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Development of the Mobile Vision Enhancement System (MOVES) for Sight-Assist Mechanism

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ABSTRACT

Vision-related diseases can have various effects on the human eye, ranging from minor sight distractions to the most severe cases of total blindness. There are multiple medical treatments available for the patient, as well as alternative methods, including wearable tools, to assist the patient in their daily routine activities. The most commonly used tool is the guide stick, which requires the user to hold it, thus limiting its flexibility. The technology-aided system also depends on the power supply, which also adds to the limitation. Inspired by the solar-based system, this project applies the portable sight-assist system, which is easy to use and comes with wearable design ideas. The proposed Mobile Vision Enhancement System (MOVES) is a solar-powered system that assists the user in detecting obstacles in their path. It is designed to fit in the hat worn by the user. The MOVES is designed using the Arduino Nano Microcontroller Board with a compatible poly-crystalline solar panel for solar-powered systems, an ultrasonic sensor for obstacle detection, and a buzzer for the alert system. The main objectives of the headwear design are that the system operates by using a solar panel, which is practical to place at the top, and the user does not have to hold it by hand, making it a hands-free system. The MOVES system has been tested in controlled environments with various obstacle placements. This is important, as the system must be able to detect any obstacle in the user's pathway to avoid collisions and endanger the user. Based on the test, the MOVES had proven to be useful in assisting the user in detecting obstacles and helping the user in avoiding any obstacle in their path, with a mean relative error of less than 5%. Thus, MOVES is proposed as an alternative sight-assist system to be used by a visually impaired person.

Keywords: *obstacle detection system; mobile system; sight-assist system; solar-based system.*

1. INTRODUCTION

Since humans receive 83% of their information from their surroundings by sight, vision is the most important part of their physiology [1]. According to a recent statistic by the World Health Organisation (WHO) in the World Report on Vision, as of 2019, there are 2.2 billion people worldwide with a visual impairment or blindness, with 11.9 million reported with moderate or severe vision impairment due to glaucoma [2]. Many studies have been conducted to improve the autonomy of visually impaired or blind people, particularly in their ability to explore their surroundings [3–4].

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The study has been conducted on electronic travel aids in the last two decades, as well as non-electronic devices to assist the blind [5–6]. Since they cannot readily locate obstacles for comfortable navigation, blind people find mobility challenging and dangerous. Autonomous navigation without colliding with other objects and object discrimination have become big tasks in their everyday lives. Several attempts to provide travel aids for visually disabled people have been underway since the early 1950s [7]. The current system consists of equipment or aids such as white canes for assisting them in detecting obstacles and travelling to locations, pet dogs, and mobile devices such as a vision torch for blind people. However, there were many drawbacks and issues with current structures, such as the white cane, which could easily split or crack. The white cane can become stuck between the cracks in the pavement caused by various artefacts. Pet dogs, on the other hand, are expensive and require extensive training [8].

The Mobile Vision Enhancement System (MOVES) is designed to enhance the safety of visually impaired individuals during their mobility. By utilising advanced technology, this system enables obstacle detection, enabling visually impaired users to navigate their surroundings with confidence. At the core of the MOVES system lie an ultrasonic module and a microcontroller. These components work in tandem to calculate the distance between the user and obstacles within their path. The real-time distance measurement is then conveyed to the user through an integrated buzzer. This auditory feedback empowers the user to make informed decisions and adjust their direction to avoid potential collisions. The core innovation lies in the incorporation of a microcontroller, allowing the obstacle detection system to be condensed into a compact, wearable scale. This design principle ensures the system's functionality remains completely independent, offering convenience and assistance to visually impaired individuals without the need for external help.

To create a functional prototype, the MOVES system is ingeniously integrated with a solar energy-based mechanism. A small solar panel is seamlessly integrated to generate the required power for the entire system. This approach enhances the device's self-sufficiency and reduces its reliance on traditional power sources. Placing the prototype within a hat not only makes it convenient for users but also maximises solar exposure, harnessing the unlimited power of the sun as an alternative energy source. To validate its effectiveness, the MOVES system undergoes rigorous testing. This involves assessing the system's obstacle detection range and comparing it to the actual distances of obstacles. Through these tests, the accuracy and reliability of the system's obstacle detection capabilities are evaluated, ensuring that it provides accurate information to users for safe navigation.

2. LITERATURE REVIEW

Several attempts have been made to create guards or obstacle avoidance systems for visually impaired people using components with limited applications. This section will go through some of these details, attempts, and limitations on visual impairments.

2.1 Visual Impaired Diseases

The most prominent of human senses, which is vision, is essential in every aspect and stage of life. Humans struggle to learn to walk, read, engage in school, and work without eyesight, which is taken for granted. When the visual system and one or more of its vision functions are affected by an eye disease, vision impairment occurs. Individuals with vision impairments face serious consequences throughout their entire lives. However, immediate treatment for high-quality eye

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care and rehabilitation can help reduce many of these effects. Visual impairment, often known as vision impairment or vision loss, is a loss of eyesight to the point that it creates issues that are not remediable by traditional methods such as spectacles. Some also include those who are unable to see well due to a lack of access to glasses or contact lenses. Visual acuity is a non-invasive test that determines how much the visual system can distinguish between two high-contrast spots in space.

A vision chart is often used to test distant visual acuity at a set distance (usually 6 metres or 20 feet). The distance at which a "healthy" eye can read that line of the vision chart is expressed as a fraction, with the numerator referring to the distance at which the chart is seen and the denominator referring to the distance at which a "healthy" eye can read that line of the vision chart. Visual acuity of 6/18, for example, implies that a person can see a letter that a person with normal vision would be able to see at 18 metres while standing 6 metres away from the vision chart. 6/6 is considered "normal" eyesight [9]. A best-corrected visual acuity of less than 20/40 or 20/60 is frequently used to identify visual impairment. The term "blindness" refers to the loss of all or almost all of one's vision. Without adaptive training and equipment, visual impairment can make it impossible to do things like read and walk. Cataracts (51%), glaucoma (8%), childhood blindness and corneal opacities (4% each), uncorrected refractive errors and trachoma (3% each), diabetic retinopathy (1%), and unknown causes of blindness (21% each) are the leading causes of blindness [10].

2.2 Sight-Assist Project

R. Radhika et al. [11] proposed the implementation and design of a smart blind stick for an obstacle detection and navigation system. Infrared, ultrasonic, and water sensors were used in the system. The GPS and GSM modules were also included. The stick, as shown in Figure 1, will be guided by GPS for positioning and navigation. When a blind person is threatened, the GSM module assists in providing alerts. A rechargeable battery powers the device. The GSM/GPRS module on the smart stick allows the blind person to make calls in an emergency. The data obtained by the GPS module also aids in the tracking of the blind person. It alarms the blind person with a beep sound that gets louder as the person gets closer to the barrier, allowing him to step away from it. When obstacles are identified, it also sends out the appropriate speech alert message via Bluetooth earphones. The use of a rechargeable battery in the system often means that the system can be used for longer periods. Since it was not intended to be foldable, this proposed stick has the disadvantage of being difficult to keep.

S. Mohite et al. [12] propose the Voice-Enabled Smart Walking Stick for Visually Impaired Persons. A simple walking stick with ultrasonic sensors is used to provide information about the environment, such as object detection, pit sensing, and water sensing. GPS technology is used in conjunction with pre-programmed positions to decide the best path for the blind to take. A voice-activated equipment switching system is also available to assist the blind person in the private domain. The smart stick not only assists in detecting obstructions in front of the user at a distance but also provides real-time assistance via GPS. Voice warnings provide information about obstacles, eliminating the issue of interpreting vibration patterns that existed in previous systems. Their device is a low-cost navigational aid for visually disabled people.

N. Nowshin et al. [13] proposed an intelligent walking stick for visually impaired people, and this can be seen in Figure 2. The proposed navigation system for the visually impaired uses

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infrared sensors, RFID technology, and Android devices to provide voice output for obstacle navigation. The unit is equipped with proximity infrared sensors, and RFID tags are installed in public buildings as well as in the walking sticks of blind people. The computer is Bluetooth-connected to an Android phone. An Android application is being developed that provides voice navigation based on RFID tag reading and also updates the server with the user's location information. Another programme allows family members to access the location of the blind person through the server at any time. The drawback of their approach is that it is not compact.

Figure 1: The Smart Blind Stick Prototype

Figure 2: Intelligence Stick Prototype

M.A. Therib [14] proposed a smart blinding stick with holes, obstacles, and pond detectors based on a microcontroller. It is made up of two SRF06 ultrasonic sensors and an Arduino microcontroller. One sensor is mounted on the stick at a 40-degree angle to detect stairs or gaps, while another detects obstacles, for instance, a wall or people in front of the visually impaired person. A moisture sensor detects wet surfaces or ponds, determines the amount of land soil moisture in front of the blind, and warns him when it reaches a predetermined level that could submerge his feet through a vibration motor and buzzer. The system can sense holes, stairs, obstacles, and moist surfaces but is not rechargeable. The setup of the system is illustrated in Figure 3.

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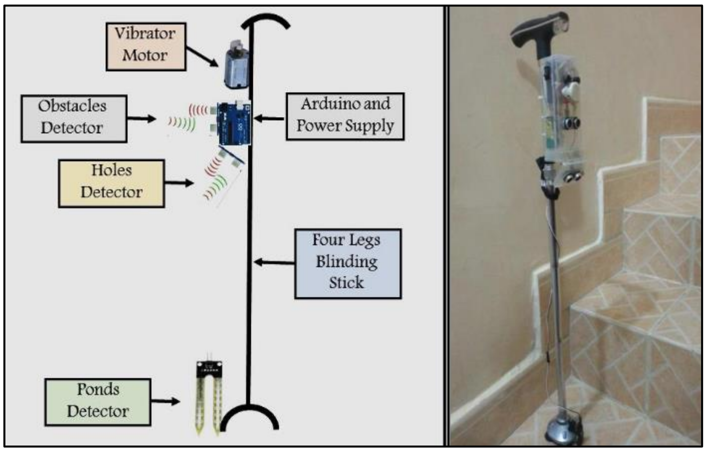

Figure 3: Advanced Obstacle Stick Prototype

K. B. Swain et al. proposed the Arduino-Based Automated Stick Guide for a Visually Impaired Person [15]. As shown in Figure 4, the device includes an Arduino Uno as its controller for processing signals from various sensors, two ultrasonic sensors (HC-SR04) for obstacle detection, and an infrared sensor for stair detection. The person's current location is obtained using a GPS module, and this information is transmitted through Short Message Service (SMS) to a number that has been registered using the GSM module by pressing a switch every time he feels lost. Since it has a GSM module, it can be used with an earphone to enable the disabled individual to talk to the programmed number as well as send SMS. One limitation of this model is that if the GPS module does not receive a satellite signal or if the individual is in an indoor area, the SMS will provide incorrect information.

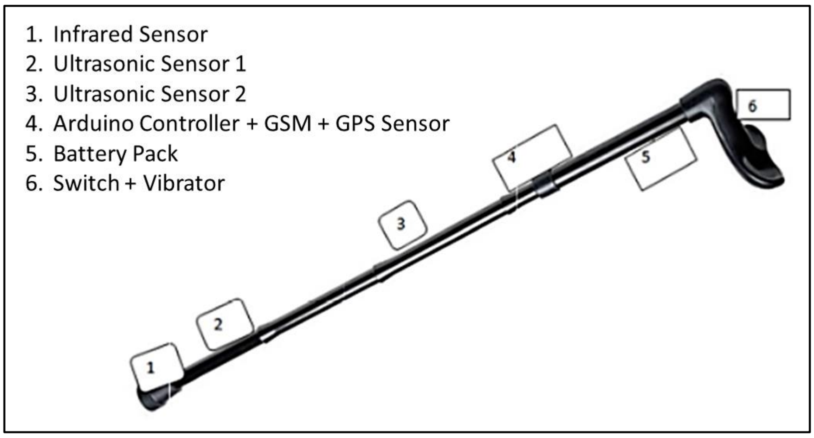

Figure 4: Arduino-based Obstacle Stick

According to Preethi et al. [16], LabVIEW and Arduino might be interfaced to create a real-time monitoring system and track the sun's location. The current value is measured by using an ACS712 current sensor, the voltage is measured by using a voltage divider, and the LDRs are used to capture the maximum source of light. All of these parameters will be obtained continuously by Arduino and sent to LabVIEW. A stepper motor was used instead of a servo motor since it has better resolution. The Graphical User Interface (GUI) is designed using LabVIEW in software development. All the parameters were obtained and presented graphically in LabVIEW.

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A. J. Ramadhan proposed a wearable smart system for visually impaired people, not only to guide them but also to improve users' mobility [17]. Based on Figure 5, the system is made up of an Arduino Uno and an ATmega328 microcontroller with several sensors. An ultrasonic sensor (HC-SR04) detects obstacles, an ADXL345 accelerometer detects the user's falling, and a voice recognition sensor detects the user's voice when he or she requires help. Due to the use of GSM and GPS modules, a warning message can be sent to a registered mobile number, and the user's location can be monitored by parents using the same registered mobile phone. It has features such as obstacle detection and localization for lower body parts, as well as contacts in emergencies. Since the device is meant to be worn on the forearm, the user must maintain good hand posture. Otherwise, it can often adjust the range or direction of obstacle detection, putting the visually impaired person in a bind when it comes to detecting obstacles.

Figure 5: Wearable Obstacle Stick

Based on these past few years' projects, all the invented systems use batteries, which is not in line with current technological advances [18]. To overcome the limitations of existing devices, the suggested system must meet specific requirements, such as selecting low-cost components with higher precision to make the system inexpensive and dependable. The gadget should be able to integrate numerous sensors and have an unlimited energy supply.

The project introduces a solar-powered wearable system designed to be worn on a hat that detects obstacles using an ultrasonic sensor and alerts the user with a buzzer. This sensor emits sound waves that bounce off nearby objects, enabling the system to calculate the distance between the user and potential obstacles. If an obstacle is detected within a certain range, the system triggers a buzzer alert, notifying the user about the presence of the obstacle. Unlike traditional tools, it's hands-free and powered by a solar panel on the hat. The solar-based design of MOVES represents a forward-thinking approach to addressing the needs of visually impaired individuals. By utilising renewable energy, the system ensures continuous operation and reduces dependency on external power sources. This not only enhances the convenience and reliability of the device but also aligns with sustainable and eco-friendly principles.

3. METHODOLOGY

The methodology is the overall research plan that describes how the research will be conducted and, among other things, determines the methodologies to be employed. These techniques, which are detailed in the methodology, specify the means or modes of data collection or, in certain cases, how a given outcome is to be calculated. For this research, information on visually impaired people was gathered from every source that led to the issue. All of this data was

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utilised to accomplish the proposed project, the Mobile Vision Enhancement System (MOVES).

3.1 System Development

The development of the MOVES consists of four important parts: the solar power supply, Arduino as the main controller, alarm devices, and the sensor. Solar-based power will be transferred to Arduino to turn on the whole system. The sensor will detect obstacles and thus notify the user by using alarms. Figure 6 shows a view of the system configuration.

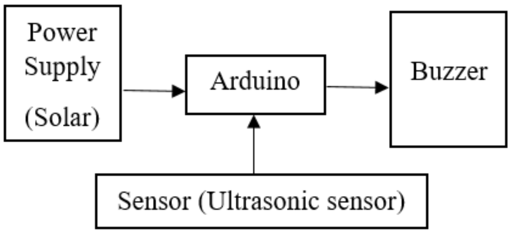

Figure 6: Block Diagram of the Proposed System

The flowchart of the system as shown in Figure 7 provides a clear view of the system since one of the key goals of this project is to offer the best assistance to visually impaired persons. Upon starting, solar photovoltaics (PV) will convert solar radiation from sunlight into electricity using semiconductors. These semiconductors within the PV cell will collect free electrons with the help of bus bars, which results in electric current. In the meantime, this action will also trigger the batteries to be charged since it was connected to them. So, if no sunlight is received by the solar panel, the system will power it using the charged batteries.

When the device supplies enough power to the Arduino, the system will be in standby mode and ready for use. Ultrasonic waves will be transmitted and detect any obstacles in front of the user. If there is any obstacle in front of the user, the system will calculate the object distance and notify the user through a buzzer. The buzzer sound is divided into 2 sections, which are beeping and sound continuous, whereby the distance is between 70 and 150 cm and less than 70 cm, respectively.

3.2 Hardware Development

The main component for MOVES is the Arduino ATmega 328P microcontroller, which will act as the brain for this project. This microcontroller will receive analogue signals from the ultrasonic sensor. The trigger pin is connected to D10, while the echo pin is connected to D9. The sensor transmits a sonic burst of eight pulses at 40 kHz when a pulse of at least 10µS (10 microseconds) is applied to the trigger pin, allowing the receiver to distinguish the transmitted pattern from the ambient ultrasonic noise. To begin creating the echo-back signal, the echo pin is set to HIGH. This action will activate the buzzer pin, which is D2, when the system coding distance has complied. Figure 8 shows the schematic of the system.

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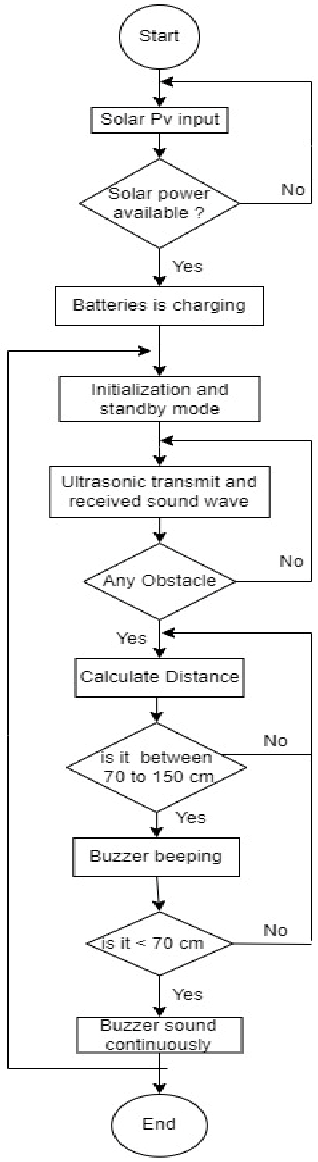

Figure 7: Flowchart of the Proposed System

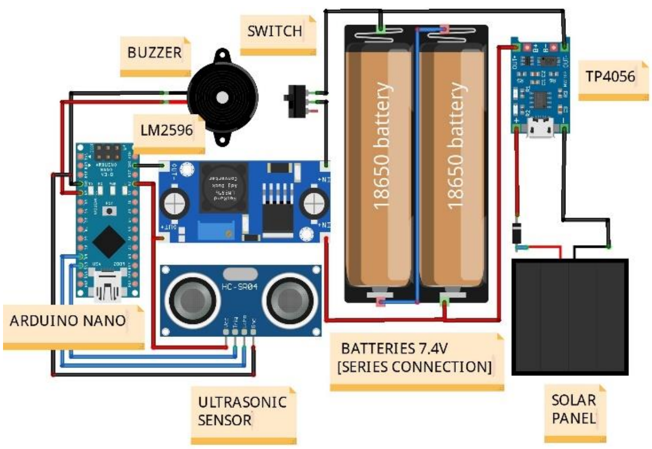

Figure 8: Schematic Diagram of the Proposed System

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Based on Figure 8, the Arduino microcontroller is powered by solar energy. The TP4056 module was chosen to charge the batteries since it supports the constant current-constant voltage charging technique for single-cell Li-Ion batteries. As seen in Figure 8, the batteries and step-down module were linked to the TP4056 module through the switch. Before transferring to the microcontroller, the LM2596 will lower the Vin voltage from 7.4V to 5V to avoid overvoltage that could damage the device. The microcontroller was programmed using the Arduino IDE software once all of the hardware had been developed. The Arduino Nano was linked to a computer via USB, and the project's code was uploaded.

Besides collecting the data for measurement purposes, the development of a self-operated system requires the utilisation of solar energy to turn on the equipment itself. This requires an initial calculation and measurement to avoid insufficient current supply for the whole system [19]. An understanding of the power rating and requirements of each system is needed in the whole design process to avoid errors and miscalculations that can make the whole system to malfunction.

4. RESULTS AND DISCUSSIONS

4.1 Prototype Design for the Proposed System

The MOVES, as shown in Figures 9 and 10, were built on a PCB board rather than just connecting the wiring system to the breadboard to minimise the hardware size. When the switch on the back of the container system is turned on, all the devices and the sensor are turned on and ready to be used. The device has been tested, and the life expectancy of the system is about 8.48 hours, which is quite good because the system has been running without the help of a charging system. This device also has a manual charging feature in addition to a solar charging system. The reason for including this feature was to make sure the device always has enough power to be utilised and to make the charging process easier.

Figure 9: Prototype of the MOVES

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Figure 10: Actual demonstration of the MOVES

4.2 Analysis Results of the Proposed System

For analysis, the MOVES are used to detect an obstacle. The range of detection is compared with the real distance of the obstacle. When a sensor in the data terminal senses an object, the buzzer activates automatically. The visually impaired individual will be able to determine the range of an obstacle by hearing the dissimilar sound of the buzzer. For example, the device is put on a moving control car and drives towards the walls. After the sensor detects the wall that is within the range of 150 cm, the Arduino will instruct the buzzer by producing a beeping sound. When the range distance between the obstacle and the sensor is below 70 cm, the buzzer will continuously sound.

For distance measurements, nine types of material textures were used, such as paper, plywood, cardboard, plastic (PVC), clay brick, ceramic tile, glass, aluminium, and cast iron. The measurements were taken using an ultrasonic sensor that was placed at various preset distances from the obstacles and recorded in Table 1. All the obstacles have the same shape and were placed at 20 cm, 40 cm, 60 cm, 80 cm, and 100 cm from the sensor. By using the same concept, distance measurement for two types of surfaces, which are rough and smooth, has been taken and recorded in Table 2. In this experiment, the same type of object (cardboard) has been used as its constant. Table 1 and Table 2 show the values of the measured distance, absolute error, relative error, mean relative error (MRE), and density of each material.

Table 1: Distance Measurement of Different Materials

(a) Paper (Density = 0.3 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	19.57	0.43	2.150
40	37.69	2.31	5.775
60	56.29	3.71	6.183
80	75.80	4.20	5.250
100	93.91	6.09	6.090

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(b) Cardboard (Density = 700 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	19.97	0.03	0.150
40	37.86	2.14	5.350
60	57.10	2.90	4.833
80	76.23	3.77	4.713
100	95.27	4.73	4.730

(c) Plywood (Density = 540 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.94	0.94	4.700
40	38.08	1.92	4.800
60	57.32	2.68	4.467
80	76.41	3.59	4.488
100	95.42	4.58	4.580

(d) Clay Brick (Density = 2000 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.4	0.40	2.000
40	39.12	0.88	2.200
60	57.82	2.18	3.633
80	77.26	2.74	3.425
100	95.73	4.27	4.270

(e) Ceramic Tiles (Density = 2200 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.54	0.54	2.700
40	38.88	1.12	2.800
60	58.62	1.38	2.300
80	77.40	2.60	3.250
100	95.73	4.27	4.270

(f) Cast Iron (Density = 7200 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.24	0.24	1.200
40	39.64	0.36	0.900
60	60.06	0.06	0.100
80	79.03	0.97	1.213
100	97.04	2.96	2.960

(g) PVC (Density = 1190 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.96	0.96	4.800
40	39.13	0.87	2.175
60	57.94	2.06	3.433
80	76.47	3.53	4.413
100	95.39	4.61	4.610

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(h) Glass (Density = 2500 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.64	0.64	3.200
40	39.46	0.54	1.350
60	58.55	1.45	2.417
80	77.04	2.96	3.700
100	96.39	3.61	3.610

(i) Aluminum (Density = 2700 kg m^{-3})

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	19.52	0.48	2.400
40	38.91	1.09	2.725
60	58.12	1.88	3.133
80	77.06	2.94	3.675
100	97.05	2.95	2.950

Based on Table 1, cast iron has the highest density, which is 7200 kg m^{-3}, followed by aluminium, glass, ceramic tile, clay brick, plastic (PVC), cardboard, plywood, and paper with 2700, 2500, 2200, 2000, 1190, 700, 540, and 0.3 kg m^{-3}, respectively. Cast iron also has the lowest mean relative error, which is 1.2745%, compared to paper with 5.08967%.

Table 2: Distance Measurement of Different Surfaces

(a) Smooth Surface

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	19.84	0.16	0.800
40	39.90	0.10	0.250
60	58.02	1.98	3.300
80	77.21	2.79	3.488
100	95.01	4.99	4.990

(b) Rough Surface

Real Distance (cm)	Measured Distance (cm)	Absolute Error (cm)	Relative Error (%)
20	20.25	0.25	1.250
40	39.20	0.80	2.000
60	53.82	6.18	10.300
80	75.16	4.84	6.050
100	93.06	6.94	6.940

The results shown in Table 2 indicate that a smooth surface has a lower relative mean error compared to a rough surface, which is 2.5655% and 5.308%, respectively.

4.3 Discussion

Based on the collected data from Table 1 and Table 2, a graph has been made for each table to make the analysis process easier. Figure 10 shows the relative error versus the real distance based on different materials.

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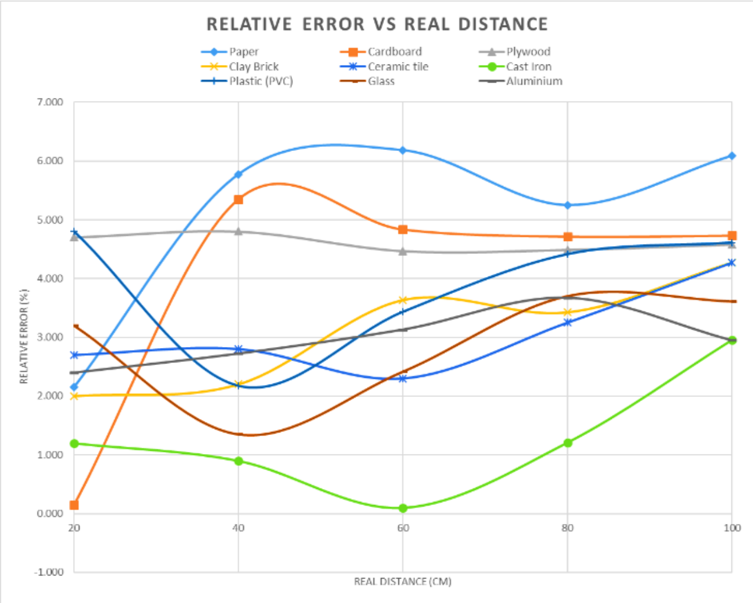

Figure 10: Relative Error vs Real Distance for Different Materials

Based on Figure 10, it can be concluded from the graph that cast iron has the fewest relative errors compared to other materials. The material of the object and the orientation of the material have an impact on the accuracy of the distance-measuring unit. When an object's substance has a lower density, the sound will be reflected slower to the ultrasonic sensor's receiver, causing the device to cease operating or display incorrect data [20]. For example, a piece of paper has a very low density and is thin. So, when the ultrasonic sensor sends its signal to the paper, some of the signals might pass through it because only a few of the signals are reflected and received by the receiver. Figure 11 shows the relative error versus the real distance between the smooth surface and the rough surface.

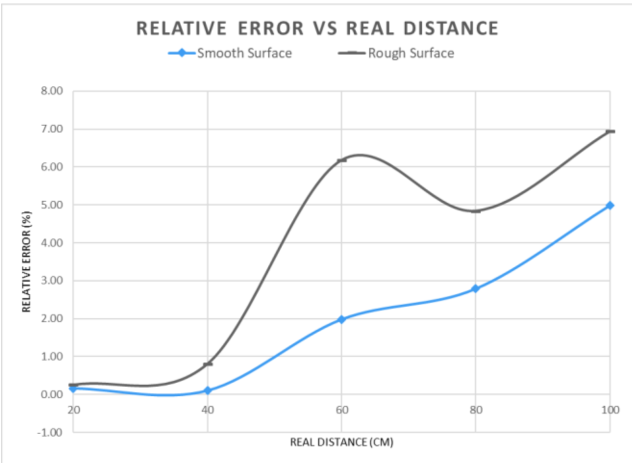

Figure 11: Relative Error vs Real Distance for Different Surfaces

Based on Figure 11, sound reflected by a smooth surface has better performance than a rough surface. This can be seen in the graph above, whereby a smooth surface has the fewest relative errors. More sound will be reflected in the sound wave that strikes a reasonably smooth surface rather than a rough one. The reason for this is that a rough or porous surface allows for a lot of

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internal reflections, which results in greater absorption and less reflection [20]. Based on this study and data analysis from both tables above, it can be concluded that ultrasonic sensors can detect objects of different textures and surfaces with ease. This is because both cases have a mean relative error below 5%. The ultrasonic sensors identify obstacles that only occur within a specified angular range [21]. Sensors are not able to detect objects that fall outside of this range. For this experiment, an object has been placed at various points from 20 to 100 cm and at different angular positions. Figure 12 shows the ultrasonic detection ranges.

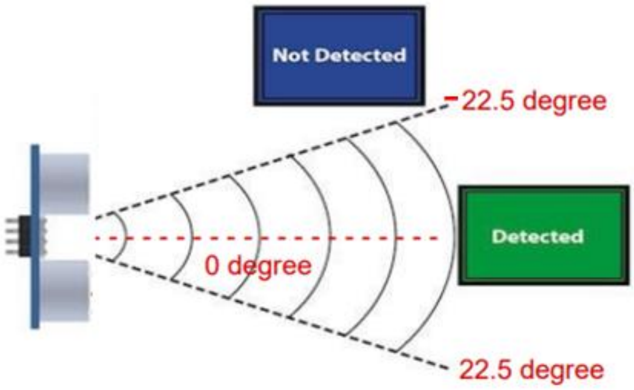

Figure 12: Ultrasonic Detection Range

Based on Figure 12, the experimental result indicates that the sensor's maximum angular range and object distance are about 22.5 degrees and 100 cm, respectively. So, the sensor must be placed within the angular range of field detection to avoid any error in measuring object distance from the user. Since any failure or inability to identify the current obstruction is hazardous to a visually impaired person and thus might lead to an accident.

5. CONCLUSIONS

In conclusion, the prototype of the MOVES has been successfully developed using Arduino and has several features. The MOVES will be set up to assist people with visual impairments to walk safely. The system was developed on a hat and consists of two systems, which are obstacle detection and solar-based energy systems. Based on the testing results, the MOVES manages to detect the obstacle within acceptable ranges. This system is expected to produce good results in identifying obstacles ahead of the user within a one-metre range and is self-powered with solar. It is also anticipated to provide a low-cost, dependable, portable, low-power-consumption, and durable navigation solution with an obvious quick reaction time.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this paper.

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REFERENCES

[1] F. Hutmacher, "Why is there so much research on vision than on any other sensory modality," *Frontiers in Psychology*, vol. 10, 2019.

[2] A. Cieza, S. Keel, I. Kocur, M. McCoy, and S.P. Mariotti, "World report on vision," *World Health Organization*, 2019.

[3] O. de Faria Oliveira, M.C. Goncalves, R.W. de Bettio, and A.P. Freire, "A qualitative study on the needs of visually impaired users in Brazil for smart home interactive technologies," *Behaviour and Information Technology*, vol. 42, no. 10, 2023.

[4] P. Theodorou and A. Meliones, "Towards a training framework for improved assistive mobile app acceptance and use rates by blind and visually impaired people," *MDPI - Journal of Education Sciences*, vol. 10, no. 58, 2020.

[5] S. Chakraborty, A. Bhandra, S. Mondal, and S. Prasad, "An intelligent and smart belt for the blind people," *Advances in Smart Communication Technology and Information Processing*, vol.165, pp 307–316, 2021.

[6] M. Kumar, R. Verma, M. Kumar, S. Singh, and E. T. Singh, "Ultrasonic Based Smart Blind Stick for Visually Impaired Persons," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 6, no. 3, pp. 1316–1322, 2017.

[7] N. H. Pauzi, and S. A. Abdullah, "Currency Identification Assistant for Visually Impaired," *Journal of Mechanical Engineering*, vol. 5, no. 1, pp 156-164, 2018.

[8] A. A. N. Azizi, M. N. Rabun, and N. A. S. Badarin, "Are we disabled among the disabled? – Disability Awareness Among University of Malaya Students," *Journal of Administrative Science*, vol. 15, no. 1, 2018.

[9] J. Marsden, S. Stevens, and A. Ebri, "How to measure distance visual acuity," *Community Eye Health Journal*, vol. 27, no. 85, 2014.

[10] S. C. Reddy and T. Thevi, "Blindness and low vision in Malaysia," *International Journal of Ophthalmic Research*, vol. 3, no. 2, pp. 234–238, 2017.

[11] R. Radhika, P. G. Pai, S. Rakshitha, and R. Srinath, "Implementation of Smart Stick for Obstacle Detection and Navigation," *International Journal of Latest Research in Engineering and Technology*, vol. 02, no. 05, pp. 45–50, 2016.

[12] S. Mohite, A. Patel, M. Patel, and V. Gaikwad, "Smart Walking Stick for Visually Impaired People," *SSRN Electronics Journal*, vol. 3, no. 3, pp. 4057–4061, 2018.

[13] N. Nowshin, S. Shadman, S. Joy, S. Aninda, and I. M. Minhajul, "An intelligent walking stick for the visually-impaired people," *International Journal of Online and Biomedical Engineering*, vol. 13, no. 11, pp. 94–101, 2017.

[14] M. A. Therib, "Smart blinding stick with holes, obstacles and ponds detector based on microcontroller," *Journal of Babylon University – Engineering Sciences*, vol. 25, no. 5, pp. 1759–1768, 2017.

[15] K. B. Swain, R. K. Patnaik, S. Pal, R. Rajeswari, A. Mishra, and C. Dash, "Arduino Based Automated STICK GUIDE for a Visually Impaired Person," *2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials*, pp. 407–410, 2017.

[16] Preethi G., Lavanya D., Sreesureya V., and Boopathimanikandan S., "Real-Time Monitoring and Controlling of Solar Panel using Labview," *International Journal of Scientific and Technology Research*, vol. 8, no. 8, pp. 1747–1752, 2019.

[17] A. J. Ramadhan, "Wearable smart system for visually impaired people," *Sensors*, vol. 18, no. 3, 2018.

[18] R. Way, M. C. Ives, P. Mealy, and D. Farmer, "Empirically grounded technology forecasts and the energy transition," *Joule*, vol.6, no.9, pp 2057-2082, 2022.

[19] A. Mateen, M.Z. Hanif, N. Khatri, S. Lee, and S.Y. Nam, "Smart Roads for Autonomous Accident Detection and Warnings," *Sensors*, vol.22, no.6, 2022.

p-ISSN 1675-7939; e-ISSN 2289-4934

[20] R. Tarulescu, C. Olteanu, and S. Tarulescu, "Texture of Material Influence at Ultrasonic Detection," *Annals of the Oradea University*, no. 1, 2014.
[21] Rameez Ali P., Shameena V., R. Senthil Kumar, and S. Prakash, "External Factors Influencing on Accuracy of Distance Measurement by Use of Ultrasonic Sensors," *International Journal of Science and Engineering*, vol. 3, no. 5, pp. 29–33, 2018.

p-ISSN 1675-7939; e-ISSN 2289-4934