimize the interferences of NOA during walks, to leave the ears of the users as free as possible. We never intend to guide a user along a very specific path with a continuous feedback. We've seen near misses on demos of such products, as users focus on following the feedback and tend to ignore their surroundings.

On the other hands, we replicated, from the ground up, the features and training methods described in book: "Foundations of Orientation and Mobility". The way NOA describes the surroundings, the way it describes an intersection, the concepts of obstacles detection...

At biped, we commit to a safe and transparent use of technology. We commit to building reliable technology that helps empower users. We commit to building things that have a long-term positive impact.

Mael, CEO. Paul, CTO. Marco, COO.

Navigating the Future of Accessibility

Artificial intelligence is revolutionizing the field of Orientation and Mobility (O&M), offering unprecedented opportunities to enhance independence and safety for individuals with visual impairments. *NOA: AI-powered Travel Aids for Orientation and Mobility* explores the transformative potential of AI in accessibility and introduces NOA, a groundbreaking AI-based tool for blind and visually impaired individuals.

This book provides an in-depth look at NOA's advanced features, including real-time obstacle detection, GPS navigation, and AI-powered environmental descriptions. Seamlessly integrating with white canes and guide dogs, NOA showcases how cutting-edge technologies can complement traditional tools without replacing them. NOA empowers users to confidently navigate diverse environments with ease.

Featuring a complete training plan, practical applications, and real-world testimonials, this guide is an essential resource for O&M professionals. Discover how NOA and AI are shaping a future where independence is accessible to all.

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