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Safe Navigation for Visually Impaired Users with a Time-of-Flight and Feedback Device

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ABSTRACT

This paper presents ALVU (Array of Lidars and Vibrotactile Units), a contactless, intuitive, hands-free, and discreet wearable device that allows visually impaired users to detect low- and high-hanging obstacles, as well as physical boundaries in their immediate environment. This solution allows for safe local navigation in public places as well as close and open places by enabling the user to differentiate free space from obstacles in their environment. The device consists of two parts: a haptic strap and a sensor belt. The sensor belt consists of three time-of-flight (Tof) sensors worn around the front of a user's waist, and the pulses of infrared light provide accurate and reliable measurements of the distances between the surrounding obstacles and user or surfaces. The haptic strap is used as a feedback device and communicates the measured distances of the obstacles through an array of vibratory motors known as dc motors worn around the user's upper abdomen, providing haptic feedback. When a user comes across a object sensor transmits the information to the feedback device through Arduino which acts as a Bluetooth device.The vibrators are used to vibrate the user when a obstacle appears in his immediate environment. Users wearing the device successfully walked through hallways, avoided can obstacle.

1. INTRODUCTION

In the present world there are approximately 300 million people suffering from visual impairment of which 15% are blind. According to a survey for every 5s one person will be added to the list of people suffering from visual impairment. There are several problems faced by these people in which some are more dangerous like, moving in a busy road, bus stations etc. Few small obstacles like chairs, pot holes etc also lead to sevier damage to their body. There are many solutions to solve their problem to an extent like white canes. But these white canes need physical contact and more concentrate on the external physical world.

In this paper we designed a technology which includes sensors and few light weight hardware devices to sense the surroundings without need of white canes. The device is implemented into the clothes of the user. From this project we can make surroundings of the visually impairment people more friendly to them.

2. LITERATURE SURVEY:

There have been several works proposed towards the solution of visual impairment. One study reported the design of a hand held device with two infrared sensors combined with audio and vibratory feedback [1].Users were not comfortable using the device in place of a white cane and the device was not successful in preventing damages and collisions with the environment [2].In some proposed works long time response made the system inefficient for real time navigation. And other study reported use of depth camera, and a neural network to detect free space[3].A related work mounted a depth camera to glasses, which was used to build occupancy map used as output displayed on the feedback test [4].The system provided a speed advantage in steering a blind user through the map only when used in conjunction with a white cane and system do not provide local obstacle detection [5].we recently showed an alternative approach to the problem using a wearable depth camera [6].and also implemented the algorithms in that work on a low power vision processor [7].

3. PROPOSED WORK

We present ALVU, a novel wearable system for safe navigation that is effective at providing a user with detailed feedback about the obstacles and free space surrounding the user. We also describe studies with blind subjects that assessed the performance and effectiveness of our system.

Specifically, we integrated an array of sensors and feedback motors into a discreet wearable system to create an assistive navigation device for a person with visual impairments. The overall system design involves two parts: A sensor array consisting of distance sensors and a haptic array consisting of feedback units. A user wearing ALVU experiences his or her distance from surfaces/obstacles in his surroundings via feedback from the haptic strap that goes around the upper abdomen. Shorter distances to obstacles are relayed by increased pulse rates with higher vibration strength. For example, when there is an obstacle to the right of the user, he or she feels strong frequent pulses on the right side through the haptic strap. For the user, this leads to the perception of an obstacle to the right. The user can then avoid the obstacle by stepping left. After stepping left, the pulses on the right side stop and the user perceives that there is no longer an obstacle on his or her right side. The goal is to integrate this functionality into a discreet wearable system.

4. METHODOLOGY

4.1. Design

ALVU consists of two components: sensing the world to create a map, and projecting the map onto the user's body through haptic feedback. These components can be implemented in various ways and we chose to build them as a sensor belt and a haptic strap. In the following sections we discuss the design of the sensor belt and the haptic strap. We addressed the key challenge of determining the number of vibration units and sensors by assessing the user's sensitivity and ability to distinguish vibrations sparsely spaced around the abdomen and the user's desired field of view.

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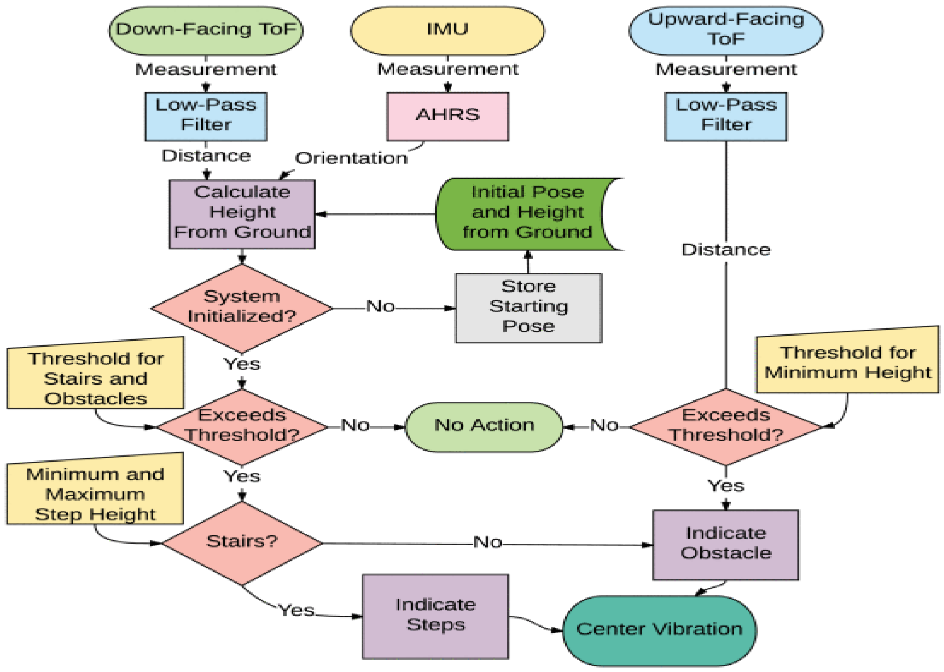
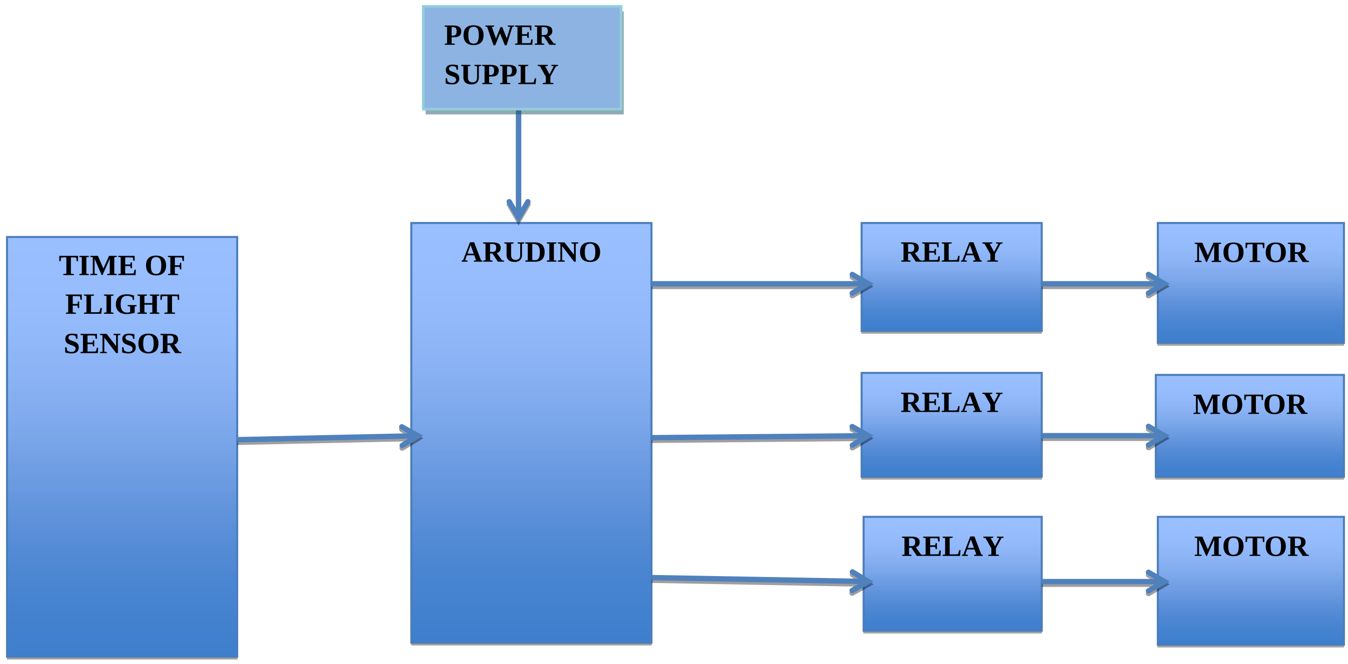
4.2. Flow chart



4.3. Block diagram:



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5. HARDWARE AND SOFTWARE REQUIREMENTS

Table: 5.1

HARDWARE REQUIREMENT	SOFTWARE REQUIREMENT
1.Time of flight[LIDAR Sensor] 2.Arduino 3.Relay 4. DC Motor	1.Embedded C

6. CONCLUSION

From this project we made a step to solve the problems faced by visually impairment people. This device helps the visually impairment people to sense the external world more efficiently and easily.

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