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# Location-Aware Emergency Button for Blind Stick Navigator

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## ABSTRACT

Blind and visually impaired people require assistance in their movement. They normally walk using a stick to preserve the sense of direction. In emergencies, they have difficulties in asking for help or contacting their guardians and they have to depend on the people around them. Therefore, this project proposes to build a blink stick with an emergency response button that uses current technologies such as GPS, GSM, and Bluetooth to connect them to their guardians. Once they activate the emergency button, an SOS message with a link to the user's location is sent to the guardian, enabling them to respond to the SOS. Thus, the response time to the SOS message is crucial to ensure the distressed person receives help without undue delay. Most research on the blind stick is focused on navigation and seldom addresses the issue of response time to the emergency signal. Therefore, this study evaluates the response time of different service providers to the SOS messages to see how long it would take from the time it is activated from the blind stick to the time it reaches the guardians and caretakers of the blind. The analysis findings have led to recommending for the blind people suitable network service providers based on a selection technique. This research output can also be extended to people who are likely to face emergencies, such as heart attack, sudden hypertension, and diabetic coma.

**Key words:** Blind and visually impaired; Blind stick, SOS message, response time, network service providers; emergencies.

## 1. INTRODUCTION

The increasing number of disabled people has created a high demand for technological devices to assist them. The World Health Organization (WHO), in their statement in 2018, estimated about 285 million people are visually impaired worldwide [1]. Of these, 39 million are blind and 246 million have partial loss of vision. About 90% of the world's visually impaired live in low-income settings, while 82% of them aged 50 years or more [4]. Based on the Country Report Malaysia, the number of visually disabled people registered with the Social Welfare Department (JKM) are about 280 thousand, which is 12% of the estimated population of the disabled persons in the country. The statistic does not reflect the real situation of disabled people in Malaysia. However [3], the number shows that the wellbeing of the visually disabled deserves urgent attention from the government and society. Thus, this project aims to provide a blind stick that is useful for blind people to navigate through obstacles while walking and help them notify their guardians of their locations in emergencies via short message service (SMS) notification. This simple text message is normally use for texting important message and is also used for other purposes such as by public market price monitoring [8].Thus, the same service can be used to send location information for the disabled person.

The navigator system normally used for location information such as to navigate movement in indoor shopping mall [9]. The proposed development of the navigator system will assist the blind while walking. Whenever they are approaching the nearest obstacles, the system will send information to the blind about the walking routes and decisions to make. It will reduce the difficulties for the blind to know their current location by informing them via ultrasound sensor and vibrator installed at the handle of the stick. The GPS tracker adds up to the security feature for the blind stick where they can send their location to the saved contacts or the authority.

This stick is installed with a microcontroller and ultrasonic sensor HC-SR04 [2] that can detect objects or obstacles. Using extra HC-SR04 onto the board helps to resolve the issue of detecting head and ground level. While the vibration motor will be placed close to the handle of the stick. When the nearest obstacles are detected by the ultrasonic sensor, it will send feedback to the board and trigger the DC motor to vibrate at the handle.

This project is called Blind Stick Navigator. First, it is meant to recognize obstacles and measures the separation between obstacles and the stick. The use of an ultrasonic sensor helps identify the objects and a vibration motor is used to translate the sensor detection before adding vibration pressure to the wrist. The handle of the stick is covered with a soft pad equipped with a vibration motor to direct trigger the blind senses on upcoming obstacles through their hands [2]. It will have GPS (Global Positioning System) to locate and identify visually impaired location i.e. longitude/latitude. An alert will be sent via SMS to the guards or authorities if help is needed.

## 2. RELATED WORKS

Research by [2] proposed a stick to be placed with a microcontroller and ultrasonic sensor HC-SR04 that can detect objects or obstacles and measure the height of the user's head above the ground. The vibration motor is placed close to the handle of the white cane. The handle is covered with a smooth fabric. When the ultrasonic sensor detects the nearest obstacles, it sends feedback to the board and triggers the DC motor to vibrate the handle. When the SOS button is pressed, it sends an SMS from the Arduino Uno that is combined with the SIM808 microcontroller board and simultaneously activates GPS. SIM808 acts as a wireless interface for the Arduino board. The Arduino board needs extra wiring and electronic process into it. The cost of each GPS device in the market for the Arduino board is very high and it focused on a certain function. While SIM808 facilitates faster and cheaper prototyping of the stick. It needs less wiring as compared to the old method that applies to the Arduino Uno board. The difference in the cost of the GPS and SIM808 board is more than 200 dollars.

Research [5] introduces the accelerometer, magnetometer, and Bluetooth as parts of the system. It works through the reiteration of the procedure to getting readings from the accelerometer and magnetometer to figure out a tilt-remunerated heading. BlueCane [5], which comes with a programmable board, can navigate along a pre-planned course keyed into the stick. It will be based on the guideline zone and study the blind path. The system provides an adequate response time and is modified with a compass instrument that will vibrate in the user's hand when they are heading in the wrong direction. It can figure possible and best courses for the blinds to follows if they are lost.

Research [6] presents another invention of Hand-Mounted Sonar Assist for the Blind with the ability to sweep the glove back and forth without giving error feedback to the board. The system uses a servo motor that can detect angles of movement hand glove is very informative. However, blind users feel embarrassed to wave their hands back and forth in the air while walking. Also, this device is very expensive.

Another research [7] proposed an electronic UltraCane to recognize potential obstacles while still a couple of feet from them. Ultrasonic waves are transmitted two transducers on the handle of UltraCane and bound off articles and impediments in the method for the blinds. UltraCane has two extents of revelation, and it passes on ultrasonic waves that range between 4 meters to the front of the blind and short-range at 2 meters to the front of the blind. If there is an object on the ground before the blind, it will enroll lower material catch that suggests while moving closer to the target the repeat of the vibration will normally augment and can clear the stick from side to side to choose the most perfect way to move around the thing.

The internet service providers are responsible to provide services such as phone calls, sending SMS or internet services for data communication. They need to secure the network from any malicious network attack [10] that may harm the network. Any network attack might cause the services to be down and might affect the delivery of SMS messages.

## 3. PROPOSED FRAMEWORK

This section shows the proposed framework and the description of the physical components and software used in the project. The circuit requires a 5v power supply. The cost can be varied to make the stick affordable by using various processors in the stick's handle unit. Further, Arduino Uno sends the warning signal to the guardian's handphone, while the ultrasonic sensor sends an alert to vibrate the handle of the stick. The proposed frameworks are shown in Fig. 1 and Fig. 2.

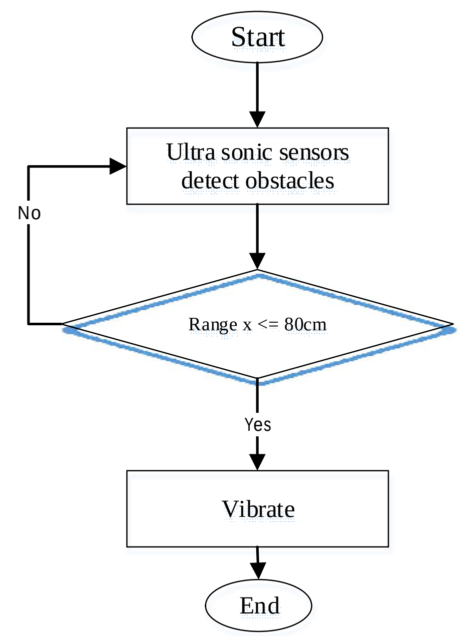


**Fig. 1:** Flow Chart for Obstacle Detection

In emergencies, when the SOS button is pressed, SIM808 instructs the GPS to get the location of the user from the satellite and send it to Arduino. Arduino sends the location through the GSM and then GSM will send it to the user's guardian's handphone as shown in Fig. 3.

In the first experiment, we measured the response time once the SOS message is activated by the user pressing the emergency button. First, the blind stick is connected to service provider A. When the SOS message is pressed by the user, the time of the receipt of the message by the guardian who is connected to Internet Service Provider (ISP) A is recorded. This experiment was repeated five times in three different scenarios, when the user was in a building, on the street, and when on the move, i.e. when the user was in a car or on a train. The stick was tested in five different locations in each scenario at the same signal strength of 3 bars and the times were recorded. The experiment was repeated with four more ISPs located in Malaysia—B, C, D, E.

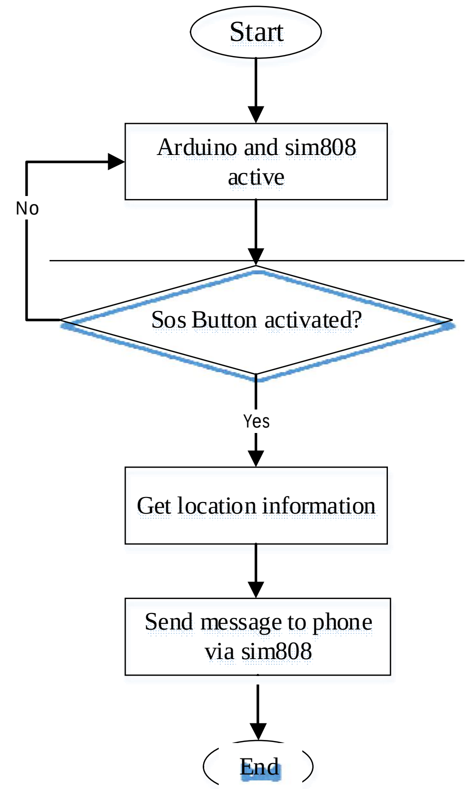


**Fig. 2:** SOS Message Flowchart

The average of 5 samples was calculated for each ISP. A total of 240 samples were collected for indoor, outdoor, and mobile scenarios. Table 1 shows the recorded times of the receipt of SOS messages received through different ISPs tested in outdoor, indoor, and on the move scenarios.

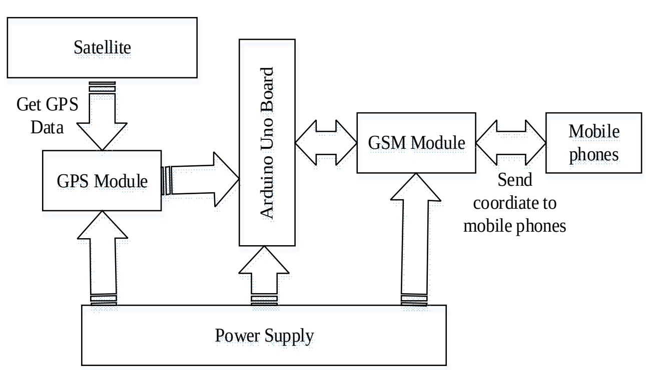


**Fig. 3:** Block Diagram

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**Table 1**: Response time for different service providers

| A | B | C | D | E |
|---|---|---|---|---|
| A | signal bar | buliding | movement | street |
| A | 3 | 2.21 | 2.11 | 1.13 |
| A | 3 | 2.23 | 2.34 | 1.13 |
| A | 3 | 2.28 | 2.41 | 2.56 |
| A | 3 | 3.29 | 3.22 | 1.65 |
| A | 3 | 3.22 | 3.65 | 2.12 |
| B | 3 | 2.23 | 3.46 | 2.09 |
| B | 3 | 3.23 | 3.77 | 1.35 |
| B | 3 | 3.22 | 3.87 | 1.51 |
| B | 3 | 3.23 | 2.67 | 1.13 |
| B | 3 | 3.23 | 3.56 | 2.35 |
| C | 3 | 2.12 | 3.44 | 1.39 |
| C | 3 | 2.54 | 2.32 | 2.02 |
| C | 3 | 3.33 | 3.23 | 2.1 |
| C | 3 | 2.65 | 3.58 | 2.16 |
| C | 3 | 2.56 | 3.78 | 2.03 |
| D | 3 | 2.17 | 3.52 | 2.08 |
| D | 3 | 2.45 | 3.66 | 1.64 |
| D | 3 | 2.26 | 3.47 | 1.78 |
| D | 3 | 3.24 | 2.11 | 3.73 |
| D | 3 | 2.24 | 2.83 | 1.91 |

## 4. RESULT AND DISCUSSION

In this study, two experiments were conducted. The first was to validate the obstacle detection and vibration features of the blind stick. The second experiment was to measure the time interval between the pressing of the emergency button and receipt of the SOS message by the user's guardian. The experiments were performed in different environments using four ISPs. A few experiments are taken at a different time of a day and repeated at the same time on different days, with varying weather conditions. The times taken to deliver the message by the ISPs were compared.

### A.Testing the obstacle detection for the blind stick

The blind stick was tested for its ability of obstacle detection using two different kinds of sticks. The first blind stick used HC-SR04 with an original length of 85 cm. This type is to detect obstacles at 100 cm and 40 cm above the ground level, such as stairs, and at the body-level as the user approaches them. While the second blind stick, 45 cm long was tested for detecting obstacles at a distance of 85 cm from the user and 55 cm above the ground level. Considering the mobility aspect, two blind sticks were used in the experiment because the Blind Stick Navigator does not fold like the traditional white cane. After a few times of testing to find a suitable distance, the results that were obtained are shown in Fig. 4.

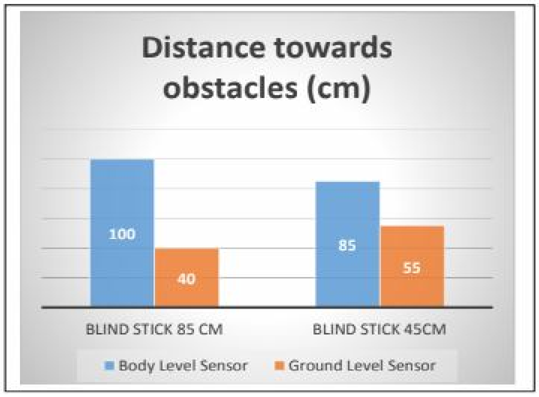


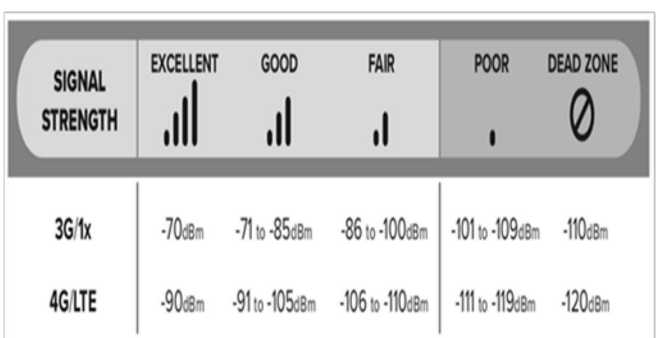

**Fig. 4:** Specific Measurement for the Two Types of Blind Sticks

### B. Testing of the blind sticks' vibration

The obstacles are detected via an ultrasonic sensor. The sensor detects the obstacle and sends the output to the board. The microcontroller processes the signal and sends the output to the relay, which turns on the DC motor. If an obstacle is detected at the body level, the DC motor vibrates with a 200-millisecond (0.2 sec) delay. For the obstacles that are detected at ground level, the DC motor will automatically vibrate continuously and stop only if the obstacle is not sensed anymore.

### C. *Response time for SOS*

The experiments for response time were conducted to record when messages were received by the recipient. For each of the ISPs, five samples are taken from the same location, ensuring that the signal strength was 3 bars, which is a good signal strength for sending SOS messages (Fig. 5).



| 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. 5**: Signal Strength

The experiments of our blind stick system were conducted to test the ISP's response time. The proposed system was installed at different places for different types of experiments. Fig. 6 shows hardware used with GSM for sending SOS messages and the results are recorded and presented in Table 1.

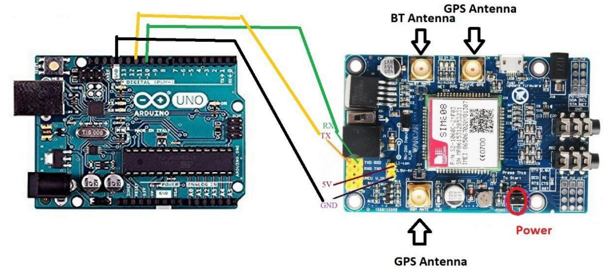



**Fig. 6:** GSM Installation

Fig. 7 shows the SOS message received by the guardian of the user once the SOS button is pressed. By opening the message and selecting the map, the guardian who receives the text can see the location of the user on the map and can plan immediate action.

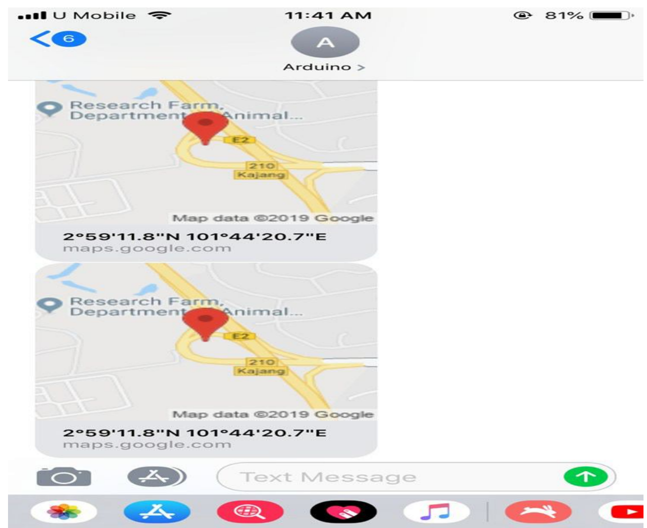
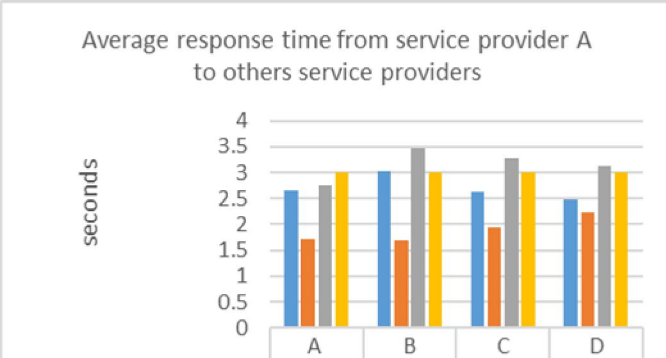



**Fig. 7:** SOS Message

### D. *SOS message sent from service provider A to other service providers*

The first set of experiments was conducted to collect the response times of ISP A to other service providers from indoor and outdoor locations and when the user was moving. All graphs represent the average results of five experiments. Fig. 8 shows that the best and the fastest way to send the SOS message is from ISP to the same ISP A, but not from an indoor location. ISP D was the fastest with a time of 2.47 seconds and the slowest response time of 3.028 seconds was from ISP B. But ISP B was the fastest when tested outdoors with a response time of 1.686 seconds.

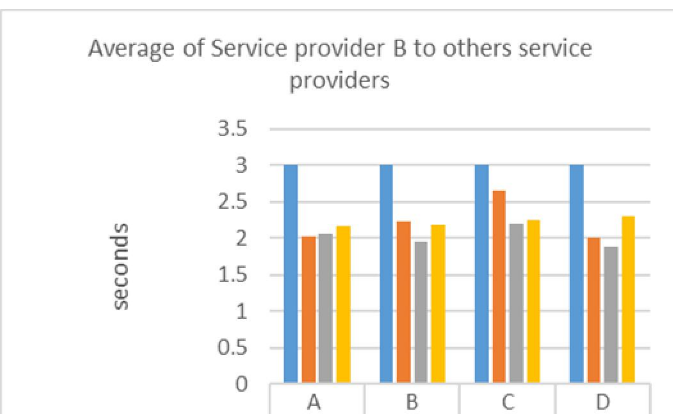



| | A | B | C | D |
|---|---|---|---|---|
| Average of buliding | 2.646 | 3.028 | 2.64 | 2.472 |
| Average of street | 1.718 | 1.686 | 1.94 | 2.228 |
| Average of movement | 2.746 | 3.466 | 3.27 | 3.118 |
| Average of signal bar | 3 | 3 | 3 | 3 |

**Fig. 8:** Service Provider A to Other ISPs – Results

**E.*SOS message sent from* ISP to other ISPs**

The second experiment was conducted by sending an SOS message from ISP B to other ISPs. The summary of the result is shown in Fig. 9. The best time of 1.878 seconds was observed when the SOS was sent when on the move from ISP B to ISP D. The slowest response time of 2.204 seconds was when the SOS was sent to service provider C. The response time for indoor messaging from ISP B to ISP D was the shortest. Among the experiments performed outdoor, the best response time of 2.162 seconds was obtained with ISP A.

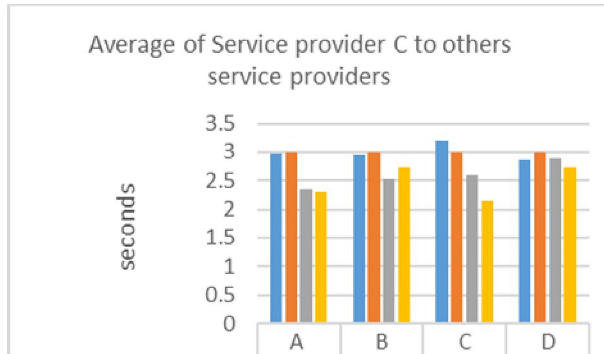



| | A | B | C | D |
|---|---|---|---|---|
| Average of signal bar | 3 | 3 | 3 | 3 |
| Average of buliding | 2.02 | 2.232 | 2.66 | 2.004 |
| Average of movement | 2.054 | 1.96 | 2.204 | 1.878 |
| Average of street | 2.162 | 2.176 | 2.252 | 2.308 |

**Fig. 9:** Service Provider B to Other ISPs – Results

**F. *SOS Message sent from service provider C to other service providers***

The third experiment was is conducted by sending SOS messages from ISP C to the other ISPs. The results are summarized in Fig. 10. In the outdoor scenario, the fastest time recorded was when the SOS was sent from ISP C to ISP C. In the indoor scenario, the shortest time of 2.356 seconds was recorded when the SOS was sent to ISP A. The slowest response time of 2.89 seconds was recorded with ISP D. On the move, the best time of 2.87 seconds was recorded with ISP D. The results lead to the conclusion that the best option is to use ISP C as the sender and the recipient of the message.

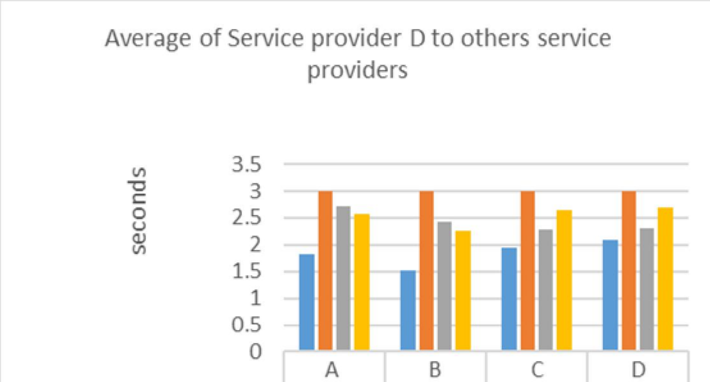



| | A | B | C | D |
|---|---|---|---|---|
| Average of movement | 2.966 | 2.948 | 3.188 | 2.872 |
| Average of signal bar | 3 | 3 | 3 | 3 |
| Average of buliding | 2.356 | 2.532 | 2.6 | 2.896 |
| Average of street | 2.302 | 2.718 | 2.142 | 2.734 |

**Fig. 10:** Service Provider C to Other ISPs – results

**G. *SOS Message sent from service provider D to other service provider***

We calculated the average and tabulated the result as shown in Fig. 11. The Figure shows that, for the outdoor scenario, sending a message from ISP D to the other ISPs show the best response times. But this is not true in the indoor scenario as ISP C has the best response time of 2.292 seconds and the slowest response, 2.714 s, was when using ISP A. However, on the move, ISP B was the fastest with a response time of 2.256 seconds. The result shows that the best option is to use ISP D as the sender and ISP C as the recipient.




| | A | B | C | D |
|---|---|---|---|---|
| Average of street | 1.822 | 1.518 | 1.954 | 2.092 |
| Average of signal bar | 3 | 3 | 3 | 3 |
| Average of buliding | 2.714 | 2.43 | 2.292 | 2.314 |
| Average of movement | 2.564 | 2.256 | 2.646 | 2.696 |

**Fig. 11:** Service Provider D to Other ISPs – results

## 5. CONCLUSION

The results show that various ISPs show different response times in different areas and under different conditions. Experiments were conducted indoor, outdoor, and when the user was on the move. The results of the experiments indicate that there is a need to choose the right service provider to ensure the successful delivery of a message within the shortest response time to ensure the guardian of the user receives the message with the least delay in an emergency.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