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Original Article

Selection Technique for Sending SMS Message based On Signal Strength for Blind Stick Navigation

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Abstract - *Blind sticks are essential for assisting the visually impaired in navigating their surroundings but lack integrated emergency communication capabilities. Blind individuals typically rely on others for immediate help during emergencies, and contacting guardians becomes especially difficult when they do not have their phones. Current solutions do not address this critical need, leaving a gap in accessible emergency response technology for people who are blind. Thus, this project intends to design a blind stick integrated with an emergency response button. By integrating GPS and GSM (SIM808) technology, the proposed device will allow users to directly connect with their guardians in emergencies, enhancing mobility and safety. Once the emergency button is pressed, an SOS message with the blind location is sent to alert the guardians so they can decide to respond to the situation. It is important to ensure that the SOS message is received by the guardian within the least possible time so that they receive help as soon as possible. This study assesses the time various service providers take to respond, measuring the duration from the activation of the blind stick to the moment the alert reaches the guardians or caretakers of the blind. A selection algorithm is designed to choose between two service providers automatically depending on the signal strength. The experiment results show that for weak signal strength of -107dbm, the time the message is received is within 2.5 minutes after the message is sent. The message was not sent in a worst-case scenario where the signal strength is below the marginal value. The experiment results also show that the selection algorithm improved the delivery of SOS messages by selecting the service provider with higher signal strength.*

Keywords - *Blind stick, Efficient location-aware, Emergency Button for blind stick, Blind stick with obstacle detection, Selection algorithm.*

1. Introduction

It is difficult to differentiate between a blind person and a normal person. This is because their appearance is the same as that of normal people. They can only be identified when their faces are seen or when they walk using a blind stick, which indicates that they need assistance or cannot see. Because of this, some normal people tend to bump into them while they are walking, which can cause harm to them. Most normal people do not understand the struggles or challenges blind people face. A book titled “My Son Will Never Be a Beggar” describes the struggles and difficulties faced by a blind person not known to society. The book explains how the blind live their daily lives and the struggle they have to endeavor to fulfill everyday routines. The biggest challenge blind people face is when they are out in the street. Blind individuals can navigate their homes independently, as they are familiar with the location of items within the house. However, they have a big challenge when they have to move outside of their homes to buy some groceries or to get medical supplies. Blind individuals value their independence, especially when navigating outside their homes. With the assistance of a walking stick, they are comfortable moving around without relying on others to guide them. They are confident in managing daily tasks, showing they are just as capable as anyone else and not a burden to their family or community. They seek equal treatment, desiring to live a normal life without being seen as incapable or dependent.

2. Related Works

The GPS system designed by [1] operates by pressing the SOS button, which sends an SMS using an Arduino Uno integrated with a SIM808 microcontroller board. The SIM808 acts as a wireless middleman for the Arduino board. The research shows the cost effect, and it takes a lot of time to configure using Arduino Uno as a standalone. The Arduino board requires extra wiring and electrical components. GPS devices available in the Arduino board market are expensive and typically emphasize a specific feature. In contrast, using the SIM808 provides a faster and more cost-effective approach for prototyping this project, utilizing fewer wires than the previous methods employed with the Arduino Uno board.

An enhanced navigator system to aid blind and visually impaired people was developed by Bhandari et al. [2], Albahar et al. [3], Subbiah et al. [4] and Elhadi. When a blind person approaches an obstacle, the system will provide guidance on the optimal walking routes and decisions to make. This functionality helps alleviate spatial awareness challenges by notifying them of their surroundings through ultrasound sensors and vibrations in the stick's handle. A GPS tracking system enhances security for blind individuals by sending their location to nearby contacts and relevant authorities. This stick is equipped with a microcontroller and an HC-SR04 ultrasonic sensor [4] that can detect objects or obstacles in front. Adding an HC-SR04 sensor to the board addresses the need to detect obstacles at head and ground levels. A vibration motor is situated near the handle of the white cane, carefully wrapped in a smooth cloth. Upon detecting nearby obstacles, the ultrasonic sensor will relay feedback to the board, activating the DC motor to cause vibrations at the handle.

Another study introduces an adaptive network mechanism for a smart farming system that utilizes LoRaWAN and IEEE 802.11ac protocols. This study presents an adaptive network mechanism to enhance the system's performance and create a more reliable smart farming solution. The system can adjust its protocol according to the prevailing network conditions. For example, the IEEE 802.11ac protocol is ideal for transmitting high-data-rate content, such as images or videos. In contrast, the LoRaWAN protocol is more appropriate for transmitting small data packets, like sensor readings. An adaptive mechanism that integrates the strengths of both protocols enables the system to achieve reliability while conducting monitoring tasks. The system has been assessed in real deployment scenarios. The results show that the proposed system enhances reliability regarding average latency and the total number of sensor data collected [5].

Bluecane [6] is a model for a Blind Client Navigation System that assists blind individuals by providing directions through Bluetooth and cardinal bearings using haptic feedback. The system comprises two primary components: Arduino slave programming and professional code management. Jacob Simon, the 17th member of the community, founded it. The system contains the accelerometer, magnetometer, and The system is equipped with an accelerometer, magnetometer, and Bluetooth components. It functions by repeatedly obtaining readings from the accelerometer and magnetometer, displaying the tilt-compensated direction. The Bluetooth mode vibrates to indicate the desired direction, while the Compass mode vibrates only when facing north. Bluecane serves as a prototype navigational device for blind users, allowing them to receive route-guided instructions through Bluetooth and cardinal directions using haptic feedback.

The reliability of SMS delivery is significantly influenced by signal strength, as higher signal levels typically enhance message delivery speed and success rates. Research indicates that inadequate signal strength leads to increased latency and message failures. For example, Moessner and Kanoun [7] highlight that communication reliability is closely linked to signal quality in wireless applications. One of the author also found a direct correlation between signal strength and SMS delivery performance, emphasizing the necessity of robust signal conditions for optimal functionality.

3. Proposed Framework

This section presents the proposed framework along with descriptions of the physical components and software utilized in this study.

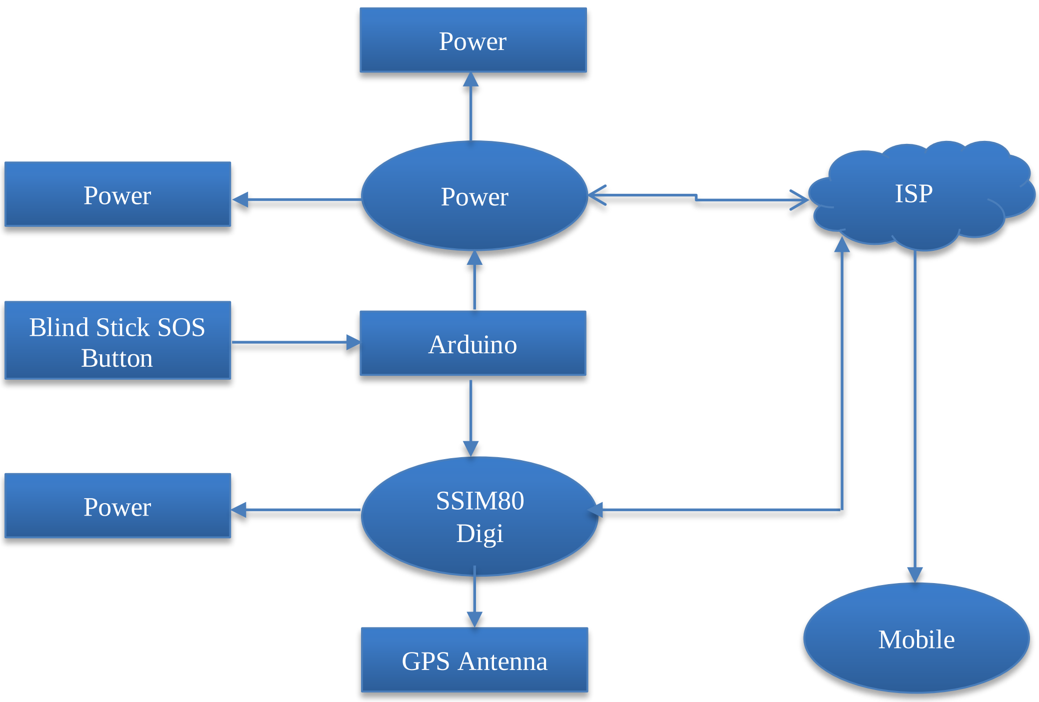


Fig. 1 System architecture

Figure 1 shows the system's function, enabling the blind person to send an SOS message. When the blind presses the SOS button, the Arduino will turn on the two SIM808. The reading of the signal strengths is obtained from both SIM808. Depending on the stronger signal strength between the service providers, the processor will choose which SIM808 will send the message. Then, the SOS message is sent to the blind emergency contacts such as the parents or relatives. The prototype's main components are the hardware consisting of two SIM808, an Arduino board plus an SOS button, ultrasonic sensors, a buzzer, and a vibration motor. The SIM808 module is a dual-function GSM and GPS module designed for sending messages and tracking locations. The second component is the connectivity to the internet service providers once the SOS button is activated. The third component is a mobile phone, where the recipient will receive the message.

The workflow of the proposed system shows two main functions. The first function is for obstacle avoidance, and the second function is the activation of the SOS message. Figure 2 shows the workflow. When the ultrasonic sensor recognizes the obstacle from a distance of 80cm, it will activate the vibration motor. It also shows the SOS message process when the blind presses the button that will activate the SIM808. The Arduino will check the signal strength for both SIM808 and compare the stronger signal. If the first SIM808 has a stronger signal than the second SIM808, then it will send the message using the first SIM808 and vice versa.

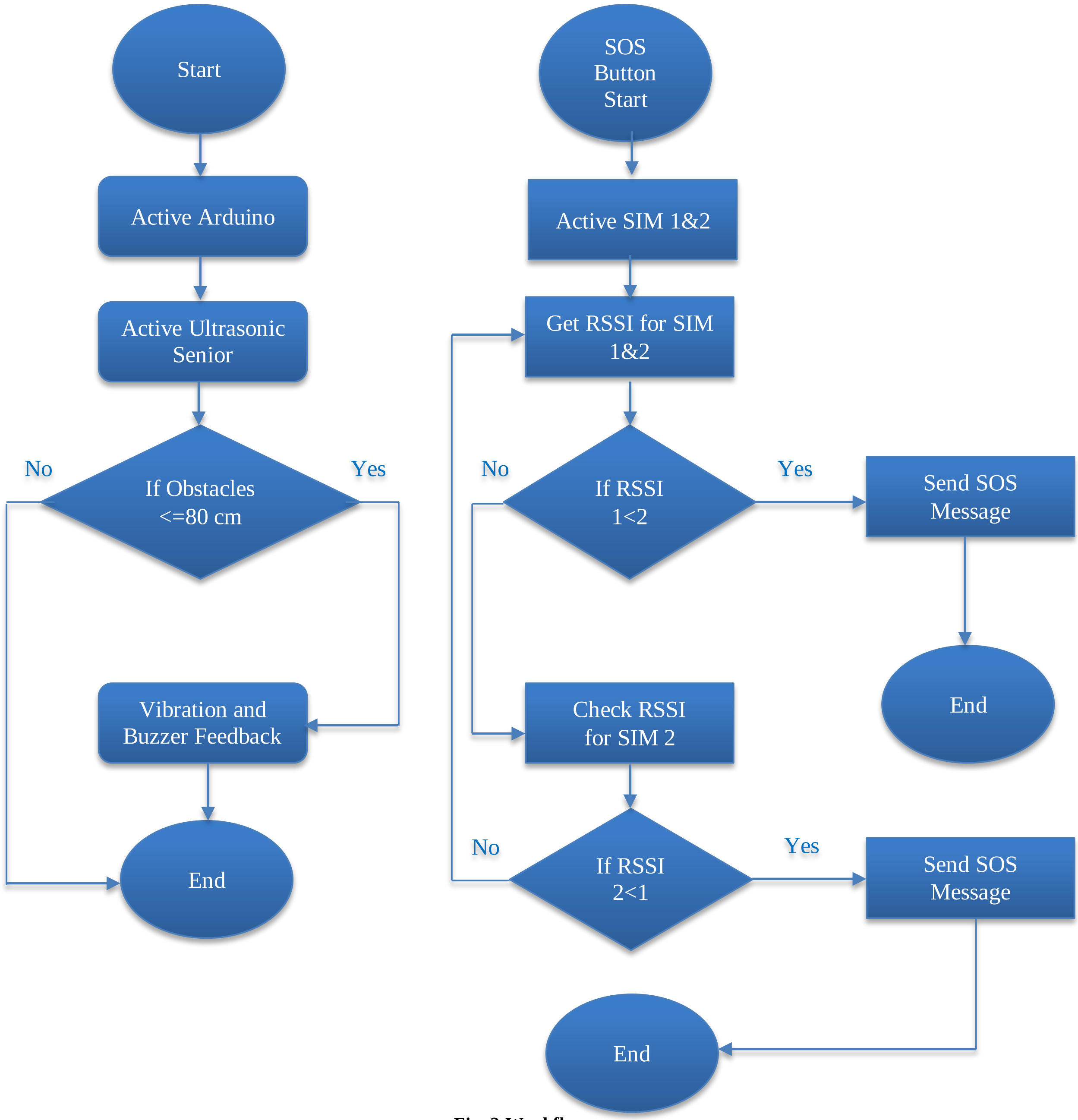


Fig. 2 Workflow

Figure 3 shows the circuit diagram of the blind stick and how the components are connected. The power supply is 9v to turn on Arduino, ultrasonic sensors to help the blind avoid obstacles, and vibration to vibration the stick when obstacles are detected.

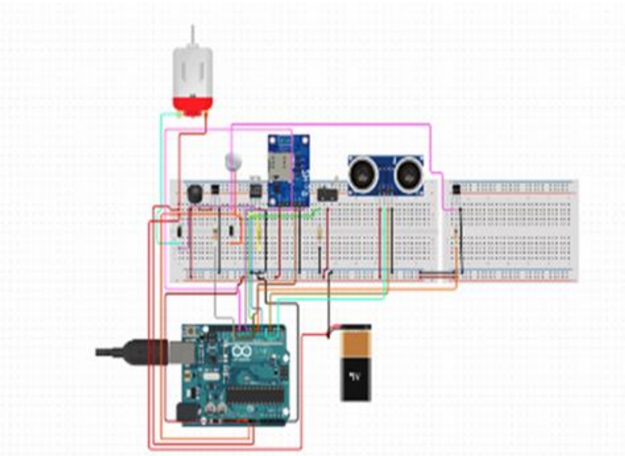


Fig. 3 Circuit diagram

The experiments are organized as follows: In the first experiment, the blind stick is connected to a service provider referred to as Service Provider A. When the blind individual presses the SOS button, the time at which the recipient receives the message is recorded.

This experiment is conducted five times across three different scenarios: when the blind individual is in a building, on the street, and while in motion, such as in a car or on a train. In each scenario, 5 different locations are tested with the same signal strength of 3 bars. The recipient's location is not noted. The experiment is repeated with three additional service providers: Service Provider B, Service Provider C, and Service Provider D.

The average of five samples is calculated for each ISP, resulting in a total of 240 samples collected across indoor, outdoor, and basement settings. Figure 4 shows data from the service provider outdoors, indoors, and in the basement.

U mobile	Signal Bar	Building	Basement	Street
A	3 bars	2.21 sec	2.11 sec	1.13 sec
A	3 bars	2.23 sec	2.34 sec	1.13 sec
A	3 bars	2.28 sec	2.41 sec	2.56 sec
A	3 bars	3.29 sec	3.22 sec	1.65 sec
A	3 bars	3.22 sec	3.65 sec	2.12 sec
B	3 bars	2.23 sec	3.46 sec	2.09 sec
B	3 bars	3.23 sec	3.77 sec	1.35 sec
B	3 bars	3.22 sec	3.87 sec	1.51 sec
B	3 bars	3.23 sec	3.67 sec	1.13 sec
B	3 bars	3.23 sec	3.56 sec	2.35 sec
C	3 bars	2.12 sec	3.44 sec	1.39 sec
C	3 bars	2.54 sec	2.32 sec	2.02 sec
C	3 bars	3.33 sec	3.23 sec	2.1 sec
C	3 bars	2.65 sec	3.58 sec	2.16 sec
C	3 bars	2.56 sec	3.78 sec	2.03 sec
D	3 bars	2.17 sec	3.52 sec	2.08 sec
D	3 bars	2.45 sec	3.66 sec	1.64 sec
D	3 bars	2.26 sec	3.47 sec	1.78 sec
D	3 bars	3.24 sec	2.11 sec	3.73 sec
D	3 bars	2.24 sec	2.83 sec	1.91 sec

Fig. 4 Data from service provider

4. Results and Discussion

This section presents and discusses the experiment's results, comprising three test types. The first experiment aims to validate the obstacle detection and vibration features of the blind sticks. The second experiment focuses on measuring the response time for the SOS message. For the second experiment, the message is sent from one service provider to another service provider with various signal strengths to observe the difference between different service providers in various signal strengths. The experiments are conducted with four service providers in various locations. Several tests are carried out at different times of the day (morning and evening) and repeated simultaneously on different days under varying weather conditions (rainy days and normal days). The third experiment is to obtain the result of the selection algorithm implemented in the system. The selection algorithm evaluates two service providers to determine which will send the SOS messages. Subsequently, the experiment is conducted with these two service providers to test the effectiveness of the selection algorithm. These experiments have been done inside the IUKL campus in 3 different locations (free area, hostel room, parking basement).

4.1. Obstacle Detection for Testing the Blind Stick

In this experiment, the length of the blind stick was 125 cm, indicating the obstacles sensed by the ultrasonic sensor as blind people approach obstacles 100 cm of body level and 60 cm of ground level for steep stairs. The ultrasonic sensor is below the middle by 5 cm. The ultrasonic sensor is located in this position to detect both body level (humans, walls) and ground level. (stones, holes, stairs) After a couple of times tests to get a suitable distance, the result can be seen in Figure 5. In the obstacle detection experiment, an error of 1% is observed in the measured value compared to the real distance. Consequently, this tolerance is incorporated into the controller to adjust the measured distance. As a result, the graph in Figure 5 demonstrates consistent outcomes, with values ranging only from 99 cm to 100 cm.

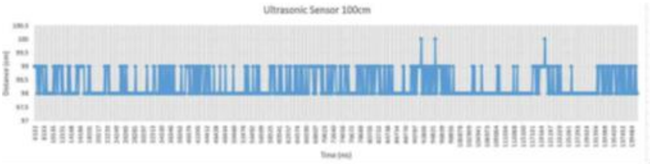


Fig. 5 Obstacles detection

4.2. Vibration Testing on the Blind Stick

When the ultrasonic sensor detects obstacles, the sensor sends the new output back to the board, and the microcontroller processes this information based on the programmed sketch (code). It then provides feedback to the DC motor to activate it. If the detected obstacles are within 100 cm, the DC motor will vibrate in response, with each vibration delayed by 200 milliseconds (0.2 seconds). If the obstacles are out of this range, nothing will happen. The vibration pulse can be seen in Figure 6.

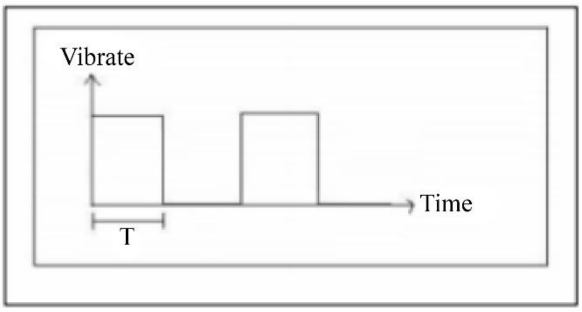


Fig. 6 Vibrations test

4.3. Response Time for SOS Message

In this experiment, five samples are collected from each service provider situated in the same location, with the signal strength fixed at three bars. 3 bars mean that the signal strength is good, as shown in Figure 7.

SIGNAL STRENGTH	EXCELLENT	GOOD	FAIR	POOR	DEAD ZONE
3G/1x	-70dBm	-71 to -85dBm	-86 to -100dBm	-101 to -109dBm	-110dBm
4G/LTE	-90dBm	-91 to -105dBm	-106 to -110dBm	-111 to -119dBm	-120dBm

Fig. 7 Signal strength and corresponding signal bars

The SIM808 module is a dual-function GSM and GPS module, as illustrated in Figure 8. It utilizes the latest SIM808 GSM/GPS module from SIMCOM, which supports the GSM/GPRS Quad-Band network and integrates GPS technology for satellite navigation.

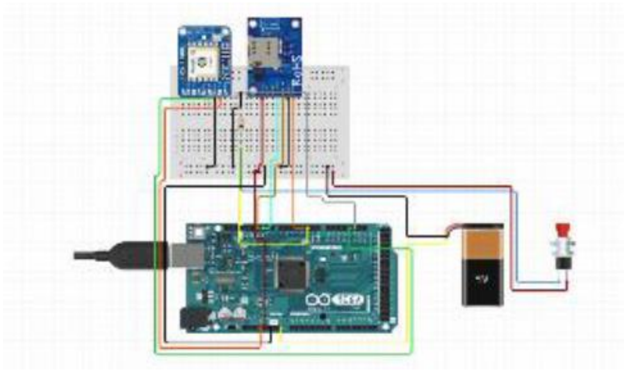


Fig. 8 SOS message circuit diagram

The SIM808 is a GSM_GPS module used in emergencies, that is, when the SOS button is pressed. This module receives the information from the GPS satellite in NMEA format. It transfers the latitude and longitude information as SMS messages to a predefined mobile number in case of emergency. Figure 9 shows the SOS message that the recipient received when the blind pressed the SOS message for help. Once the message is opened, and by clicking on the map, the whereabouts of the blind people are shown on the map.

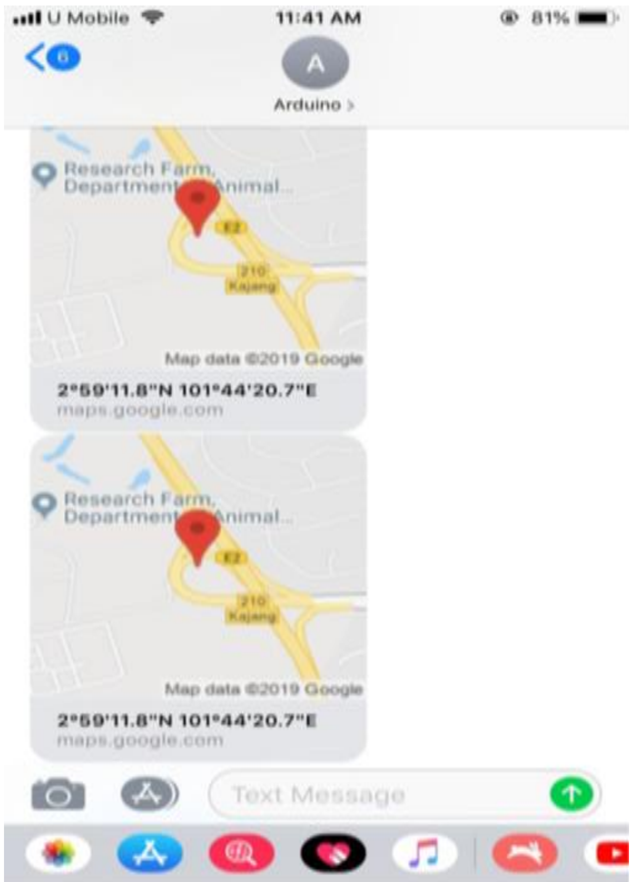


Fig. 9 SOS message display

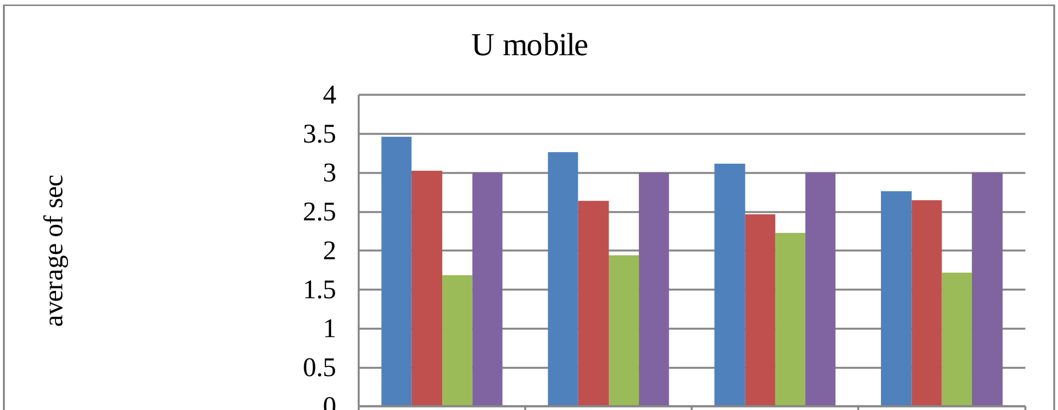
4.4. SOS Message Transmission from Service Provider A to Other Service Providers

In this experiment, a service provider is selected to send the SOS messages to the different service providers of the recipient. In the first experiment, A is fixed as the service provider for the sender, and the message is received from different service providers, such as service provider B, followed by service provider C, service provider D and service provider A. This is set in sequence, and one service provider receives the message simultaneously. However, the response time does not show any big difference between the service providers, i.e., the difference is just in seconds, and, in some situations, it is less than a second.

4.5. SOS Message Transmission from Service Provider C to Other Service Providers

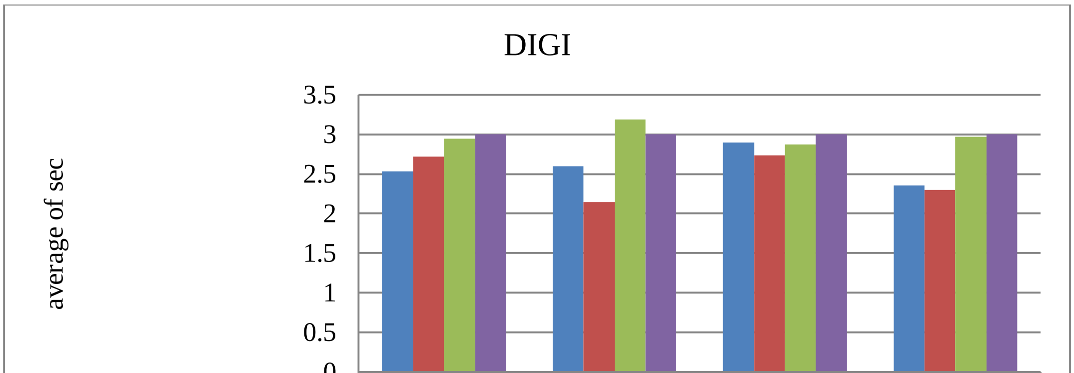
In this experiment, a service provider is selected to send SOS messages and varies the recipient service providers. In the second experiment, service provider C is fixed as the service provider for the sender, and the message is received from different service providers, such as service provider B, followed by service provider C, service provider D and service provider A. This is set in sequence, and one service provider receives the message simultaneously. 5 samples of reading are taken for each service provider.

After collecting 5 samples for each service provider in three different locations with fixed signal strength, the average reading is calculated and tabulated in Figure 10. However, the response time does not show a big difference as it's just seconds and, in some situations, was less than a second. Due to this, other experiments were done with the same service provided in the same locations without fixing the Received Signal Strength Indicator (RSSI).



	CELECOM	DIGI	MAXS	U mobile
Average of building	3.466	3.27	3.118	2.764
average of street	3.028	2.64	2.472	2.646
Average of basement	1.686	1.94	2.228	1.718
average of signal strength	3	3	3	3

Fig. 10 A to other internet service provider results



	CELECOM	DIGI	MAXS	U mobile
Average of building	2.532	2.6	2.896	2.356
average of street	2.718	2.142	2.734	2.302
Average of basement	2.948	3.188	2.872	2.966
average of signal strength	3	3	3	3

Fig. 11 Service provider C to other internet service provider results

5. Scenario 2 with Selection Algorithm

These experiments were conducted using the proposed selection algorithm. In this setup, two SIM808 modules were integrated into the hardware. The experiment recorded which service provider was selected based on signal strength to send the message. The selection algorithm automatically determines the service provider without any user intervention.

5.1. Basement to Level 18

In this experiment, two SIM808 were slotted, and only the sim with the best signal strength was chosen to send the SOS message. The sender is located in the parking basement, while the receiver is located on level 18 of the D-centrum apartment. The experiments were performed 5 times, and the signal strength values were recorded by the time the messages were received, as Figure 11 shows. It was observed that the signal strength for service provider C in the basement was also weak; the strongest signal was 99dbm, and the time the message was received was within 1.17 minutes after the message was sent. While service provider A didn't have any signal strength, all the messages were sent through service provider C. Service provider C has better signal strength than service provider A from the basement.

	Location			
	basement - level 18			send by
signal stengh	Value	indicator	time received	
99dbm	7	marginal	1.17.20 minutes	C
101dbm	6	marginal	1.21.55minutes	C
101dbm	6	marginal	1.21.17minutes	C
103dbm	5	marginal	1.34.64minutes	C
107dbm	3	marginal	2.34.36minutes	C

Fig. 12 Form basement to level 18

5.2. Room Level 18 to Lobby

In this experiment, two SIM808 were slotted, and only the sim with the best signal strength was chosen to send the SOS message. The sender is located at level 18 of the D-centrum apartment, while the receiver is located in the residents' lobby of D-centrum. The experiments were performed 5 times, and the signal strength values were recorded when the messages were received, as Figure 12 shows. It was observed that the signal strength for service provider C in level 18 of the D-centrum apartment was very good. The strongest signal was 85dbm, and the time the message was received was within 39.42 seconds after the message was sent. Service provider C sends as many as 4 times messages, while service provider a sends one message with signal strength 89dbm, and the time the message is received is within 420 seconds after the message is sent. Therefore, service provider C was better than A from level 18 of the D-centrum apartment.

	room level 18 to lobby			
signal stengh	Value	indicator	time received	send by
89dbm	12	Ok	41.31seconds	C
85dbm	14	Ok	41.57 seconds	C
85dbm	14	Ok	40.88 seconds	A
87dbm	13	Ok	40.17 seconds	C
85dbm	14	Ok	39.42 seconds	C

Fig. 13 Experiment conducted from Level 18 to the resident's lobby

5.3. IUKL Campus to a Room on Level 18 of the D-Centrum Apartment

In this experiment, two SIM808 were slotted, and only the sim with the best signal strength was chosen to send the SOS message. The sender is located at the IUKL campus, while the receiver is located on level 18 of the D-centrum apartment. The experiments were performed 5 times, and at the time the messages were received, the signal strength values were recorded, as Figure 13 shows. It was observed that the signal strength for service provider A in the IUKL campus was very good; the strongest signal was 71dbm, and the time the message was received was within 35.77 seconds after the message was sent. Service provider A sent 4 times while service provider C only sent one message with signal strength 37dbm, and the time the message was received was within 73.62 seconds after the message was sent. Thus, service provider A was better than service provider C from the IUKL campus.

	iukl campus to room level 18			
signal stengh	Value	indicator	time received	send by
71dbm	21	excellent	35.77 seconds	A
71dbm	21	excellent	35.97 seconds	A
71dbm	21	excellent	36.55 seconds	A
73dbm	20	excellent	37.62 seconds	C
75dbm	19	good	40.34 seconds	A

Fig. 14 IUKL campus to room level 18

6. Discussion

The results suggest that the ultrasonic sensor can detect objects at a distance of about 99 cm. With this result, ultrasonic sensors are good for detecting obstacles and are cheap as well. The vibration motor also is programmed to have a delay of 0.02sec.

These experiments were conducted using the proposed selection algorithm. The system incorporates two SIM808 modules in the hardware, with a service provider selected to send messages based on signal strength. The selection algorithm autonomously determines which service provider to use for sending SOS messages, requiring no user intervention.

The results show how the proposed system provides different behaviors at different places and how far data can be transmitted successfully. Experiments were conducted in 3 different areas, and the experiment results show different behaviors. In this experiment C is tested as the sender and A as the receiver and vice versa. The result shows the differences between the signal strength and the response time depending on the service provider's coverage area. With the implementation of the selection algorithm, the blind do not have to change the SIM card every time the coverage area of a service provider is poor. However, the selection algorithm sends messages automatically, depending on the strength of the signal. The result confirms that some areas with no coverage, such as the basement, prevent the message from being sent and, therefore, fail to reach the guardian during emergencies. However, having the selection algorithm ensures that the message can be sent with higher chances, as another service will be provided if the other one has no coverage. This makes the proposed selection algorithm a better option.

7. Conclusion

The SIM808 technology stands out as a leading solution in the Global System for Mobile Communications (GSM) sector, integrating GPS, GPRS, and Bluetooth functionalities at a low cost. However, challenges related to data transmission, particularly in maintaining signal strength, can hinder performance. The proposed research addresses these issues through the introduction of a novel selection algorithm that enhances signal robustness, significantly increasing the reliability of emergency message transmission for blind users. Experimental results indicate that coverage varies based on geographical location, emphasising the need for a dynamic approach to adapt to fluctuating signal conditions.

The proposed blind stick not only aids in mobility but also incorporates an emergency communication feature that connects users with their guardians. This advancement surpasses existing assistive technologies, providing a more comprehensive solution for visually impaired individuals. By combining enhanced functionality with cost-effectiveness, the blind stick represents a significant step forward in promoting independence and safety, allowing users to navigate their environments with greater confidence and security.

Acknowledgment

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