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Developing a User-Friendly Smart Blind Stick for Visually Impaired Individuals in the Digital Era

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Abstract: This study designs and develops a user-friendly Smart Blind Stick for visually impaired individuals, enhancing mobility and independence in the digital era. The objectives of this study are to improve obstacle detection accuracy, enhance user experience through intuitive alerts, and increase accessibility and safety. Our innovative system integrates ultrasonic sensors, GPS, GSM, and amplifier modules, offering improved audibility and enhanced location tracking capabilities compared to existing solutions. Leveraging Industrial Revolution 4.0's digital infrastructure, the GSM module enables emergency location sharing via SMS, providing visually impaired individuals with greater autonomy and security**.**

***Index Terms*: Arduino Uno, Digital Era, Industrial Revolution 4.0, Loudspeaker, GPS Module, GSM Module, Ultrasonic Sensor, Smart Stick.**

I. INTRODUCTION

According to the 1987 NSSPD, 0.4% of participants (6,826 individuals) reported blindness, increasing to 12.33 million individuals with visual impairments by 2006, accounting for 14.9% of all impaired individuals [1]. Blind persons face unique daily challenges due to physiological impairments. The primary obstacle is accurately detecting and avoiding obstacles, currently addressed by guide dogs and guiding instruments. However, training guide dogs requires substantial resources and long-term commitment, and their assistance is temporary. This study aims to develop an innovative, cost-effective Smart Blind Stick, enhancing mobility and independence for visually impaired individuals through intuitive obstacle detection, providing a user-friendly alternative to traditional guiding instruments.

II. RELATED WORKS

The CTT blind guide developed by Xu Xiangyu's group [2] is accurate and clear in locating obstacles from a threedimensional standpoint. It still cannot be used practically, and its operability and practicability are restricted. The intelligent trip navigation helmet for blind individuals made by Huang Hongzhi [3] uses visual processing to identify obstructions and traffic signals. Despite its many features, the helmet is heavy and difficult to carry. Although infrared detection is used by Lin Chen's intelligent blind walker [4] to automatically avoid obstacles and transmit information with head-mounted sensors, the precision of infrared rays is not high, is highly dependent on the surroundings, and is cumbersome to carry. According to the intensity of reflected light, Wu Xue et al.'s multi-directional infrared-ranging intelligent bracelet [5] uses infrared ranging, and the system accurately verifies its obstacle avoidance capability over black, white, and gray obstacles. The bracelet can detect just a restricted number of things, which limits its use. A blind aid system is available in the public space created by the Karen Duarte team; however, its use is restricted to the relatively small space of a shopping center. The Sularso Budilaksono team's blind guide rod, which is small and only has one function—the HC-SR04 ultrasonic sensor—is controlled by an Arduino master controller. This means that blind individuals cannot benefit from a better experience. This paper designs a blind guide stick with an STM32 single-chip microcomputer at its core. This microcomputer can accurately measure the distance by ultrasonic and feed back to the blind in time through voice broadcast, making up for the shortcomings of the above system's slow real-time detection, inaccurate infrared rays, and delayed feedback. When faced with danger, the vibration motor alerts the blind and allows them to send an SMS to their guardians. The system's implementation can significantly lower the potential safety risk associated with blind persons walking and the number of accidents brought on by their incapacity to perceive impediments [6]. This paper's primary contributions include an assessment of the state-of-the-art in travel aids from a design standpoint and an investigation of the following problems: (1) The significance of design concerns in wearable travel aids and the degree to which these are considered in various devices; (2) Any connection, if any, between the location and mode of use of travel aids and their features, design, and functions; (3) The limitations of current devices, the absence of certain ones, and future directions for research, especially in terms of satisfying the needs of potential users [7]. In this study, we provide a tool that facilitates the detection of impediments and puddles of water. This system consists of Android applications (APPs) and a walking stick. The walking stick has sensors, a global position system (GPS) module, a Raspberry Pi and programmable interface controller (PIC) as a control kernel, and components that provide alerts embedded in it. Obstacles can be identified with the use of sensors, and the VCP is alerted about them via buzzers or vibrations. Parents can use an application to track their child's location after the GPS module receives the coordinates of the VCP. Another crucial app is the emergency app, which allows the VCP to instantly contact friends or parents by shaking their phone or, in an emergency, pressing the power button four times in five seconds. We employed fewer parts to create a lightweight, comfortable, and feature-rich gadget with excellent performance. In the end, this gadget will boost VCPs' confidence in an unfamiliar setting by enabling them to live somewhat independently (and securely) [8]. Third Eye for the Blind using Ultrasonic Sensor [9]. A heart pulse sensor and other electronic modules that can be linked to the nearest relative's Android smartphone are used in the construction of this blind stick. The purpose of using pulse heart sensors is to measure a person's pulse rate per minute in order to assess their overall health [10]. Low-Cost Walking Stick for Obstacle and Stair Detection using Arduino [11]. The design, development, and testing of an Internet of Things-enabled smart stick that can identify and alert users to impediments is presented in this work [12]. The device is intended to help visually impaired persons traverse the outside world. This study presents the design, development, and testing of an Internet of Things (IoT)-enabled smart stick that can identify and notify users of impediments to aid visually impaired people in navigating their environment [13].

III. Material and Methods

3.1. The table below shows the materials used in this research

S/N	Names	Quantity used
1	Arduino Uno	1
2	Ultrasonic Sensor	1
3	GSM Module	1
4	GPS Module	1
5	Loudspeaker	1
6	Batteries	3
7	Switch	2

3.2 Methods

In the study, an adapter is used to power on the system using dry cell batteries, and if the batteries run out, the adapter is utilized to charge the batteries. To turn the entire system on or off, use a switch button. When the system is powered on, the system will not create any sound until the ultrasonic sensor used in this research senses an obstacle, then it will make a sound that "Obstacle Detected" with the help of the sound amplifier used in this research. In the event that the blind man presses the panic button and finds himself in danger, the GPS module utilized in the study also notifies the registered cell phone number.

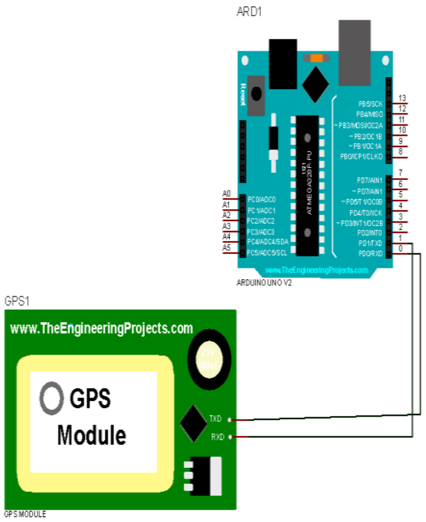

Fig. 1: Interfacing of the GPS Module to the Arduino Uno

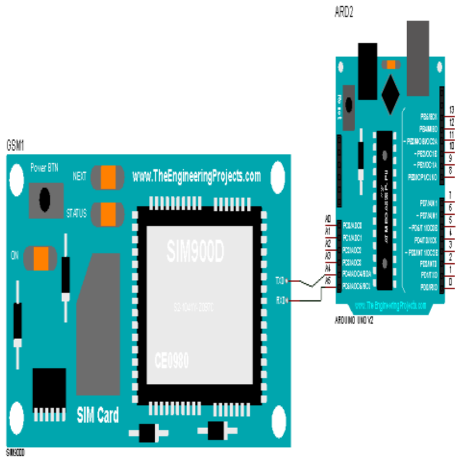

Fig. 2: Interfacing of the GSM Module to Arduino Uno

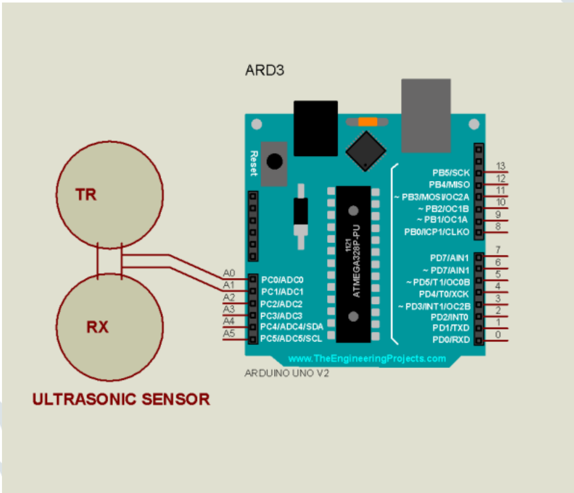

Fig. 3: Interfacing of the Ultrasonic Senor to the Arduino Uno

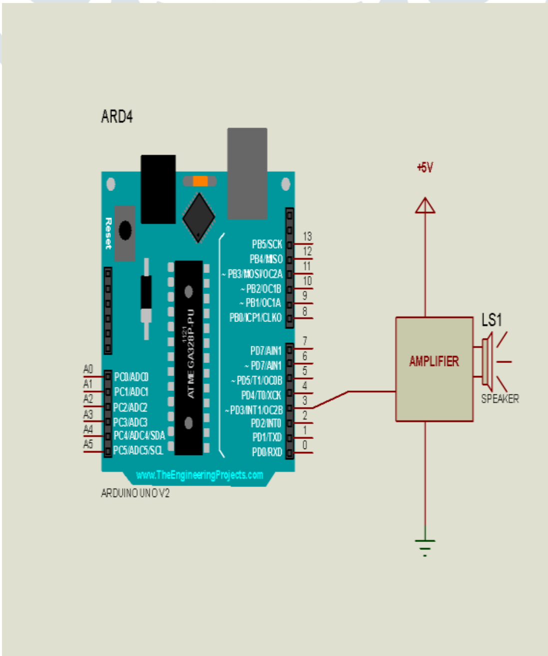

Fig. 4: Interfacing of the Sound module amplifier

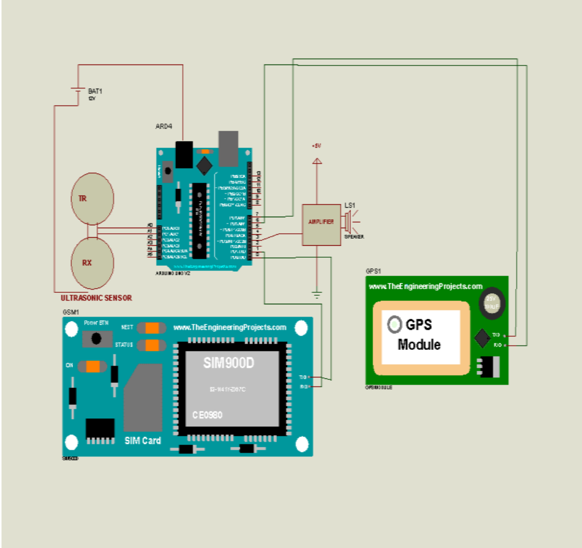

Fig. 5(a): The Pin Configuration of the whole Circuit

Fig. 5(b): The internal circuitry of the implemented system

Fig. 6: The Ultrasonic sensor used in the detection of an obstacle

IV. RESULTS

The outcomes of the deployed system and text messages sent from a smartphone are shown below.

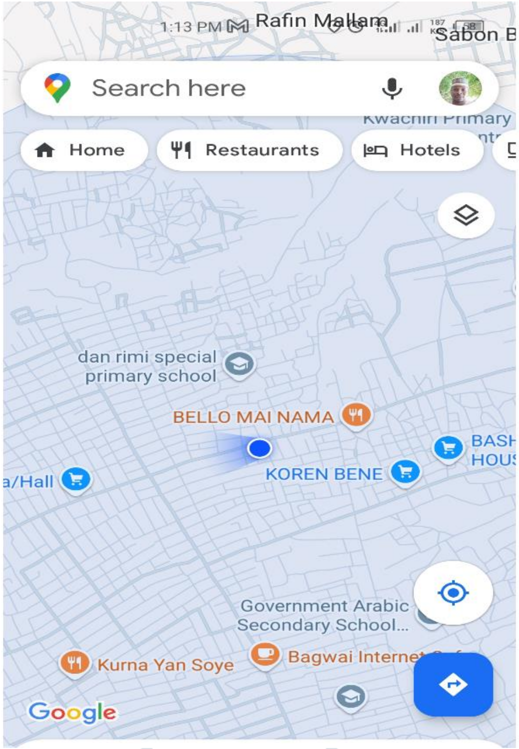

Fig. 7: Location of the stick from google map

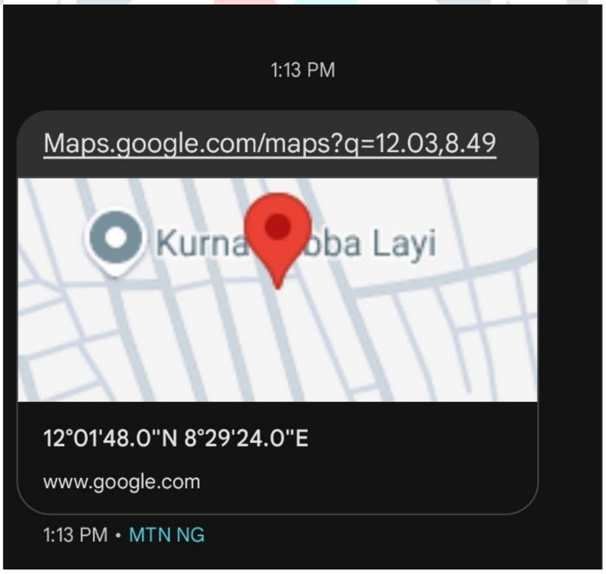

Fig. 8: The message sent via smart phone

Fig. 9: The implemented blind man stick

IV. CONCLUSION

This study has examined a number of papers that show us how technology is developing and what happens when blind or visually impaired people use it. We've also spoken about the supplies needed to carry it out and the implementation method considering the fourth industrial revolution 4.0. The fact that many of the examined publications did not address implementation methods and benefits simultaneously [14–16] is evidence of the benefits of using the smart blind stick. In this study, we used an Arduino Uno, an ultrasonic sensor, GPS, a GSM module, and a sound amplifier system to develop and build a low-cost blind man stick.

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