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## A Smart Walking Assistance for Visually Impaired People – A Review

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**ABSTRACT:** Blind stick or white cane is introduced to blind people after the First World War as a mobility tool to detect the obstacles in the path of the user. This paper proposes an Arduino Nano based obstacle finding stick for visually impaired people, which helps a blind person by detecting the obstacles using ultrasonic sensors and android mobile application. It is able to inform the blind person about the circumstances & present condition of the path where he/she is walking. This paper presents the smart walking stick based on ultrasonic sensors and Arduino for visually impaired people. There are approximately 37 million people across the globe who are blind according to the World Health Organization. People with visual disabilities are often dependent on external assistance which can be provided by humans, trained dogs, or special electronic devices as support systems for decision making. Thus, we were motivated to develop a smart white cane to overcome these limitations.

**KEYWORDS:** White cane, Android Mobile Application, HC SR-04 ultrasonic sensor, Mobility aid, Visually Impaired Person, Alarm system

### I. INTRODUCTION

Visually impaired people are the people who find it difficult to recognize the smallest detail with healthy eyes. Those who have the visual acuteness of 6/60 or the horizontal range of the visual field with both eyes open have less than or equal to 20 degrees. These people are regarded as blind. A survey by WHO (World Health Organization) carried out in 2011 estimates that in the world, about 1% of the human population is visually impaired (about 70 million people) and amongst them, about 10% are fully blind (about 7 million people) and 90% (about 63 million people) with low vision according to [1]. The main problem with blind people is how to navigate their way to wherever they want to go. Such people need assistance from others with good eyesight. As described by WHO, 10% of the visually impaired have no functional eyesight at all to help them move around without assistance and safely. The figure 1 below is a chart showing the percent of blind people across the globe.

This study proposes a new technique for designing a smart stick to help visually impaired people that will provide them navigation. The conventional and archaic navigation aids for persons with visual impairments are the walking cane (also called white cane or stick) and guide dogs which are characterized by many imperfections. The most critical shortcomings of these aids include: essential skills and training phase, range of motion, and very insignificant information communicated been communicated. Our approach modified this cane with some electronics components and sensors, the electronic aiding devices are designed to solve such issues. The ultrasonic sensors, water sensor, buzzer, and RF transmitter/Receiver are used to record information about the presence of obstacles on the road. Ultrasonic sensor have the capacity to detect any obstacle within the distance range of 2cm-450cm. Therefore whenever there is an obstacle in this range it will alert the user. Water sensor is used to detect if there is water in path of the user. Most blind guidance systems use ultrasound because of its immunity to the environmental noise. With the rapid advances of modern technology both in hardware and software it has become easier to provide intelligent navigation system to the visually impaired.

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Recently, much research effort have been focused on the design of Electronic Travel Aids (ETA) to aid the successful and free navigation of the blind. Also, high-end technological solutions have been introduced recently to help blind persons navigate independently. Another reason why ultrasonic is prevalent is that the technology is reasonably cheap. Moreover, ultrasound emitters and detectors are portable components that can be carried without the need for complex circuit. RF module will help the person to find the stick wherever it is placed. Whenever the user wants to locate it, such a person will press a button on remote control and buzzer will ring, then the person can get the idea of where the stick is placed. Vision is the most important part of human physiology as 83% of information human being gets from the environment is via sight.

The 2011 statistics by the World Health Organization (WHO) estimates that there are 70 million people in the world living with visual impairment, 7 million of which are blind and 63 million with low vision. The conventional and oldest mobility aids for persons with visual impairments are characterized with many limitations. Some inventions also require a separate power supply or navigator which makes the user carry it in a bag every time they travel outdoor. These bulky designs will definitely make the user to be exhausted. The objectives of this research work include: to design an assistive technology for visually impaired people that can detect obstacles and provides alternative routes for the blind; to alarm the user through vibration to determine the obstacles direction sources; and to help the user find his stick when he cannot remember where is was kept.

Several attempts have been made to design guard or obstacle avoidance devices for the blind using components with limited number of applications. This section will discuss some of these attempts and their shortcomings. For instance; [2] proposed a Smart Walking Stick for Visually Impaired. The proposed method is a simple walking stick equipped with sensors to give information about the environment. GPS technology integrated with pre-programmed locations allows the user to choose the optimal route to be taken. In the system, ultrasonic sensor, pit sensor, water sensor, GPS receiver, level converter, driver, vibrator, voice synthesizer, keypad, speaker or headphone, PIC16F877A microcontroller and battery were used. The source code for the PIC microcontroller was developed with MPLAB software.

The proposed system intended to provide low cost and efficient navigation aid for the blind which gives a sense of artificial vision by providing information about the environmental scenario of objects around them whilst providing real-time assistance via GPS. The performance of the prototype developed was evaluated with four obstacle-scenario which are: Concrete wall, Human body, Cardboard box, and Plastic. The proposed solution is a moderate budget navigational aid for the visually impaired. As far as localization is concerned, it will be able to provide accurate details of the location of the blind in case they get lost via the GPS. The developed prototype gave good results in detecting obstacles placed at a distance in front of the user. Obstacles and pit can be determined easily by sensor readings. The cost effectiveness of the proposed solution leads to compromises in performance. One of the drawbacks of their proposed method is that the capability of the prototype is limited as a visually impaired person can travel only to four locations using the stick. Also, the navigation system will need to convey information other than that needed for guidance, and it is not feasible to provide guidance information at high intermittencies. It did not provide the functionality for voice control using speech recognition. Other improvements that could have improved the proposed system include: Increasing the range of the ultrasonic sensor and implementing a technology for determining the speed of approaching obstacles. Synchronization with external memory to increase the number of routes stored. Synchronization with various navigation software applications available on the internet so that new, un-programmed destinations can also be chosen. Integration of a GSM module for safety purposes.

According to the famous philosopher and scientist Aristotle, our knowledge about the outside world depends on five sense organs and sight is one of those five organs. And visually-impaired are those unfortunate people who are completely or partially suffering with eye sight issues. According to the survey of World Health Organization (WHO) and International Agency for Prevention of Blindness (IAPB) [1], approximately 285 million people around the world are visually –impaired among which 39 million are completely blind. Blind stick is a special device used by visually

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disabled people for centuries. But in recent times Electronic Travel Aids (ETAs) with sensors and sound systems are designed for improved navigation of blind people [2], [3]. Here we proposed an advanced blind stick that allows visually challenged people to navigate using advanced technology like ultrasonic sensors & mobile application. We already know about traditional blind sticks [4]. But the question that comes into our mind is that how this system can give idea about the surrounding by using GPS system. The advantage of our project is that it can detect any obstacle with the help of ultrasonic sensors and it can provide correct location of obstacle by using the GPS system. Thus it will help blind people when they are walking outside from their home.

## II. BACKGROUND WORK

ETA device has become a revolution over the last few decades to guide a visually impaired person and to make their life even easier and safer. As the ETAs getting popular day by day, researcher has been working on this field to make the device even more light, portable, safe and low cost for better service. An ultrasonic sensor based blind stick is proposed by Agarwal & Kumar [5] in 2015 with GPS system, vibrating motor and a buzzer. As they didn't give any pictorial view of the stick, so according to device description it seems to be pretty heavy. Besides that, there was no information about how long the buzzer & vibrator would be in ON condition. And the sending sms issue by an illiterate blind person seems to be quite impossible. Another sensor based smart stick is introduced by Gayathri in 2014[3].

It uses a GPS receiver, vibrator and a headphone to navigate the blind person. But the device has some limitations like: - water sensor can detect if the water level is over 0.5 cm, the stick can detect only four types of obstacles (concrete wall, human body, plastic & cardboard box) and it is not feasible to provide guidance at high intermittencies. An outdoor navigating device also came into attention in 2012[6]. The stick uses GPS technology and a SD card to store information about different locations. But the device cannot help in indoor environment as there is no GPS signal available. In 1973, an optical triangulation based laser cane was proposed, which could only detect head-height obstacles [7]. And in 1989, a navigating device equipped with a small computer and sensors was planned [7]. It took images and then translated them into a series of audio cues to inform the user which routes are blocked by obstacles. And after late nineties, wearable obstacle detection system was introduced, which was quite heavy to wear and handle [8].

Reference [3] designed and implemented a Smart Stick for Obstacle Detection and Navigation. Their proposed system utilized infrared, ultrasonic and water sensors. It also used GPS and GSM module. GPS to give positioning and navigation to the stick. GSM module helps to give notifications when the blind person is faced with threats. The system is powered by a rechargeable battery. The hardware implemented on their proposed system consists of the Pair of ultrasonic sensors, Infrared sensor, Water sensor, GPS module, GSM/GPRS module, and Arduino Uno microcontroller board (ATmega328P).

The smart stick facilitates the blind person to make calls at times of emergency via the GSM/GPRS module. The GPS module also helps to trace the blind person through the data collected by it. It warns the blind person through beep sound whose intensity increases as the person nears the obstacle which aid him to move aside of the obstacle. Also, when obstacles are detected, it invokes the right speech warning message through a Bluetooth earphone. The use of a rechargeable battery in the system also ensures longer time usage. Their proposed system can also detect obstructions that are hidden such as downward stairs, holes etc. The drawback of this proposed stick is that it can be difficult to keep because it was not designed to be foldable. Modification to the proposed system would be: A Braille input device to give the blind person an uncomplicated method to provide the destination address for navigation. Programmable wheels to steer the stick away from the obstacles and also lead the blind person towards his/her destination. Employing IoT to give the benefits of inter-communication between smart sticks (or mobile, PCs) nearby to utilize the functionality of the other stick when one stick's functionality breaks down. Also, running this integrated set of hardware requires an alternative to the battery. The use of solar panels for instance, will be more advantageous in order to get recharged. Obstacles within the distance of about 3m can be detected with the help of these sensors.

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In [5] the Voice Enabled Smart Walking Stick for Visually Impaired persons was proposed. Their proposed system consists of a simple walking stick equipped with ultrasonic sensors to give information about the environment such as object detection, pit sensing and water sensing. GPS technology is integrated with preprogrammed locations to determine the optimal route that the blind should navigate. Also, a voice enabled equipment switching is provided to help the blind person in private domain. The proposed system used two Ultrasonic detectors which are Pit sensor and Water sensor; GPS receiver, GSM module, Voice synthesizer, ATmega328/P microcontroller, relay, speaker and battery. The GSM module and relay are for the purpose of switching on the equipment. It helps in transferring the information about the needed operation to be performed on the equipment and generates the resultant switching action. The central merit of this system is that it helps the blind people in both inside and outside, care-free navigation. The GPS based blind device with user input interface signals the blind person when he/she reaches the destination by voice. The integration of room equipment switching along with this system makes it even more useful, thus making it suitable for both indoor and outdoor environment. The smart stick not only aids in detecting obstructions placed at a distance in front of the user, but also provides real time assistance via GPS. The information regarding barriers is given through voice alerts that eradicate the problem of understanding vibration patterns which was used in previous systems. Their system is a reasonable budget navigational aid for the visually impaired. The cost effectiveness of the proposed solution leads to compromises in performance. Some improvements that could be made are as follows: Increasing the range of the ultrasonic sensor, and implementing a technology to determine the speed of the approaching obstacle. Also, running this integrated set of hardware requires an alternative to the battery. It should also accommodate wide varying grips for flexible handling. Their proposed combination of various working units makes a real-time system that monitors position of the user and provides dual feedback making navigation more safe and secure.

Reference [6] proposed Smart White Cane which is a Sophisticated and Economic Walking Aid. Their proposed stick is designed to detect obstacles which may help the blind to navigate carefree. Their device is made up of components such as ATmega328PU microcontroller, 4 HC-SR04 Ultrasonic Sensor Modules, Sound IC-APR33a3, Vibration Motor, headphones and battery. Audio feedback. Their method alerts users by pre-recorded sound messages and a haptic feedback in form of vibrations. The stick can detect pits, potholes, downfalls, staircase (up and down), low lying and knee level obstacles and even those above the waist. Their system is a moderate budget navigational aid for the visually impaired. The entire circuitry along with the battery cubicle is hidden within the stick thereby decreasing the risk of damage to the circuit and making the device less bulky. The system provides ON/OFF switch, vibration

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feedback and the audio jack on the handle itself. The system does not have a global positioning method to find the position of the user using the GPS and guidance to their destination given to the user by voice navigation. The stick does not have the ability to detect oncoming vehicle, slippery floor, and there is no fire or smoke alarm. The idea behind the design of the stick was to keep it structurally similar i.e. thin, lightweight and easy to handle, yet give an active feedback to the user regarding hazards in his walking path.

In [7] an Intelligent Walking Stick for the Blind was proposed. The proposed navigation device for the visually impaired is focused on providing voice output for obstacle navigation using infrared sensors, RFID technology, and android devices. The device has proximity infrared sensors; RFID tags are installed into public building and also integrated into blind person's walking stick. The device is connected to an android phone through Bluetooth. An android application is designed which gives voice navigation based on RFID tag read and also updates person's location information on the server. Another application is designed for family members to access the blind person's location through the server whenever needed. The components of the system are: AT89C51 microcontroller, Bluetooth HC05, MAX232, ADC 0808 and IR sensors, RFID sensor, Android phone, Server and Android application. The system can be used both indoor and outdoor navigation. Blind person's location can be tracked whenever needed which will ensure additional safety. Their approach have the ability to detect obstacles and alerts the blind person through vibration alert and speech output. The drawback of their approach is that it is not 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. The RFID sensor does not have to read it explicitly. The whole device is designed to be small and used in conjunction with the white cane.

Reference [8] proposed Smart Electronic Stick for Visually Impaired. Their proposed system is a theoretical model and a system concept to provide a smart electronic aid for blind people. The system is intended to provide artificial vision, object detection and emergency messaging facility. Ultrasonic sensors calculate the distance of the obstacles around the blind person to guide the user towards the available path. Output is in the form of beeps which the blind person can hear. GPS and GSM are used to acquire the exact location of the blind person at times of emergency and send the co-ordinates to his/her relatives. The hardware consists of Arduino mega board ATmega2560, ultrasonic sensor, Infrared sensor, GPS, GSM, Keypad and two speakers. The sensors used in the stick proposed are highly accurate and sensitive. They provide exact readings of obstacles and distance to be travelled. The GPS and GSM modules provides the location of the patient and thus help the patient in time of need by sending an emergency messaging. The speaker helps in human-machine interface by sending the signals to the patient about obstacles and route to be travelled. Special lineament like extra secondary IR/laser sensor package, remote monitoring package, weather monitoring package and other hardware can be integrated in the design. Also, running this integrated set of hardware requires an alternative to the battery. Their proposed stick was intended to provide low cost and efficient navigation aid for the blind.

Reference [9] proposed a multidimensional walking aid for visually impaired using ultrasonic sensors network with voice guidance. The proposed method implemented a network of ultrasonic sensors capable of detecting the direction and position of obstacle(s). The performance and functionality are improved by the addition of alert light, and voice guidance signal which is relayed to a miniature headset. Hardware used in the implementation of the system are ISD 2590 voice record/playback chip, PIC16F887 microcontroller, ultrasonic sensors, voltage regulator, and speakers (headset and loudspeaker). The recorded voice alerts the user of the presence and direction of the obstacle(s). The prototype of the visually impaired aid is able to detect obstacles in all directions of the user. The performance of his proposed stick in detecting obstacles is low, that is, 1 meter maximum range of detection. The walking stick cannot determine the distance of the obstacle to the multidimensional. The prototype of the multidimensional walking aid was able to detect obstacles within the range of 0m to 1m at the left, right and front of the stick with an appropriate voice alert.

In [10] the authors designed and implemented a microcontroller based mobility aid for visually impaired people. Their proposed stick consists of special detection sensors integrated to AT89C52 microcontroller for receiving, processing and sending signals to the alarm system. The system was designed, programmed with assembly language and tested for accuracy and checked by the visually impaired person. The hardware used consists of AT89C52 microcontroller, sensors (Ultrasonic, water, and light dependent resistor, LDR), and alarm. Their mobility aid designed for blind people is affordable, reliable and easy to operate. It reduces stress for people assisting the blind and provides comfort to blind during walking. The system

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consists of an ultrasonic sensor for obstacle detection, a water sensor for water detection in slippery areas and a light dependent resistor for dark detection. Each sensor is differentiated from one another through pattern of sounds. The cost effectiveness of the proposed solution leads to compromises in performance. The proposed method is a low cost and light weight system designed with a microcontroller that processes signal and alerts the visually impaired person over any obstacle, water or dark areas through beeping sounds. Their research work focuses on obstacle detection, light detection and water detection in order to reduce navigation difficulties for visually impaired people.

The study in [11] proposed the sensor assisted stick for the blind people. The main objective of this design is to develop an application for blind people to detect the objects in various directions, detecting pits and manholes on the ground to make free to walk. Their proposed method utilizes multiple sensors with features to detect the obstacle for collision avoidance, and to detect objects in all direction. Another sensor is placed near the bottom tip of the walking stick to detect pits on the ground. It integrated these sensors to the voice record and play chip. The prototype was modelled using Pro/E creo 5.0 Software. The hardware components used in the design are ATmega8 microcontroller, sensors, power supply unit, Servomotor, Buzzer, Voice record and play back device, and speaker. It is simple, cheap, configurable, and easy to handle intelligent guidance system. The results of the test on the system indicates that it is efficient in its capability to specify the source and distance of the obstacle. The prototype of the visually impaired aid is able to detect obstacles in all directions of the user. The proposed system has advanced features which detects front and top side of obstacles, pits and water stagnated/manholes on the ground. The implementation is quite expensive. It is not a cost-effective approach. Also, running this integrated set of hardware requires an alternative to the battery. The use of solar panels for instance, will be more advantageous in order to get recharged.

### III. PROPOSED MODEL

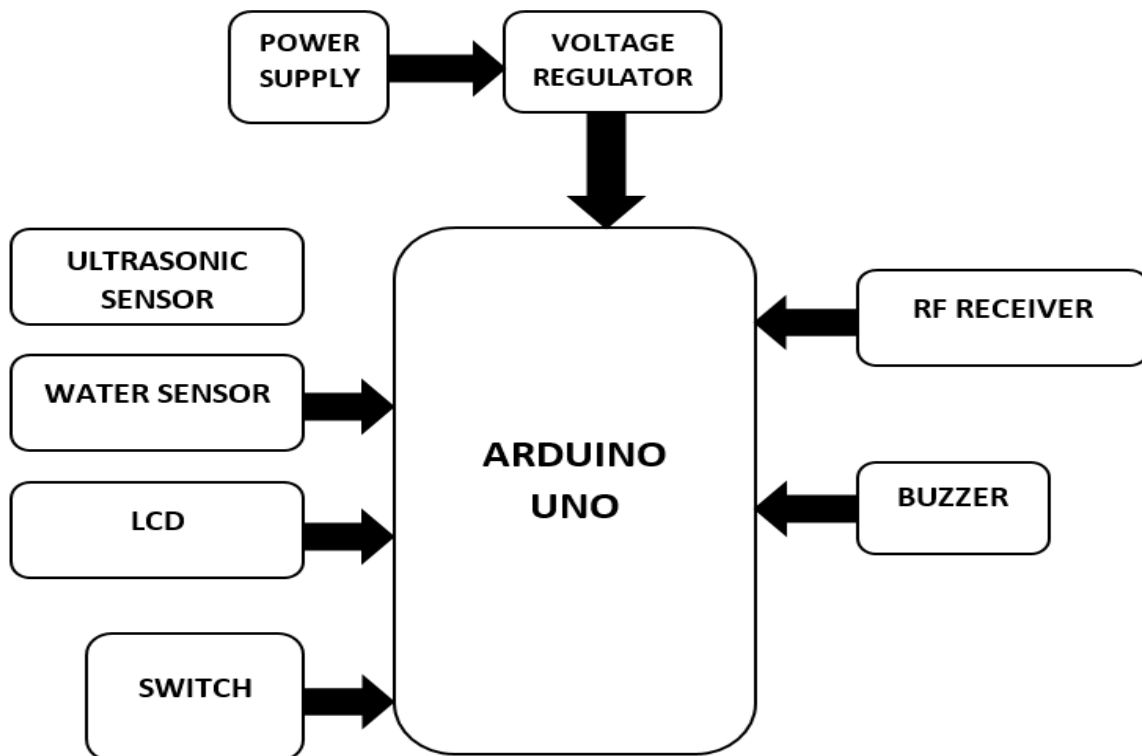


FiG1: show the block diagram of the RF transmitter block diagram and Circuit diagram of the system respectively.

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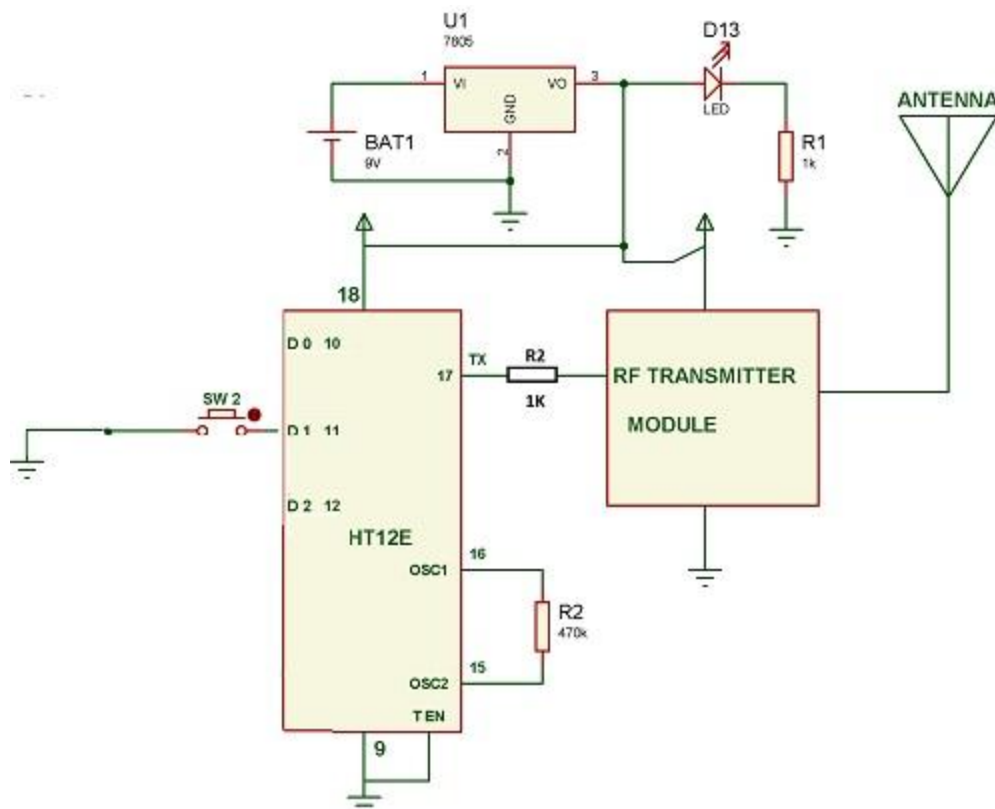


Fig2: Circuit diagram of the RF transmitter

## IV. CONCLUSION

The technologies behind blind sticks are upgrading day by day. And our model ensures one thing that is making the task of moving of a blind person easy and comfortable. The stick is also very light and handy to carry. And the components or parts that we used in the stick are also easily available and less in cost. And besides all that the manufacturing cost is also quite low, that makes the stick affordable for people of all class and age. In future, if further improvement and investment is carried out with the stick then it will be an even more effective device for the future world.

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