NOA: AI-powered Travel Aids for Orientation and Mobility

Instructional strategies and illustrated examples

FIRST EDITION

biped.ai

CONTENTS

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 a 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 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.

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).

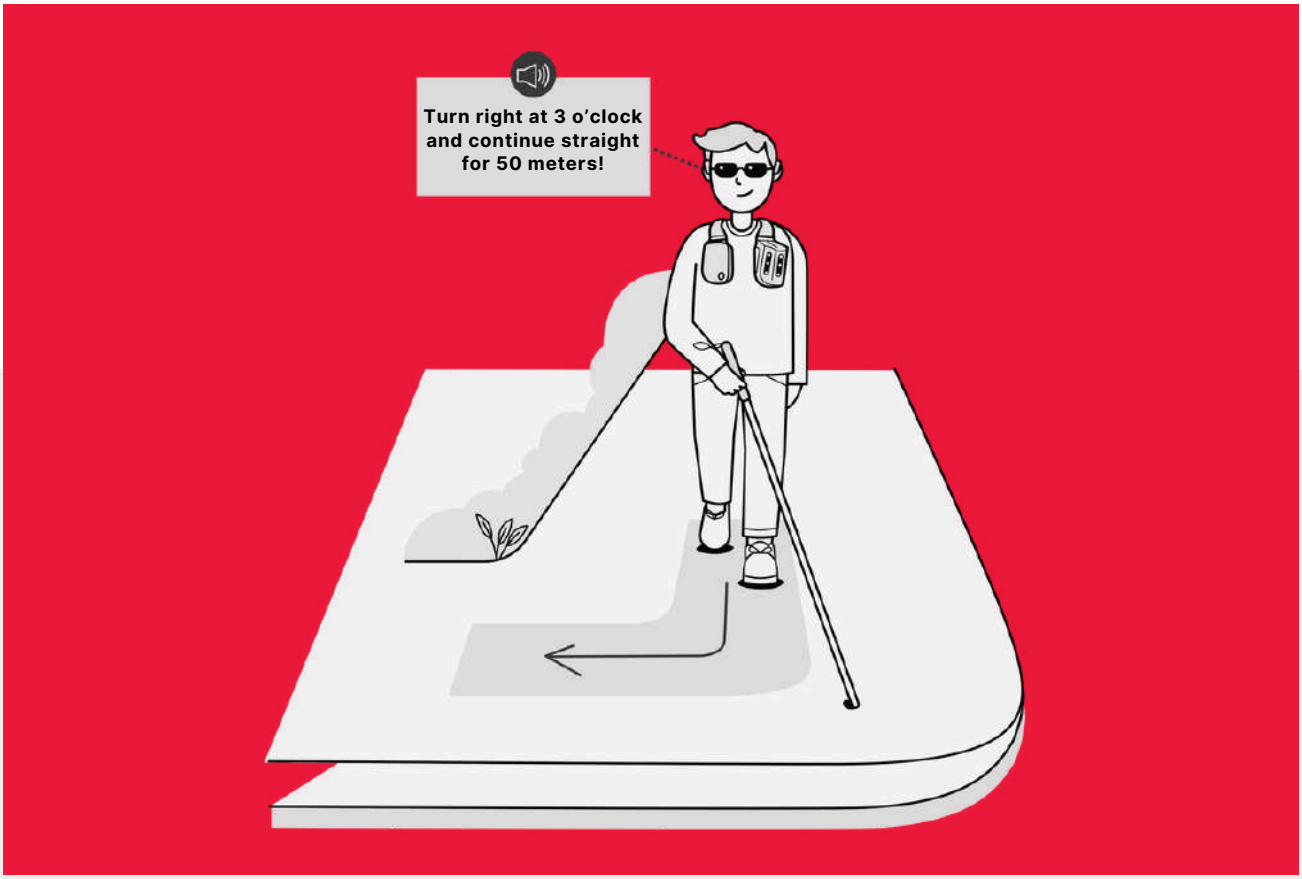
6 buttons on the right outer side compose the Features panel which trigger the navigation, obstacle detection and AI functionalities. **On the left inner side, there are 3 buttons.** The first one at the top, the Select button, allows you to select features from the Features panel. The two other buttons 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: 1. **N1 (Left):** Select destination (1, 2, 3) and **press the select button** to confirm selection to start GPS navigation. 2. **N2 (Right):** North tracking and display important surrounding information from the GPS, such as nearby streets.
	**OBSTACLE:** The middle row consists of Obstacle buttons: 1. **O1 (Left):** Change range between 1, 1.5, 2, and 3 meters. **Press the select button** to confirm selection and set the new range. 2. **O2 (Right):** Obstacle scanning will scan your surroundings and generate “beeps” for all obstacles around you.
	**SCENE DESCRIPTION WITH AI:** The middle row consists of AI buttons: • **A1 (Left):** Find objects (1, 2, 3, 4, 5) 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



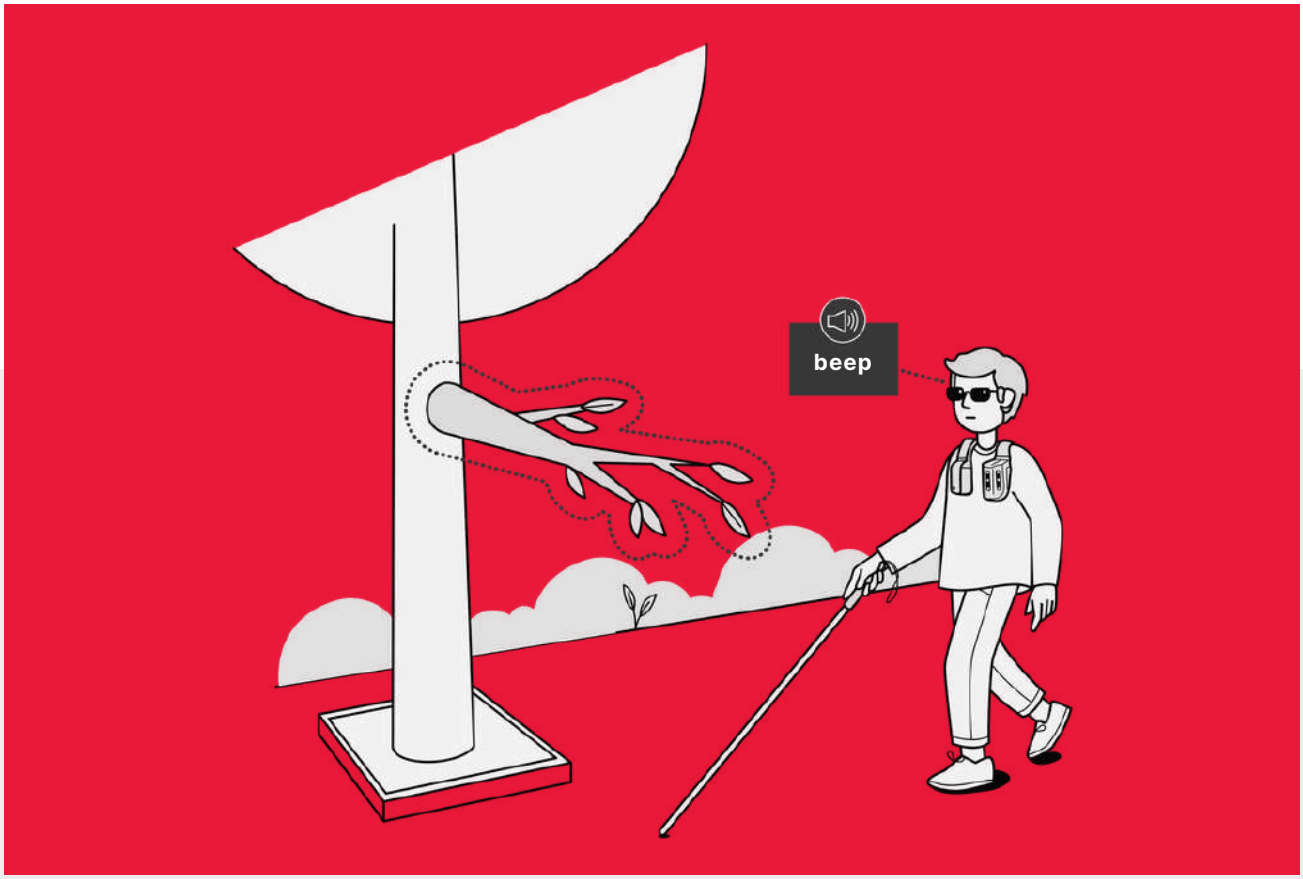
NOA provides turn-by-turn GPS instructions, identifying crosswalks, confirming directions, indicating turns, and rerouting users as needed. These instructions are delivered through bone-conducting headphones, leaving users' ears free to remain aware of their environment. Users can choose their route 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. Three 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 current location, north tracking, and important information about your surroundings, such as surrounding streets. 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" 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.

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, 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, 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 for Text reading, twice to find Doors and exits, three times to find Crosswalks, four times to find stairs and elevators and five times to find free seats. 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 user
- Users with mental disabilities
- Wheelchair users

Not Suitable for

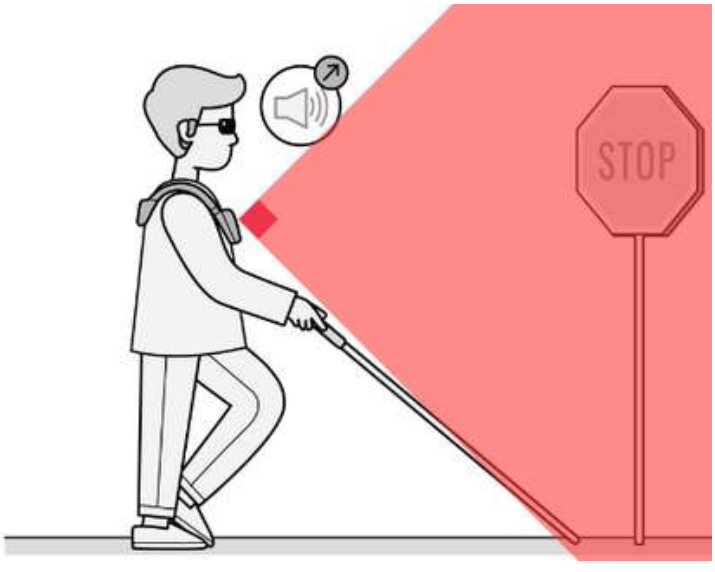
- Users under 130cm
- People with hearing impairments who do not have Bluetooth hearing aids or implants
- For full use of NOA features, a smartphone is required

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 users, 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 all the time. 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 users use. For obstacle detection, guide dog owners will not be warned by ground-level obstacles as their companion will already play that role. Moreover, they 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.

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

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 a detailed lesson plan for O&M specialists to teach the use of NOA.

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).

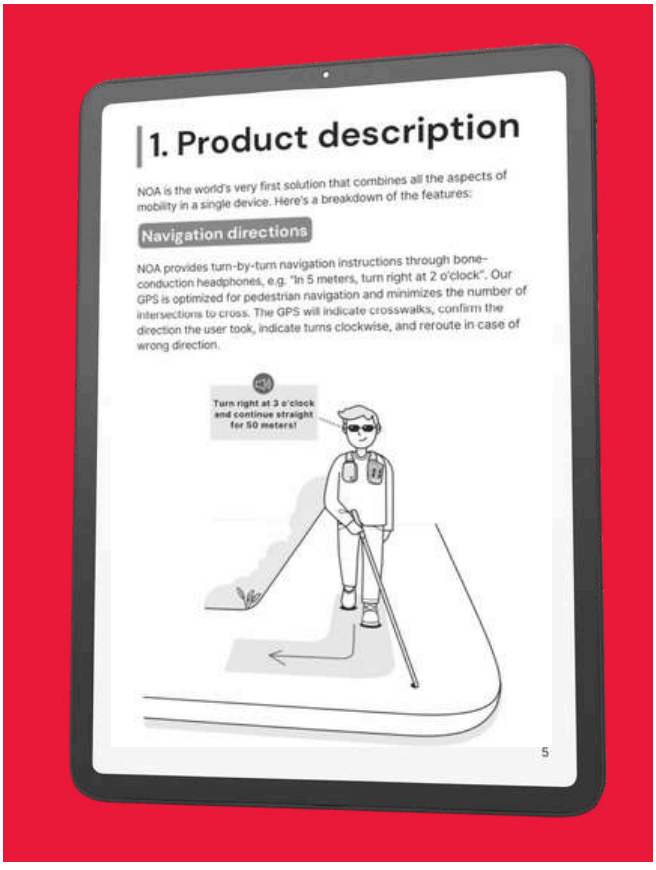
The training begins with an introduction to the device, its functionalities, and buttons, as well as the NOA Companion App. Detailed instructions help the user set up their device and app based on their mobility aid, profile, and preferences.

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 a comprehensive training template 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). While the course was designed specifically for NOA, it can also be valuable for the learning of other ETAs.

The training plan is 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 user. For the Obstacle Detection feature, a map showing all the obstacles in the user'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.

Prerequisite Lesson

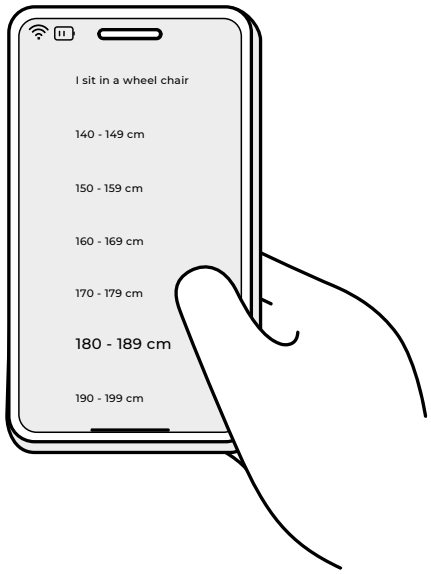
The first lesson is recommended to be done **at home**, either independently by the user or with the help of a caregiver. The objective is to **familiarize learners with NOA's purpose and features before beginning practical training**.

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, limitations are clearly explained to allow for a good understanding of NOA. The learner should therefore be familiar with the device and its features at the end of the lesson. The location of the buttons and the battery compartment, as well as the use of the NOA Companion App should clearly be understood.

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.

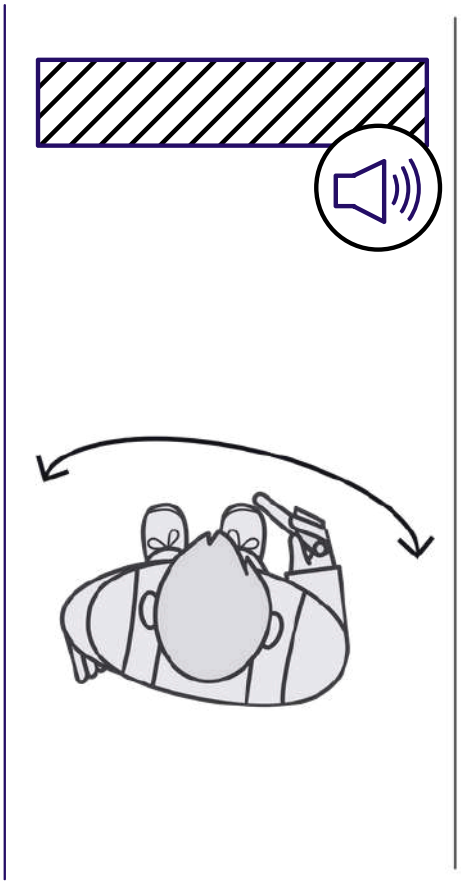
1) Setting Up the Device and App: The first exercise aims to teach learners how to turn on, set up, and wear the device. The O&M specialist will first remind the user of the device's functions and buttons, and answer any questions the user may have. The learner will then learn how to insert the battery, 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.). 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. 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 (ground-, waist-, and head-level) 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. 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 finding 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. This exercise should be repeated until the learner confidently identifies staircases and their endpoints using NOA.

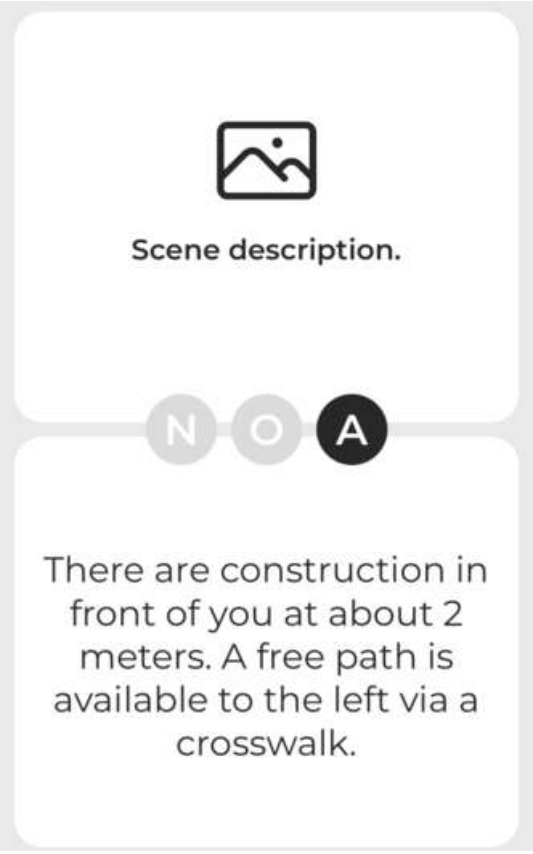
During subsequent sessions, the learner will be introduced to using NOA in outdoor environments. It is essential that the indoor lessons are thoroughly mastered before progressing to Lesson 4. Outdoor settings present additional challenges and distractions, making it critical for the learner to be fully 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). 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. Before beginning this task, the O&M specialist introduces the long description feature, explaining that it provides a detailed description of their surroundings. The learner is encouraged to compare it with the short description feature 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

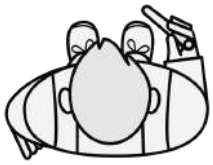
The objective of this lesson is to teach the learner to **set up and use the Navigation functionality from NOA.**

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.

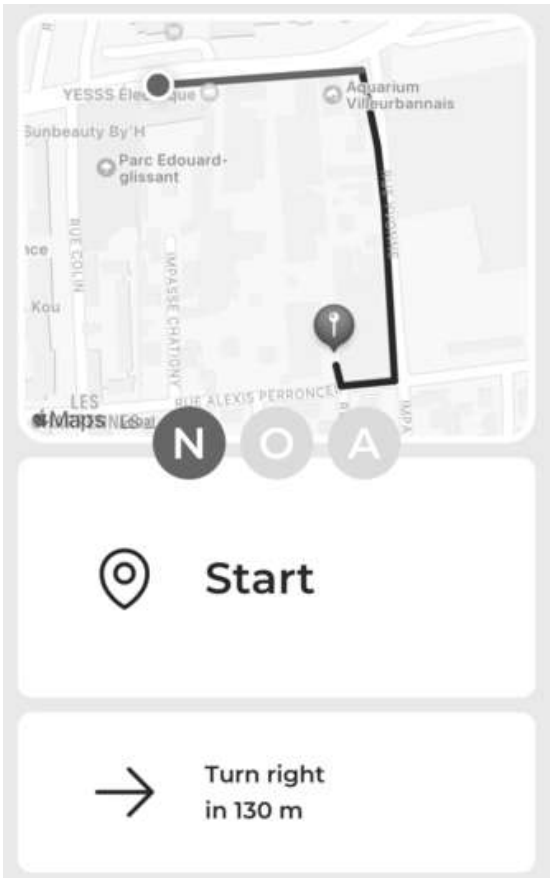
1) Setting Up the Navigation Feature: The first part of the lesson will focus on mastering the Navigation and GPS functionality on the device and in the app. The O&M specialist will remind the learner of the type of navigation instructions provided by NOA and how to use the feature with the NOA Companion App and buttons on the device. The learner will learn how to navigate the app page, save and edit their three 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 to set up and understand 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.

1.



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. An evaluation sheet can be found on the next page which can be used by O&M specialists to evaluate the competence of the learner.



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**.

O&M Assessment

Name of Student: **Date:**

Concept / Skill	Status (Y/N)	Comments
Turn NOA on/off and put it on pause (main button)		
Charge battery, insert it and be aware of battery levels		
Open NOA Companion App, connect NOA to internet and to headphones		
Set up and modify settings in NOA Companion App		
Change obstacle detection range (O1) and pause the feature when needed (2x O2)		
Scan surroundings with spatialized sound (O2)		
Detect obstacles, regardless of their height or position, and avoid them		
Detect stairs and holes		
Cane technique or guide dog navigation not affected by the use of NOA		
Set up itineraries on the NOA Companion App, and start them from the App or with NOA (N1)		
Get information on position and location (N2)		
Find specific objects with NOA (A1)		
Use Navigation and AI features for intersections		
Use the two scene description features correctly (2x main button or A2)		
User expresses confidence with NOA		

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.

What kind of feedback does it provide?

NOA generates sound feedback in headphones. But more specifically, biped provides spatial audio feedback in headphones. We recommend using bone conduction headphones.

Bone conduction headphones are simply headphones that are worn around the ears, not in the ears. They leave your ears free for conversations and important sounds. The Shokz Open Run Pro are the best performing headphones of this type.

When an obstacle is detected, for example the branch of a tree, at your head-level, on your left, biped will generate a short music note, like a "beep". The music note has a spatial effect, so you will intuitively feel that the sound comes from the left. If the obstacle is at your head level, it will be a high pitch "beep", and if it's on the ground level, it's a low pitch "beep". In a very short sound, you're therefore able to understand that an obstacle is located at your head-level, on the left.

Do I need the smartphone to use NOA?

NOA uses the GPS system of your smartphone to get GPS navigation instructions, and the network sharing to get the AI feature. Obstacle avoidance however doesn’t need any smartphone connected, so NOA could run standalone just for that.

Does NOA work under the rain?

NOA satisfies IP43 standards, which means light to medium rain. There is a risk that sensors operate with a degraded performance under heavy rain, so we do not advise keeping NOA out in such a case. We include a small travel bag for NOA that is rainproof if ever you need to pack it quickly under the rain.

Does NOA work at night?

Most of the features of NOA also work at night. NOA will be able to detect obstacles and holes, and provide GPS navigation. The AI description might now work properly.

Does NOA work indoor?

The GPS navigation system does not provide reliable instructions indoors. However, all other features perform well and have been tested indoor too.

What are NOA's technical specifications?

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

Can NOA be used with kids?

The current version of NOA has a size that would prevent anyone below 1.40 meters from feeling comfortable using NOA.

Can NOA be used if I have a retinitis pigmentosa?

Yes! Our infrared cameras are especially helpful for the low light settings people would struggle with.

Can NOA be used with a cochlear implant?

Yes! We ran tests with end-users who successfully managed to navigate with NOA, while having a cochlear implant connected over Bluetooth.

Can NOA be used with a hearing aids?
Yes! Modern hearing aids are Bluetooth enabled.

Can biped be NOA with a wheelchair?
Yes! We tested NOA with a couple of patients in a wheelchair, whom for white cane usage is possible, but harder. We noticed very good responses from end-users, and created a specific mode. To enable it, simply select "Wheelchair" in the settings of the NOA app.

Can NOA be used for hemispatial neglects or field cuts
Yes! We very early on included beta-testers who had field cuts or hemispatial neglects. We adapted NOA's software to only analyze the part of the image that the person does not process. To enable it, simply select "Hemispatial / Field cut" in the settings of the NOA app, and select whether you want to give feedback on the left or on the right of the image.

Can NOA be used if I have an age-related macular degeneration?
Yes!

Does it replace a white cane or a guide dog?
NOA does not replace the white cane nor the guide dog. At biped, we value the importance of these primary aids, we understand how effective they are to protect the very first meter in front of you, and we designed biped to work in conjunction with them. If you have had white cane training before, or if you are a guide dog user, just use NOA as a complement to your daily navigation habits.

Maintenance

How will the product evolve over time?
As an early product, NOA's AI is constantly being developed and tested to enhance its features so that it meets your expectations better with every update. We value your feedback and appreciate your patience as we work to create a solution that better meets your needs. To ensure you always have access to the latest and greatest NOA features, be sure to update your device from time to time.

How often is NOA updated?
Every 3 months. You get an email update the week before

I broke a glass of the device, what now?
It is a rather easy task to replace the protective glass, but we run these operations with our manufacturer. Contact us on support@biped.ai

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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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