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Implementation of Microcontroller Based 3D-Intelligent Walking Stick to Assist the Blind People

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ABSTRACT:
Vision is a precious gift from God that one can able to see and enjoy this beautiful world. But many people throughout the world are deprived of this. According to October 2017 report of World Health Organization (WHO) an estimated 253 million people live with vision impairment: 36 million are blind and 217 million have moderate to severe vision impairment. Un-operated cataract is the main reason for blindness in low income and developing countries. Even in China by the end of 2017, the population over 60 will reach 241 million, accounting for 17.3 percent of the country's total population and nearly 40 million are disabled and semi disabled, according to data released by the Committee for the elderly in 2018. So, in this case most of the visually challenged people cannot afford an expensive device to use as their supporter. So, in this project we have proposed a cost-effective 3D intelligent Walking device. This is mainly depends on the sensors because Sensors can improve the world through diagnostics in many applications and it helps to improve performance. This device is implemented using Arduino Controller, IR Sensors (For 3D),Vibration Sensor (Piezoelectric sensor is for Pressure and Acceleration) as well as GSM and GPS for location Sharing. Also we are introducing Voice module with this to give the directions through audio format. This Entered device is programmed by simple deep learning algorithms to optimize the machine.

Keywords: 3D Blind Stick, GSM, GPS, Arduino Controller, Deep Convolutional Neural Network Algorithm.

1. INTRODUCTION

Independence is the important methodology in achieving objectives, dreams and goals in life. Visually impaired/blind persons find themselves challenging the dangerous paths to go out independently. There are millions of visually impaired or blind people in this world who are always need the help from others. For many years the normal walking stick became a well-known attribute to blind person's navigation and later efforts have been made to improve the walking stick by adding remote sensor. Blind people have big problem when they walk on the street or stairs using normal walking stick, but they have sharp haptic sensitivity. The electronic walking stick will help the blind person by providing more efficient and convenient

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means of life. Moving through an unknown environment becomes a real challenge for the blind or impaired people. Those who go out from the house with the white stick, often use well-known routes and difficulties with new ones. Moreover, many people simply afraid of being helpless in constant movement of people, vehicle and other road users. It is therefore advisable to offer new solutions of the problems with existing technologies. This paper proposes the design and develops a portable stick for a blind people/impaired people for convenient use and navigation in public and private places.

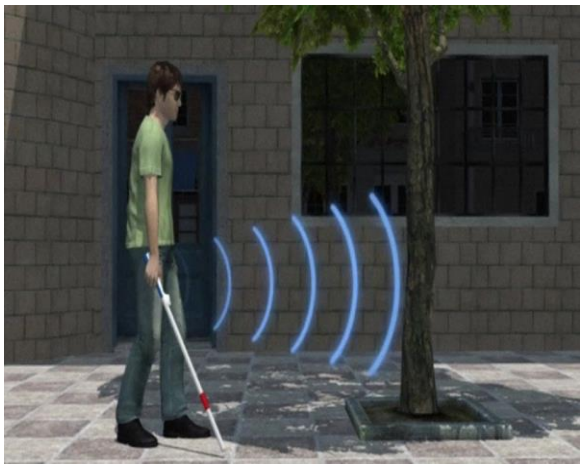

Figure 1: Blind People with smart walking stick.

Visual debilitation also known as blindness is the condition which is affecting many individuals around globe. This leads to loss of vision. Blind individuals must recognize objects. So, these people require some aiding equipment. Almost all blinds cannot walk around independently and require dependent on someone to travel. The preferred walking aid for blind is the traditional white cane. White cane is one such tool which are used by blind or who have imperfect vision to be independent. The cane helps blind to find obstacles and to overcome them safely. It was recognized as the standard gear for the visually impaired. Therefore, various technologies are used as solution to assist the blind people. Some researchers have developed walking stick for visually impaired people for safe navigation. In work [1], walking stick consists of a camera, earphone for output and four ultrasonic sensors. This system gives the result for all 360 degree from the position of the cane. The camera is used for text and object recognition. In [2], authors have developed walking stick with an ultrasonic sensor for detecting obstructions using various buzzer sound for each type of obstruction. This system includes wireless RF remote control which alarm buzzer uniquely when pressed and also for locating the blind stick when it is misplaced.However a more astonishing fact is that out of these 285 million people, 39 million people are completely blind. It is not a herculean task to comprehend the amount of hardship which is inflicted upon these innocent souls. Even, many children are blind since birth and we must remember the fact that these children have a very long life ahead of them. Their lives can be improved significantly if their dependence is reduced to a considerable extent. This played an essential role in our decision to come up with the very notion of an advanced blind stick. Owing to amount of strain which is being subjected to our eyes, the probability in enhancement of number of blind people are bound to rise. The purpose of this blind stick would be to make blind

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people more independent [2]. In fact, it will give positive dimensions to their life. The traditional obstacle detection methods are obsolete and need considerable modifications. In this paper, we were expected to tackle a real world problem. In a nutshell, we aimed at providing a technical solution to a real world problem which would help society in some form or the other. The purpose of this project would be to identify ways and means to make the lives of blind people much easier. To be specific, this project will help blind people identify obstacles and make their next movement according to presence or absence of obstacle. At the same time, we realize there may be circumstances wherein the blind person may be bewildered about his next movement. Authors have introduced system which includes crutch and bracelet. So that crutch will detect obstacles in front of them with sensors. The other invention [4] by authors is smart cane which can detect all obstacles in range of 4m during 39ms and output is through audio-based frequency clips for announcing obstacles detection. In [5], the authors have developed portable device for blind peoples that will provide direction to new locations and alert them about obstacles in their path during outdoor navigation. Using a ST microelectronic, this system has MEMS digital compass module which will allow to give more accurate direction for the blind person. We have proposed a system for blind people to navigate in safe path by alerting presence of obstacles.

2. RELATED STUDY

A. Advanced Computer Algorithms (AI) Based Smart Mobility Aid for the Visually Impaired Society. The realm of electronics is growing rapidly. Advanced electronics are employable in assisting the visually impaired society in various ways. According to World Health Organization (WHO) approximately 285 million people are blind. Major researches have been under consideration on developing a smart stick for seeking a smoother routine life and welfare towards the blind society. This paper proposes and analyses a brand new thought in eliminating the stick and mount these sensors on the visually handicapped person body itself [4]. B. Real-time Dangling Objects Sensing: A Preliminary Design of Mobile Headset Ancillary Device for Visual Impaired This analysis planned a mobile Real-time Dangling Objects Sensing (RDOS) prototype, which found on the cap to sense any front barrier. This device utilizes low cost un-hear able sensing element to act as another complement eye for blinds to know the front hanging objects. The RDOS device will dynamically regulate the sensor’s front angle that's trusted the user’s body height and promote the sensing accuracy. Two major needed algorithms to measure the height-angle activity and un-hearable sensing element alignment and planned unit area. The analysis team additionally integrated the RDOS device with mobile automation devices by human action and Bluetooth to record the walking route [3].

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C. Assistive Infrared Sensor Based Smart Stick for Blind people In this paper authors tend to propose a smart stick with lightweight weight, low cost, user friendly, quick response and low power consumption and stick supported by infrared technology. A combination of infrared sensors will observe stair-cases and different obstacles presence within the user path. The experimental results gives good accuracy and therefore the stick is ready to observe all of obstacles [2]. D. Design and Implementation of Mobility Aid for Blind People. The proposed system is a jacket which will have sensors mounted on it. There will be five sensors mounted on the jacket. One sensor detects potholes or stairs. The other obstacle near head. The three sensors are used to detect obstacles in front, right and left direction. The user is notified about the obstacle through specific voice commands which are stored in a Micro SD card. These instructions are played by the microcontroller and are heard by the user through the headphones [1].

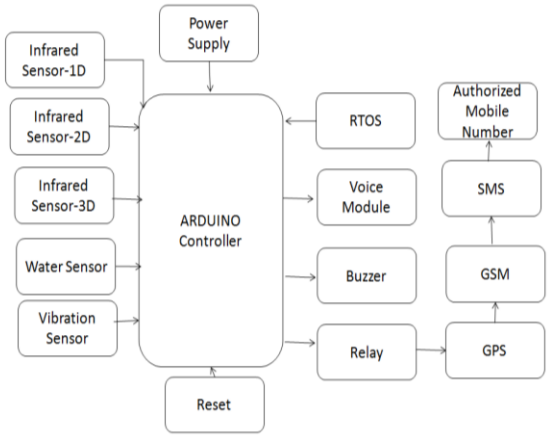

Figure 2: Proposed model.

3. PROPOSED SYSTEM

There are number of blind people in the society, who are suffering while exercising the basic things of daily life and that could put lives at risk while travelling. There is a necessity these days to provide security and safety to blind people. There have been few devices designed so far to help the blind. Blindness or visual impairment is a condition that affects many people around the world. The usage of the blind navigation system is very less and is not efficient. The blind traveler is dependent on other guide like white cane, information given by the people, trained dogs etc. Many virtually impaired people use walking sticks or guide dogs to move from place to place. A guide dog is trained for guiding its users to avoid the accidents from objects and barriers over a fixed path or in a fixed area. When a visually impaired person uses a walking stick, he waves his stick and finds the obstacle by striking the obstacles in his way.

The study of previously developed systems and analysis of the implementation methods used, led us to define a new system which could overcome the disadvantages in the previous systems. Therefore using the existing technologies we provide a solution to the stated problem. The device has proximity infrared sensors which provide the vibration alert to avoid the obstacles..The whole device is designed to be small and is used in conjunction with the white cane. This device is connected to an android phone through Bluetooth. An android

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application is designed which gives voice navigation based on GPS tags read and also updates person's location information on the server. Also, vibration alerts are provided through the smart phone on obstacle detection. One more application is designed for family members to access the blind person's location through the server, whenever needed.

The visually impaired have to face many challenges in their daily life. The problem gets worse when they travel to an unfamiliar location. Only few of the navigation systems available for visually impaired people can provide dynamic navigation through speech output. None of these systems work perfectly for both indoor and outdoor applications. In this paper, we propose a navigation device for the visually impaired which is focused on providing voice output for obstacle prevention and navigation using infrared sensors, Wireless technology, and android devices. The proposed device is used for guiding individuals who are partially sighted or blind.

4. DEEP LEARNING ALGORITHM

The recent ground-breaking advances in deep learning networks (DNNs) make them attractive for embedded systems. However, it can take a long time for DNNs to make an inference on resource-limited embedded devices. In this project mainly focus on the how to effectively achieve rapid detection and positioning of the reversing environment, and distinguish obstacle distances become one of the focuses of research on intelligent blind people safety.

Compared with active measurement sensors such as ultrasonic sensors and laser sensors, infrared sensors, have the advantages of simple installation, rich information, and high efficiency, which makes the application of obstacle information more and more in the field of blind people assistance with intelligence. To achieve this objective of our project we preferred the simple deep learning algorithm which are helpful to calculate the distance and avoid the interference problem between multiple numbers of sensor signals.

The downtime of electronic machines and automations can lead to a direct loss of people souls and expensive. Accurate prediction of such failures using sensor data can prevent or reduce the downtime. With the availability of Wireless transmission technologies, it is possible to acquire the Multiple sensor data without any interruption. In our project we can use number of sensors like MQ3, Vibration, Water Sensors and 3 IR Sensors, as well as GPS and GSM Modules. Due to this more number of sensor nodes it may causes hanging problem in the system also it impacts on the system efficiency. To avoid this we are used simple Deep Learning (DL) algorithms can then be used to predict the part and equipment failures, given enough information (Location and Distance) to the respective registered mobile numbers as SMS. DL algorithms have shown significant advances in problems where progress has

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eluded the practitioners and researchers for several decades.

4.1 Deep Convolutional Neural Network Algorithm for evaluating the Sensor Unit

- The signals captured by the sensors from the outside environment then fed to the Transducer unit.
- The Transducer unit convert the Sensor unit signals into the desirable i.e in electrical.
- Then Signal Processing and Data Integration is done applied to the noise detecting unit i.e to maintain the accuracy, completeness, and reliability of data throughout its lifecycle.
- If there is any noise in the signal then error orientation and error path is established otherwise is directly fed to the respective unit.

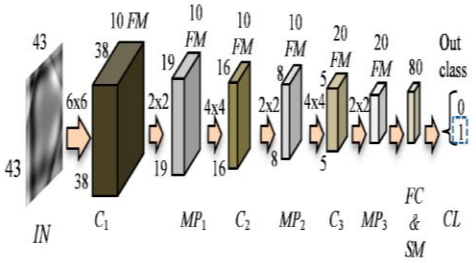

Figure 3: Schematic view of the deep convolutional neural network (*DCNN*DND) architecture for evaluation of defect occurrence;

From the Figure 3 the layers:

IN—input,
C—convolutional,
MP—max-pooling,
FC &SM—fully connected and softmax,
CL—classification;
FM—feature maps.

The consideration the above details, in this project, the possibility of DCNN utilization was analyzed. The axial-symmetric transducer presents similar sensitivity for any flaws (or in general any non-uniformity) affecting the changes of the examined materials' magnetic properties, regardless their orientation in reference to the x-y axis (Sensor Structure). Previously, the details of the construction of the utilized transducer and the preliminary results of defect detection and evaluation were presented in figure 4.

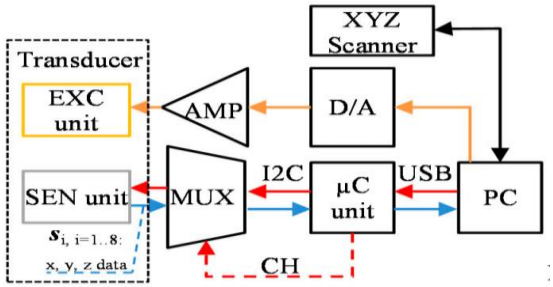

Figure 4: The utilized measuring system configuration diagram.

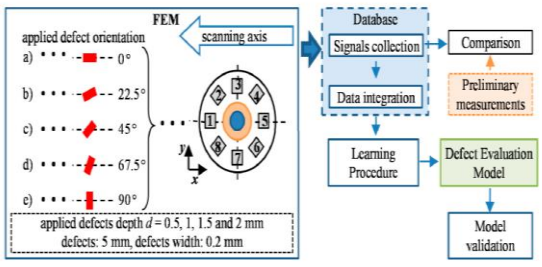

Figure 5: The Finite Element Method to defect the Measurement Model.

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4.2 Distance Measurement System with DLA

Based on the Figure 5 system design, this project first uses the Faster R-CNN model for non-contact obstacle recognition, which can complete the stereo matching task of the signal plane during distance measurement. Faster R-CNN is an end to end target detection algorithm, which unify the steps of

- The signal encoding and bounding box regression and classification to the framework. This structure avoids the problem that the algorithm needs extra space to cache a large number of sensors, and reduces the difficulty of training, and has a great improvement in the accuracy and speed of detection and positioning.
- The test process can be divided into four steps. First, features are encoding and decoding using a convolutional neural network and combined into a more abstract feature map; then, the feature map is input into the RPN (Region Proposal Networks) to extract the candidate region of the target.
- Then use the ROI pooling layer to pool the target candidate area to a fixed scale connected full-connected layer, and finally, the softmax regression algorithm is used to classify the target, and the target boundary frame is obtained by using the multi task loss function.
- The output of the network is a 3-dimensional vector containing the target category and location information.

5. OPERATION WITH RESULTS

The proposed device is focuses on the visually impaired people who cannot walk independently in unfamiliar environment. The main aim of our system is to help the blind people to move independently in the unfamiliar environment.Fig.3 shows the architecture of the proposed system. The system has four main modules: A. PCB unit, GPS, GSM and Wireless sensors. The first is PCB unit, which consists of ARM microcontroller, MAX232 and IR sensors. Along with these components, there will also be an Water Level sensor and Vibration Sensors. ARM Microcontroller is used to control the various elements on the PCB unit. 3 IR sensors are used for 3- Dimensional obstacle detection.

5.1 Results

The idea of the proposed system came into existence because of a short visit to a blind school.

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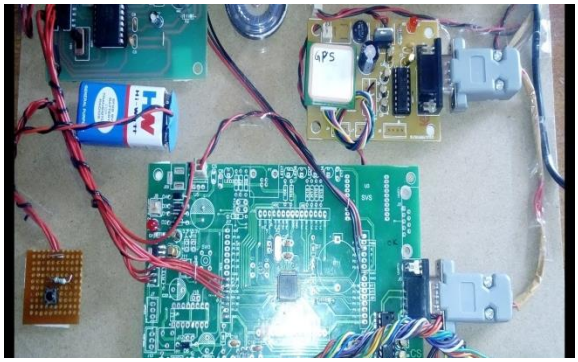

Figure 6: Hardware Kit Implementation Location formation using GPS and GSM module.

It was seen that the individuals were given training to walk with a stick along a fixed path every day with a person to guide each of them. The inception of the project was marked by the conversations held with the blind people in the school and their staff. The data collected was indicative of the facts and miseries of their daily life. The visual disability made them incapable of doing any kind of simple chores independently. This laid us to research on the already existing technologies and conduct literature survey.

When a blind or elderly person is out of home for walk or for other reason, if his/her health becomes suddenly poor i.e. if he feels that it is difficult for him to reach home back, he can intimate one of his relatives about this. There is an alert button provided on the stick, this button when pressed sends the coordinate of stick to a pre stored mobile number, i.e. "+91**********" via GSM module through SMS. The GPS module calculates the latitude and longitude of the location of the user.

Significance of the System

The main advantage of the system is that it helps the blind people in both indoor and outdoor, care-free navigation. The devices placed in the stick makes it comfortable and easy to handle. The smart stick helps in detecting obstacles placed at a distance in front of the user. The system is suitable for both indoor and outdoor environment. The information regarding obstacles is given through voice alerts, eliminates the difficulty of understanding vibration patterns which was used in earlier systems. The system is a moderate budget mobile navigational aid for the visually impaired.

6. CONCLUSION

The proposed system tries to eliminate the flaws in the previous system. It aims to solve the problems faced by the blind people in their daily life. The system also takes measures to ensure their safety. The project intended the blueprint and architecture of a smarter concept of 3D INTELLIGENT WALKING STICK for blind and disable people. This blind aid system can be rendered a fresh dimension of useful assistance and gives a sense of artificial vision along with dedicated obstacle and hollow detection circuitry. This cost effective and light weight device can be designed to take of pattern of a clastic and portable device, which can be unconditionally mounted on an ordinary white cane or blind stick. The aimed combination of several working sub-systems makes a time demanding system that monitors the environmental scenario of

static and dynamic objects and provides necessary feedback forming navigation more precise, safe and secure. It can be further enhanced by using VLSI technology to design the PCB unit. This makes the system further more compact. Also, use of active RFID tags will transmit the location information automatically to the PCB unit, when the intelligent stick is in its range.

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