

Finger-Mounted Obstacle Detector for People with Visual Impairment

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Abstract—Mobility is the ability to move. People with visual impairment has limited mobility as they have limited vision to move safely without colliding against obstacles. This paper presents a wearable device using technology to help people with visual impairment to detect obstacles. The device uses an ultrasonic sensor to obtain real time information of distance between device and obstacles. This information is interpreted into an audio feedback which will alert or notify users the presence of obstacles in their path. The device is small enough to be worn on the finger and direction of detection can be changed by pointing the hand or finger elsewhere. Three experimental testing were conducted to evaluate the prototype. First experiment was to determine the detection rate on indoor and outdoor obstacles of different sizes and shapes in a controlled environment. Second experiment was to test the prototype with participants wearing blindfolds (no vision simulator) and walking in an indoor environment filled with real life obstacles. Third experiment was conducted with participants wearing low vision simulators walking in an outdoor environment. Results showed the prototype works better for people with low vision than no vision.

Index Terms—assistive technology, obstacle detection, ultrasonic rangefinder, visual impaired

I. INTRODUCTION

Mobility is the ability to move easily and safely from one location to another. Human beings are designed to be a mobile creature but not everyone is mobile. Disease, accident, and genetic can result in mobility limitation. One limitation, visual impairment, reduces the mobility of people who suffers from the impairment.

Assistive devices or tools are used to improve the mobility of people with visual impairment such as a cane, guide dog and human assistance. However, the existing tools have limitations. Sweeping or tapping of the cane on the ground helps people with visual impairment in detecting ground level obstacle but not obstacles that are above waist level such as tree branches and open windows. Guide dogs could be trained to stop when there is obstacle, but it requires more care and expenses to maintain the dogs. Human assistance is the best solution but is very impractical as it involves constant human supervision.

II. BACKGROUND

Numerous studies were conducted to improve the mobility of people with visual impairment by designing a device that can detect obstacles. Two common obstacle detection techniques used are vision-based and sensor-based. Vision-based obstacle detector obtains information through camera which can be mono-camera, stereo-camera or RGB-D camera [1]. In most vision-based applications, it requires a processor with high computational power to break down and obtain the desired information from the camera image which contains many information. There are many algorithms developed by researchers to do certain tasks but it has limited functionality in obtaining information on objects that are transparent and in dark environment.

Sensor-based method is usually straightforward as the sensors are designed to perform a specific task. Laser sensor has high precision and resolution which are commonly found in mobile robot navigation. The sensor, however, can be expensive and may not perform well in an environment exposed to strong sunlight. An ultrasonic sensor can measure distance of obstacles but it has lower accuracy when compared to laser. It has a wider range of detection but depending on usage, this characteristic can be a drawback when a precise detection of obstacle location is desired.

Some existing research works are ultrasonic-based obstacle detection which can be categorized into cane, robot and wearable. Smart canes are walking sticks used by people with visual impairment embedded with smart technology and are developed by several researchers [2]-[6]. The distinct differences of the developed prototypes are the amount of sensor implemented, the feedback system used for notification, length of the stick, and the field of detection.

Two ultrasonic sensors were implemented and were located at the bottom of the stick [2]. It detects ground level obstacle from left and right simultaneously. Haptic feedback was implemented on the handle of the cane. The prototype was designed to replace walking stick and is capable of detecting obstacle taller than 10cm. However, the maximum detectable height was not evaluated.

A similar prototype [3] was built with two ultrasonic sensors located at the bottom, haptic feedback but with an additional feature of audio feedback. Sets of sound are stored and will be played when obstacles are detected. It is designed to detect ground-level obstacle so people with

Manuscript received January 26, 2018; revised March 5, 2018; accepted April 10, 2018.

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Foundations of Orientation and Mobility William R. Wiener, Richard L. Welsh, Bruce B. Blasch, 2010 Foundations of Orientation and Mobility the classic professional reference and textbook has been completely revised and expanded to two volumes by the most knowledgeable experts in the field The new third edition includes both the latest research in O administration assessment and program planning and a chapter on research in O M No O M student or professional can afford to be without this essential resource [Foundations of Orientation and Mobility, 3rd Edition](#) William R. Wiener, 2010 Foundations of Orientation and Mobility the classic professional reference and textbook has been completely revised and expanded to two volumes by the most knowledgeable experts in the field The new third edition includes both the latest research in O teaching O the use of technology based travel systems and travel in complex environments No O M student or professional can afford to be without this essential resource **Low Vision - E-Book** Christine Dickinson, Ana Hernandez Trillo, Michael Crossland, 2022-11-04 Providing an ideal balance of theory and practice Low Vision Principles and Management covers all aspects of providing effective eye care to individuals with visual impairment This concise yet comprehensive resource covers everything from theoretical background to current rehabilitative aids and low vision treatment strategies all while adopting a practical approach to vision care It brings practising eye care professionals and students fully up to date with current optical and electronic devices and how they are used in everyday practice as well as evidence based vision rehabilitation guidelines Features comprehensive guidance on visual rehabilitation for acuity loss and visual field loss Describes a wealth of practical advice and real world case scenarios to help guide your day to day patient interactions as well as your most challenging situations Covers hot topics including the link between mental health and low vision assistive technologies measures of quality of life and other outcome measures WHO classifications of visual impairment and best practices for auditing and commissioning vision services Contains over 200 diagrams illustrations and patient photos to aid in visual understanding Explains how eye care professionals can work within a multi disciplinary team to provide complete care An eBook version is included with purchase The eBook allows you to access all of the text figures and references with the ability to search customize your content make notes and highlights and have content read aloud

Wearable Haptic Devices for Realistic Scenario Applications Federica Barontini, 2024-11-02 This book delves into the application of wearable haptic feedback technology in various contexts focusing on prosthetics for individuals with upper limb loss and navigation systems for the visually impaired Central to the book is the development of technologies that address users needs and demands It highlights the pivotal role of a user centred approach in designing and creating novel feedback mechanisms Beginning with focus groups and experimental campaigns each chapter introduces innovative haptic devices that are characterized tested and refined to consistently meet user requirements The research culminates in the creation of a fully integrated feedback system within a prosthetic socket This book provides comprehensive insights into

developing practical user friendly haptic devices that significantly improve the quality of life for individuals with sensory impairments **Handbook of Research on Human-Computer Interfaces and New Modes of Interactivity** Blashki, Katherine,Isaías, Pedro,2019-05-31 Due to its versatility and accessibility individuals all around the world routinely use various forms of technology to interact with one another Over the years the design and development of technologies and interfaces have increasingly aimed to improve the human computer interactive experience in unimaginable ways The Handbook of Research on Human Computer Interfaces and New Modes of Interactivity is a collection of innovative research on the methods and applications of interactive technologies in the modern age Highlighting topics including digital environments sensory applications and transmedia applications this book is ideally designed for academicians researchers HCI developers programmers IT consultants and media specialists seeking current research on the design application and advancement of different media technologies and interfaces that can support interaction across a wide range of users

Representing Space in Cognition Thora Tenbrink,Jan M. Wiener,Christophe Claramunt,2013-10 This book considers how people talk about their environment find their way in new surroundings and plan routes Leading scholars and researchers in psychology linguistics computer science and geography show how empirical research can be used to inform formal approaches towards the development of intuitive assistance systems **Manual of Classification** United States. Patent Office,1920 Includes list of replacement pages *Universal Access in Human-Computer Interaction. Human and Technological Environments* Margherita Antona,Constantine Stephanidis,2017-06-28 The three volume set LNCS 10277 10279 constitutes the refereed proceedings of the11th International Conference on Universal Access in Human Computer Interaction UAHCI 2017 held as part of the 19th International Conference on Human Computer Interaction HCII 2017 in Vancouver BC Canada in July 2017 jointly with 14 other thematically similar conferences The total of 1228 papers presented at the HCII 2017 conferences were carefully reviewed and selected from 4340 submissions The papers included in the three UAHCI 2017 volumes address the following major topics Design for All Methods and Practice Accessibility and Usability Guidelines and Evaluation User and Context Modelling and Monitoring and Interaction Adaptation Design for Children Sign Language Processing Universal Access to Virtual and Augmented Reality Non Visual and Tactile Interaction Gesture and Gaze Based Interaction Universal Access to Health and Rehabilitation Universal Access to Education and Learning Universal Access to Mobility Universal Access to Information and Media and Design for Quality of Life Technologies *Trends and Challenges in Indian Business Management* Deepak Ashok Kumar Dr. Hari Sundar G.Ram Arun Krishnadas,2014 [The Official Raspberry Pi Handbook 2024](#) The Makers of The MagPi magazine,2024-05-07 The Official Raspberry Pi Handbook 2024 is packed with all the information beginners need to use their new Raspberry Pi computer Inside you ll also find the best projects from the past year for long term Raspberry Pi enthusiasts With a special section on Raspberry Pi 5 the latest and greatest in the Raspberry Pi microcomputer line you ll learn how to code and make with this incredible computer We ve

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Manual of Classification of Subjects of Invention of the United States Patent Office United States. Patent Office,1912

Human-Computer Interaction - INTERACT 2017 Regina Bernhaupt,Girish Dalvi,Anirudha Joshi,Devanuj K. Balkrishan,Jacki O'Neill,Marco Winckler,2017-09-19 The four volume set LNCS 10513 10516 constitutes the proceedings of the 16th IFIP TC 13 International Conference on Human Computer Interaction INTERACT 2017 held in Mumbai India in September 2017 The total of 68 papers presented in these books was carefully reviewed and selected from 221 submissions The contributions are organized in topical sections named Part I adaptive design and mobile applications aging and disabilities assistive technology for blind users audience engagement co design studies cultural differences and communication technology design rationale and camera control Part II digital inclusion games human perception cognition and behavior information on demand on the move and gesture interaction interaction at the workplace interaction with children Part III mediated communication in health methods and tools for user interface evaluation multi touch interaction new interact ion techniques personalization and visualization persuasive technology and rehabilitation and pointing and target selection

Robotics Text Book Manish Soni,2024-11-13 Welcome to Robotics From Fundamentals to Advanced Applications your comprehensive guide to understanding and mastering the field of robotics In an era where automation and intelligent systems are revolutionizing industries robotics stands at the forefront driving innovations across manufacturing healthcare exploration and more As we delve deeper into this transformative technology it is essential for both beginners and seasoned professionals to grasp its fundamental concepts and applications thoroughly This book is meticulously crafted to

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Handbook of Research on Integrating Industry 4.0 in Business and Manufacturing Karabegović, Isak, Kovačević, Ahmed, Banjanović-Mehmedović, Lejla, Dašić, Predrag, 2020-03-27 In Industry 4 0 industrial productions are adjusted to complete smart automation which means introducing self automation methods self configuration self diagnosis of problems and removal cognition and intelligent decision making This implementation of Industry 4 0 brings about a change in business paradigms and production models and this will be reflected at all levels of the production process including supply chains and will involve all workers in the production process from managers to cyber

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