R0V3R: Robotic Guide for the Blind

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The purpose of this project is to develop a product that gives blind people the independence to be able to safely travel on their own. The robotic guide, R0V3R, is equipped with ultrasonic sensors to help users move in a straight line and to detect numerous obstacles the user may encounter. The robot is interactive with the user and can verbally describe the environment around it. With a built-in charger and its light weight, the robot makes traveling much more feasible for the visually impaired.

I. Introduction

Current solutions to the guidance of the visually impaired while functional, are not a perfect fit to the ultimate goal of independence and safety. Alone an individual can only navigate with a cane through an area in which they are familiar. Guidance by dogs is more practical but has limitations, as they are unable to read signs and cannot navigate effectively in new areas. Human guides are the most desirable, but are not always available to assist the blind. A feasible solution to the problems that blind individuals face on a daily basis is a robot to help guide them through their environment. A guide robot does not require constant attention like a dog and would give individuals a sense of independence and safety, in spite of their handicap. The robotic guide provides a more encompassing solution to assist the vision impaired. The blind struggle to walk on a straight path unassisted, the robot tracks straight when guiding until an obstacle or point to turn are located. Sensors in the front, sides, top, and bottom of the robot notify the guide of potential issues while on route. When the sensors are triggered the robot guides the user around the obstacle safely while they hold onto a handle connected directly to the robot. Another sensor locates objects above that could cause a risk of hitting the user. The robot can interact with the operator through voice commands, and when addressed be able to give a response. This is mainly done through Microsoft Seeing AI. Microsoft Seeing AI utilizes R0V3R's built in camera to view its surrounds and verbally describe it via R0V3R's speaker. The robot has a safety feature that only allows it to move when the user is holding the handle, eliminating the possibility of the guide leaving the user in an unfamiliar place. It is portable as to be carried upstairs, and rugged for guidance when off sidewalks and streets. R0V3R is water resistant so it can still operate in the rain. Using a rechargeable battery, the robot will replenish the energy that was expended while traveling and interacting with the operator. The robotic guide will help to alleviate the strain and dangers of traveling alone, returning to the visually impaired a sense of confidence and independence.

II. Materials And Methods

A common tool blind individuals use is a white cane. Blind individuals use white canes by extending them out in front of themselves and tapping around for any obstacles within their path. R0V3R expands onto the design of a white cane and transforms it into a functional robot. White canes are always slanted at an angle with the end section tapping around for objects. R0VER's handle is also slanted at an angle, but with wheels attached to a plastic casing at the end of it. Instead of having to tap around surroundings like a white cane, R0V3R moves itself with its all-terrain tires. Attached to the casing are ultrasonic sensors that detect obstacles and move the robot away from any obstacles within its path.

Figure 1. R0V3R interacting with user

The sensors are mounted above, below, and on all sides of the robot for a full 360 intake of its surroundings. This allows the robot to detect obstacles at, above, and below chest level. Obstacles at and below chest level include people, cars, and drop offs such as cliffs. Obstacles above chest level are equally as important due to head injury that low hanging tree branches or signs can cause. A rechargeable battery directly powers the voltage control board in R0VER. The voltage control board connects to the four motors that drive the robot, and the computer. The computer controls the interactions with the speaker, mic, on/off button, Microsoft Seeing AI, and the information from the other various sensors. The casing contains all of these components within it. The conduit handle attached to the casing and tires is in the shape of a "U". This ergonomic handle allows the user to have a greater hold on the device as well as allowing for easier interpretation of the robot's movements. When the robot's tires start moving away from an obstacle, it will be easier for the user to feel and sense what direction the robot wants to move in. The user will be able to feel what side of the handle is drifting away from their hand, telling them to follow the robot in a certain direction. This "U" shaped design also adds another point of contact between the handle and the casing. By having two contact points it allows for an overall less load on the points of contact, which allows for a stronger and longer connection between the handle and casing. The handle can expand and contract in order to accommodate to each user's height.

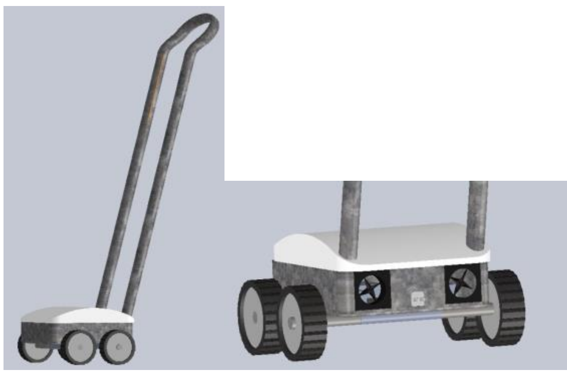

Figure 2. Design of R0V3R with casing and conduit handle

III. Electronic Components

The battery is what provides power to the whole system. It is connected to every component that requires a voltage to operate. For our system, we require a battery that can supply enough voltage to our motors, GPS, raspberry pi, and all other peripherals. Out of all these components, the one with the greatest voltage requirement is the motors. We will be using 12V motors, and because of this we will be required to have a 12V battery. The motor control system is a vital part of our system. It is going to be what ultimately guides the user around obstacles that are in front, above, below, or to the sides of them. It does this through 3 different components that give commands on how the motors should run in any given circumstance. A block diagram of this can be seen in the Figure 3 below.

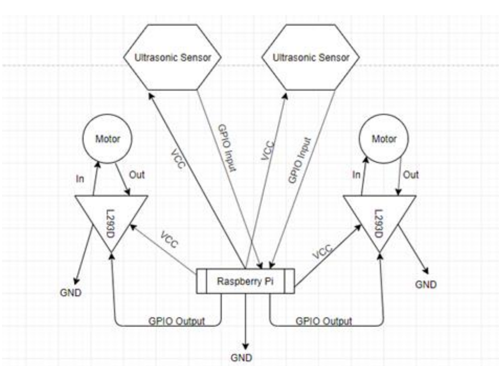

Figure 2. Connections to Raspberry Pi

The raspberry pi serves as the brains for the motor control system. It is the intercommunication between the motors and the sensors. It holds and runs the code that will tell the motors when and how-to operate. R0V3R has a programmed script in Python that consist of if-then statements. These statements use the inputs from the ultrasonic sensors and convert that into different levels of voltage that go into each motor. This process of controlling the motor speed in Python is called pulse width modulation. Pulse width modulation uses different duty cycles in the code to change the speed of the motors. It does this through the L293D chip that has the transistor built into it. The raspberry pi does this all through its GPIO pins by assigning the sensors as inputs and the motors as outputs. The L293 chip is used in R0V3R to allow for the PWM functionality to work for the motors. The GPIO output comes directly from the raspberry pi, which is used to allow current through the transistor. The diode of this circuit is only used to prevent voltage spikes for when the transistor is activated. This circuit uses the PWM functionality from the raspberry pi to control the speed of the motor.

IV. Impact to Visually Impared

With a design like R0V3R's in the market, it will inspire more products to become available for the blind community. This robotic guide is designed with materials that do not make the guide very costly. Almost everyone will be able to afford the robotic guide. No matter where the user is at globally, the robotic guide will work. The design includes all-terrain tires that allow users to use the guide almost anywhere. A charging cord is built into the robot so no matter where the user is, as long as there is an electrical outlet nearby, the user will be able to charge the robot as needed. With R0V3R, the blind community will not need human guides and will not feel like an imposition to others. The design allows for blind individuals to feel like any other member of society.

V. Conclusion

The robotic guiding device provides an effective and efficient way for the visually impaired to travel. Tasks others find simple, such as walking in a straight line, are impossible for the visually impaired. With ultrasonic sensors and features like Microsoft Seeing AI, R0V3R gives blind individuals the independency and support they need.

Acknowledgements

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