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Enhanced Smart Cane for the Blind

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Abstract - *Vision is an irreplaceable asset to humans and the loss of it makes daily life very challenging. As per the International survey by World Health Organization conducted in the year 2018, it is estimated that there are more than 2.2 billion people with visual impairment or blindness. Though this cannot be overturned completely, the blind can be aided through such smart devices. This smart cane is intended to replace traditional blind canes which are used to detect obstacles when they come in contact to the stick. It shall be able to detect different kinds of obstacles from a safe distance and warn the blind, detect wet and slippery surfaces and warn to avoid such paths. Another feature is to sense dark areas and switch on a flashlight, warning not only the blind bit alerting others in the way including fast moving vehicles. This stick provides a panic button, which when enabled shares the real time location with the required care takers. Buzzers for quick response and voice commands for clear understanding are provided to warn and alert the blind in time. The existing products are unaffordable by majority of the blind population in this country, and hence it's a rare sight to see the blind using smart gadgets. This stick is designed to be viable within low costs and thus help majority of the blind. Various interested NGOs come in handy for the channelization of such devices. Two further enhancements are proposed for those who can afford, and they are pill shape and color detection and edge based navigation through image processing.*

Key Words: **Dark areas, Location sharing, Obstacle detection, Pill colour, Voice commands, Wet floors**

1. INTRODUCTION

Sight is an invaluable asset to any human being. More than 70% of the information humans acquire about their surroundings is through vision and the rest is through other senses. Reflexes, reactions and responses are primarily based on the information feed from eyes. Also visual cortex of the brain is amongst the most responsive areas of the human brain [2], hence being an important source of swiftness and safety. Hence it can be seen that vision is a primary sense and the deprived have hard time coping with the lack of it. Their daily life is different from the normal as they have to deal with struggles constantly. To ease out their daily lives, they can be aided with helping devices such as these smart blind canes. As per the International survey by World Health Organization conducted in the year 2018, it is estimated that there are more than 2.2 billion people with visual impairment or blindness [4]. The usually used canes detect obstacles only when they come in to contact physically. The proposed tool is a smart and advanced tool that is based on a microcontroller system and this shall help the blind to sense or know about obstacles from a safer distance without coming into physical contact.

This cane is intended to replace traditional blind sticks as the only limited feature the traditional sticks offer is to detect obstacles only when they come in contact to the stick. Smart canes can help the blind in various ways using sensors, actuators and other warning devices to guide the blind safely. It detects different obstacles from a safe distance, detect wet and slippery surfaces and warn. Also it detects dark areas and switches on a flashlight to warn people and vehicles in the way along with a warning to the blind. It is natural for the blind to forget routes and sometimes feel lost when they are on their own. They may want to intimate their caretakers but might not be able to do so as they may not be able to use location sharing apps. This stick provides a panic button that shares the real time location with the required care takers. Sensing itself is not useful if the person is not warned properly. Hence buzzers for quick response and voice commands for clear understanding are provided to warn and alert the blind in time. Vibrators can also be added, so as to make the device compatible with the deaf too. Many of the already available aids are too costly and unaffordable by many. The proposed tool is a low cost viable module. Also this paper proposes two enhancements, namely detecting the medical pill colour and shape and also edge based navigation through image processing.

The paper is structured as described: in Section 2, this paper discusses about the smart cane being proposed, its architecture, planning and enhancements being made. Section 3 briefs about the required components and modules. In Section 4, a detailed overview is given about implementing the cane using various components and modules and integrating them. It also discusses about the prototype achieved. Section 5 concludes the paper overall.

2. PROPOSED SMART CANE ARCHITECTURE

The cane built is proposed to be a fully working prototype that can help build a final product. The architecture and planning of the prototype is further discussed in the following sections.

To sense each of the parameters the best possible sensor is chosen. The output devices are used to provide warnings to the blind person.

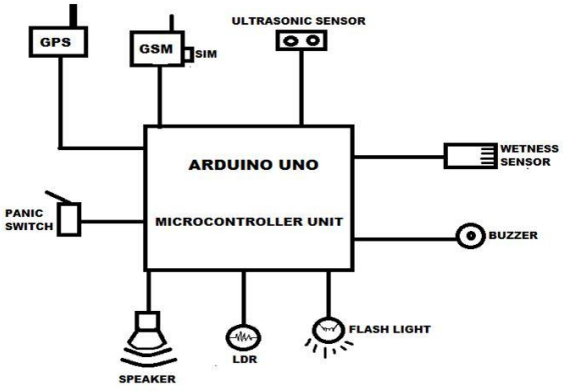

Fig -1: Block level planning

Arduino UNO is chosen as the microcontroller owing to its ease of accessibility and low cost considerations to achieve it at reasonable prices. The complete block layout design is as illustrated in the Fig. 1.

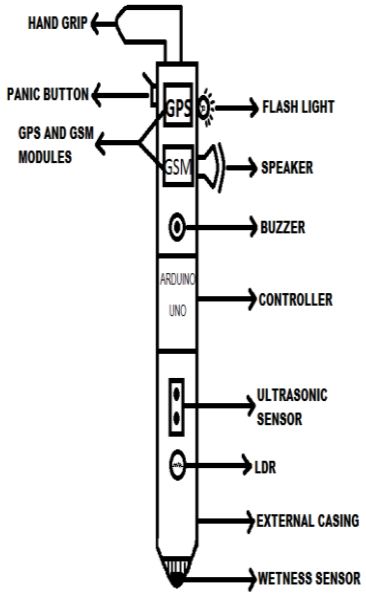

Fig -2: Module Planning

The module layout shows the planned placements of various sensors and other hardware components along with the microcontroller with respect to the stick used. Here a walking stick is used upon which all the components are planned to be integrated upon as illustrated in the Fig. 2. The placement of each of the components is decided in a way to get an efficient overall structure. Also the microcontroller unit is centrally placed to make it more accessible to all the components uniformly. This will also ensure that the wire lengths required is minimal from the MCU (Micro Controller Unit) to the components.

As the wetness sensor is required to come into contact with the floor, bushes are used at the bottom to absorb shocks and protect the sensor. Ultrasonic sensor is also placed nearly at the center to be able to sense the obstacles optimally. Panic button is thoughtfully placed near the hand grip to make it easily reachable to the hands.

3. COMPONENTS AND MODULES

The various hardware components, modules and output transducers required for the construction of the aid are as listed follows:

- Microcontroller- Arduino Uno(ATmega328p)
- Ultrasonic sensor (HC-SR04).
- Light dependent resistor (LDR).
- Moisture sensor
- GPS module.
- GSM module.
- LED
- Buzzer
- Speaker(0.5w)
- Enhancements (Camera, Python platform)

The following section describes the components and modules in a brief manner and also their working.

3.1 Obstacle Detection

To detect the obstacles from a safe distance, an Ultrasonic sensor placed at knee height is used. Here a HC-SR 04 module is used for the same. An ultrasonic sensor transmits ultrasonic waves and the same is reflected back on hitting an obstacle. This reflected wave is captured back by the sensor. The total time taken is calculated based on the amount of time echo pin remains high due to the received wave [6]. Now simply calculate the distance using a microcontroller or microprocessor that uses the relation that distance is the product of speed and time where speed of Ultrasonic wave is already a known constant (330 m/s). Based on our requirements, a safe distance limit is set and warning is triggered if the obstacle falls within this range.

3.2 Wet floor detection

To detect wet or moist floors which can be slippery, a moisture sensor is used in this module. Moisture or wetness

sensor is a device that checks the presence of wet floors and alarms instantly. Moisture sensor consists of metal strips which are used to detect water content. They allow the current to pass through the strips and then it gets the resistance value to measure the moisture value [6]. Depending on these values, an alarm is raised if it is slippery to avoid tripping and falls which may lead to injuries.

3.3 Darkness detection

To detect darkness an LDR (Light Dependent Resistor) can be used by exploiting its property of variable resistance. An LDR's resistance depends on the incident light, bright light decreases the resistance and darkness leads to high resistance [5]. When this LDR detects darkness, an alarm is raised to alert the blind person. Also a LED (Light Emitting Diode) flashlight starts blinking to warn the people and fast moving vehicles in the path.

3.4 Location sharing

To detect the current location and share it to the caretaker, a GPS (Global Positioning System) module and a GSM (Global System for Mobile) Module (SIM800L) are used. GPS is primarily a satellite based navigation system. The receiver requires to be locked on to a minimum of 3 satellites to calculate the current 2-D position comprising of the latitude and longitude [1]. Once the position has been determined, the data is pushed to the GSM module to be sent out. GSM module helps to establish communication with the GPRS. A SIM card is inserted into the module and when it receives the location data, same is sent to the required caretaker's contact number.

3.5 Warning / alerting devices

Speakers are used to provide voice alerts for the clear understanding of the warnings. The commands are set in a loud and clear fashion. To provide fast and reflexive warnings, a buzzer is used and different buzz patterns are used to notify different set of warnings.

3.6 Enhancements

Medicinal pills available in market come in a variety of shapes, colors and sizes. Similar pills might be confusing for consumption. To aid the blind with the same, these details of pills are detected through image processing. The obtained data may be integrated with the stick, which shall further provide the same info through voice to the user.

Also, through image processing, edges are detected and the user can be guided in open spaces to move accordingly. To achieve both of these enhancements, a python platform and a camera are necessary. These enhancements are tested on a computer. They can be integrated with the stick by adding this system on a Raspberry pi module.

4. INTEGRATION AND RESULTS

After analyzing all the required hardware components like various sensors and transducers, each of the components is individually tested for sensing and measurements. Each of these are connected to the Arduino UNO individually and measurements are made. They are calibrated for the required ranges for optimal functioning. Then the voice commands are tested along the buzzes from buzzer.

The GPS module is used here to detect the location and is connected to the Arduino. It requires time initially to detect three satellites to lock upon and locate it. This can initially be monitored using serial monitor on the computer to check the detection of proper latitudes and longitudes. Then the GSM module is connected and a SIM card associated to a network is inserted into the GSM module. The target number and message format are pre-coded into the MCU. When the panic button is set on, this is detected and location is shared as an SMS comprising of precise latitude and longitude values. After all the hardware components are integrated into a single circuit and a single code is obtained, all the sensors are placed in their respective positions on the stick. The modules and output transducers are also placed upon the stick at suitable places.

Fig -3: Integrating sensors on stick and encasing

The MCU is placed centrally to ensure equal transmission delays to all the components. Then the whole circuitry is enclosed in a suitable casing so as to be light weight and comfortable as depicted in Fig. 3.

For power requirements, chargeable batteries are used to ensure reusability. Ports are provided to charge the battery. There is an USB port that can also be used to reprogram the MCU in case of any requirements. After all this is carried out successfully, a comfortable smart stick is obtained.

Fig -4: Different views of the final prototype

After integrating all the components on the stick and uploading the required programs, the whole setup is encased and powered up. The case is made to look good aesthetically as shown in Fig. 4. When the device is powered up, it starts sensing the environment and works as required. It detects the obstacles, wet floors and dark areas and intimates the warning through buzzers and voice commands.

Also on exciting panic button, location is sent to the preset contact and the location was verified to be proper. Also this was achieved at a very low budget, hence satisfying the low cost objective too.

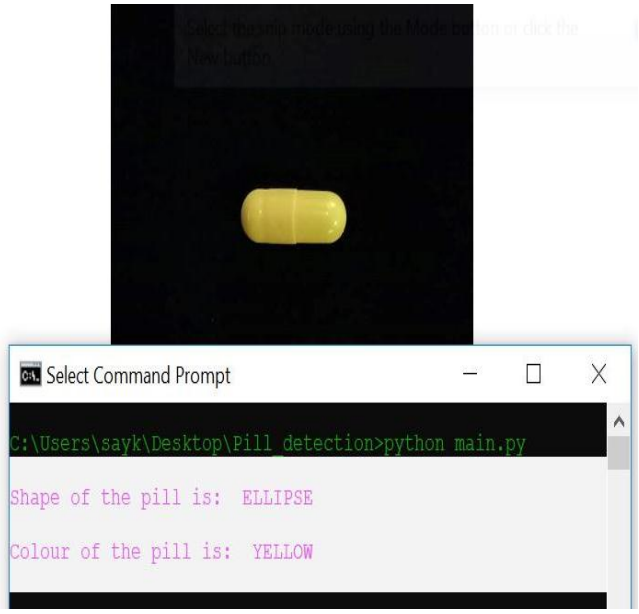

Fig -5: Detecting the color and shape of medical pills

Also the enhancements were tested on a python platform and results were obtained. The shape and color of the pills are printed out as shown in Fig. 5 and this can further be integrated to give voice outputs.

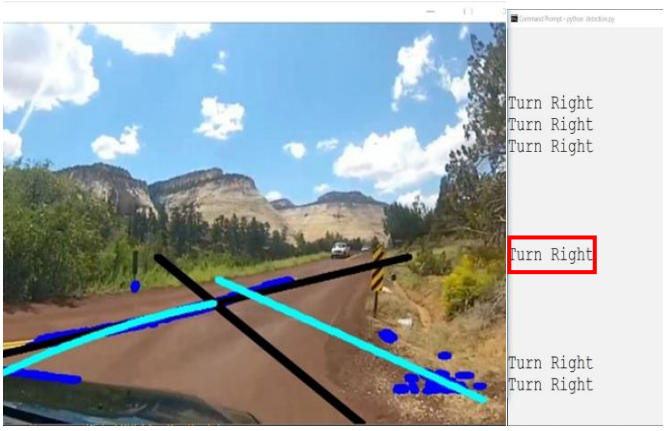

Fig -6: Edge detected and tool asks to turn right

5. CONCLUSION

The enhanced smart blind cane developed is a completely working prototype of the required features. It is potentially made nearly equivalent to a fabricated device. It is found to meet all the objectives without any noticeable hindrances. It is tested in external environments and is verified to be working fine. Obstacles within 25 cm range from the person shall trigger alert. The circuit designed is a viable candidate for fabrication as derived from the prototype. The stick is also found to be light weight (approximately 600 grams) and comfortable for use. It can be made more comfortable by the use of aluminum casing. All the parameters are efficiently

sensed and the person is alerted well in advance. Location sharing is also successful. Rechargeable batteries are found to last for 10-12 hours on use. Hence in an overall sense, the prototype is successful in sensing all the parameters and is found to be a useful aid to the blind. Also it is achieved at a very reasonable cost, fulfilling the low cost objective too. If the prototype can be effectively manufactured, the sticks can be let out within INR 2000, fulfilling the objective. The enhancements can prove to be useful in identifying pills and also navigating the blind outdoors based on image processing.

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