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Integration of IoT In Structuring a Smart Framework for Vision Hindered Individuals

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***Abstract*—The extending progression of intelligent advancements in recent days greatly affect smart gadgets. This research is about Integration of Internet of Things (IoT) in Structuring a Smart System for Vision Hindered Individuals. It accompanies numerous new and advanced features. It extraordinarily made for those impaired people who can't see or move without assistance. Here this endeavor is proposed to decrease their sufferings. It is a sharp structure where outwardly weakened stick and cap is used, in which sonar sensor, LDR and ESP32 module is utilized. The principle purpose is to help the vision impaired individuals by supporting them with present day advancement in a most affordable and worthwhile manner. Customer will bear a savvy stick and wear a cap by which they can think about sudden blocks, sewer vents, staircase in their developments adequately. The stick can likewise track down the location of the customer with the help of an android application and IoT. With this arrangement viewpoint and courses of action, finally a prototype has been actualized and attempted in different stages for execution evaluation.**

Keywords—Internet of Things, ESP32 module, sewer vents, location tracking system, android application

I. Introduction

Smart Blind stick and Cap are modern devices to improve the life of a visually impaired person. These smart blind stick and cap specially designed for the vision impaired people who usually lost their way because they can't detect in which way they have to go to reach their expected destination and this also make trouble to their family members.

The Internet of Things (IoT) is a unique worldwide system foundation with self-arranging capacities dependent on models and interoperable correspondence conventions. It is the "organize of interconnected sensor-prepared electronic gadgets that gather information, speak with one another, and can be observed, controlled or broke down remotely over the Internet" (Ahrens, "Understanding The Internet of Things"). It associates the physical world and the earth to the internet or to remote systems. It includes cloud computing, data analysis, mobile communication and different technology infrastructure and allow making objects, machines and work environments interactive. IoT makes the frameworks fit for sharing information through machine to machine. It likewise shares data containing in the database. Sensors, actuators, and numerous recently developed gadgets are utilized to gather information from the work-field. An estimation demonstrates that by 2020, 50 billion gadgets around the globe will be associated with the Web and two third of them are sensors, actuators and recently created insightful gadgets. Staying of them are PCs, tablets, cell phones and TVs and so on. The inserted insight that can see physical state changes in individual items is additionally incorporate into the limit of IoT.

II. Literature Review

A Navbelt was developed by Shovalet [1]. An obstacle avoidance wearable portable computer which is only for indoor navigation. Navbelt was equipped with two modes, in the first one the system information was translated to audio in different sounds. One sound for free for travel direction and other for blocked, it was difficult for the person to differentiate the sounds. Other problem was the system would not know the user momentary position. A stick for distance measurement using infrared sensors, have introduced by S. Innet and N. Ritnoom which is a complex and time wasting process [2]. The stick has different vibration modes for different range which is difficult for a blind to differentiate, it needs time for training. The stick informs the person clearly at dangerous stage which conveys less information and safety. The stick has no location and positioning features. DRISHTI is a wireless pedestrian navigation system for the visually impaired and differently abled. It emphasizes on enhancing the navigation experience of visually impaired people by focusing on contextual awareness. However, a lot of effort took in integrating this technology thus; the components were not optimized fully. J.Na proposed an interactive guide system for indoor positioning, which can't detect the obstacles and hurdles [3]. The system is not suitable for the outdoor activities.The Intelligent Guide Stick was developed by Sung Kang, Young Kim, and Hyuk Moon in 2001 [4]. It comprises an ultrasound displacement sensor, a microcontroller, and two DC motors, with a total weight of 4kgs. The guide stick's height and width are 85 and 24 cm respectively. The system's AI can detect the exact position of an object and relate that information to the user. Detection entails a "mapmatching technique” that involves the ultrasonic sensors, the DC motors, and the controller that connects to an encoder. When the rotators turn 18 degrees, the IR sensors that are attached to both wheels will convey the signal to the CPU to give a location update. This way the intelligent guide stick is incredibly accurate in detection and can provide continuous updates about obstacle position. The downside of this gadget, however, is that it is highly complex and costly. Moreover, the 4kg weight makes it quite heavy as compared to the other systems (Kang et al.).

The GPS artificial vision assistance was developed by Shruti Kumbhare and A. Sakhore [5]. The device features object detections, real-time assistance via GPS, artificial vision, and a voice circuit. A camera is fitted on the blind user’s head, which will employ algorithms to identify obstacles in front of him/her. Ultrasonic sensors also assist with object detection. The GPS guides the user to his/her destination. One strength of this system is that precision of the artificial unit affords the user with high output accuracy. The gadget’s drawback, however, is that its design is highly complex, which makes it difficult to operate (Kumbhare and Sakhore).

Sakhardande et al. designed a smart cane that uses normal ultrasonic sensors and the ATMEL microcontroller [6]. The cane’s power is supplied by two rechargeable batteries and recharging can be done through an AC adopter or a USB cable. When the system detects an obstacle/object, the controller triggers a buzzer and vibrations to alert the user. Sakhardande et al.’s smart cane has a range of three meters. One strength of this system is that it is quite simple to use. Further, the rechargeable batteries eliminate the need for regular replacements. The system is also easily packable in a small package. The downside, however, is that this system is unidirectional and is low in accuracy.

The guide-cane operates much like the white cane, but the difference is that it rolls on wheels that hold the guide-cane’s weight during normal operation. It consists of a servomotor, a built-in computer, ten ultrasonic sensors, and a min joystick for control. The servomotor can steer the wheel right and left relative to the cane. When an object is detected, the wheel shifts to the opposite side alerting the user to do likewise. This way the guide-cane allows faster navigation. Both wheels are fitted with encoders to determine their relative motion. The computer chooses a heading and turns the wheel accordingly based on the sensor data from its sonars and user input (Borenstein and Ulrich) [7].

III. Objectives of the Project

The following tasks have been implemented in this project for purpose of IoT based smart solution for vision impaired people.

- Through which a vision impaired people can be tracked if he lost his way.
- This will keep him safe from incoming object such as manhole and staircase.
- Keep him notify about the height or depth of upcoming surface
- Direct him towards the right way, if he enters in any unwanted place.
- Able to find when it dropped out of hand.

IV. Methodology

A. System flow chart

The system flow chart of the IoT based smart stick is shown in Figure. 1:

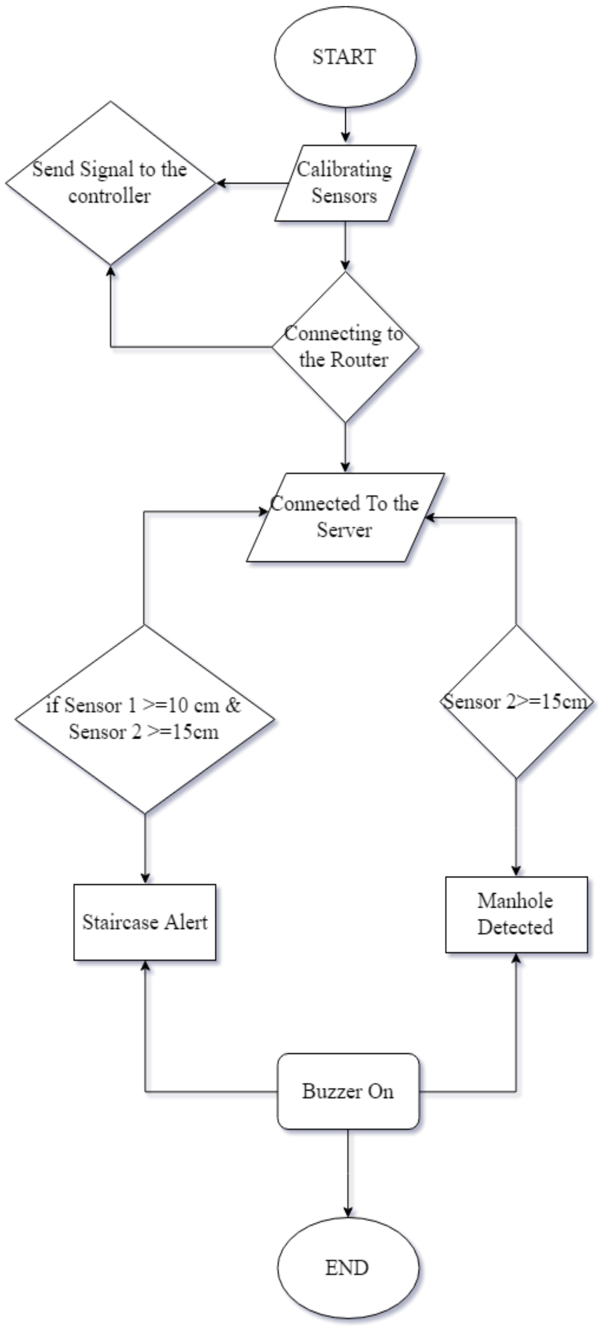

Fig. 1. *System flow chart*

B. Schematic Diagram of the prototype's circuit

The schematic chart of this task in Figure 2 and Figure 3 is drawn on Proteus 8 professional. The graph will give us an unmistakable thought regarding the task.

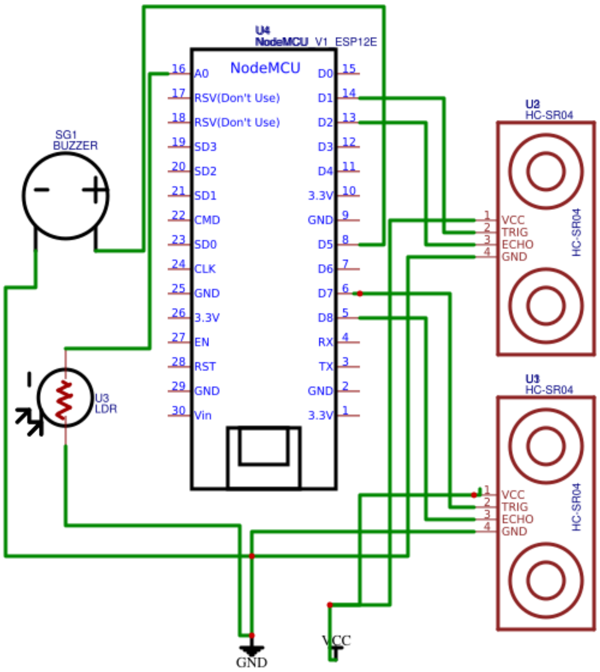

Fig. 2. *Schematic Diagram of blind stick body circuit*

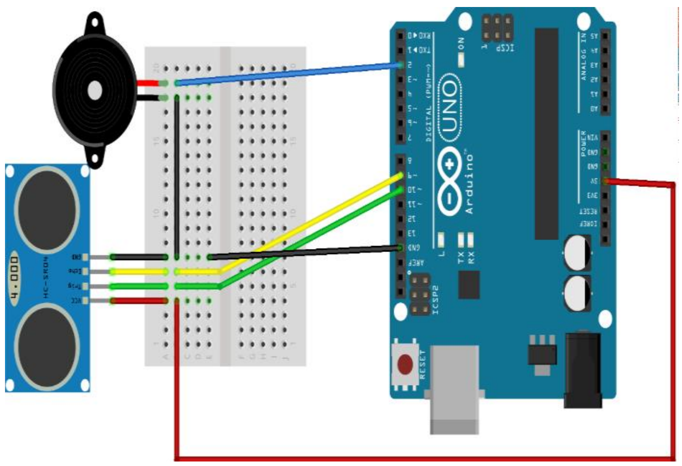

Fig. 3. *Schematic Diagram of cap body circuit*

C. Obstacle Detecting System

Obstacle detecting is another feature of this project. It is used to avoid collision and keep the user safe. This feature will keep the individual away from the obstacles ahead and notify him immediately. For this obstacle detecting system, ultrasonic sensor as well as sonar sensor has been used. Sensors has been set in the front side of the stick an cap. Whenever it gets any obstacles in front of it, the user can easily be notified.

D. Staircase and Manhole Detection

Two sonar sensors are used in the lower portion of the stick for staircase and manhole detection. Whenever the sensors detect the staircase and manhole, it gets the signal to the buzzer and then the buzzer operates. The buzzer frequency is low for the staircase and high for the manhole.

E. Location Tracking System

A HTML code is used to represent the location on a web server. Firstly, a map box account has to create for accessing the Google map and replace API token on to the HTML webpage. An android application is used to update the value of longitude and latitude of the stick position. Then it would be update data from the Think speak field, where Channel ID and Custom URL of the API would be given. By accessing the HTML webpage anyone can able to get the location of the blind stick using GPS of the cell phone. The system is shown in Figure 4.

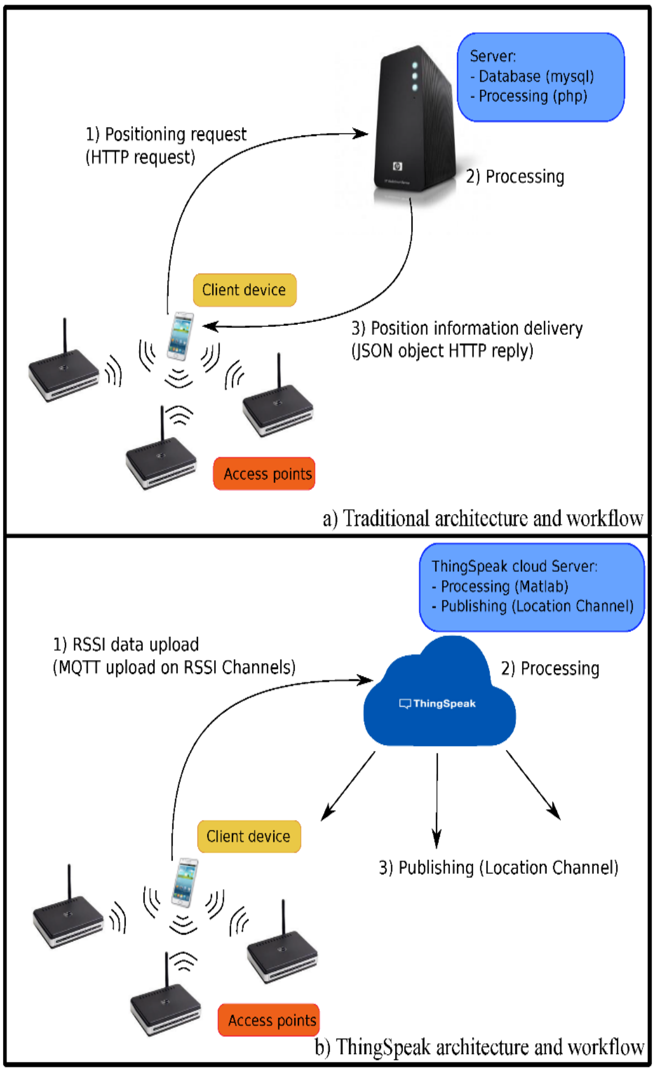

Fig. 4: *Location Tracking System*

F. Remote and Buzzer System

All control is performed by the PIC12F617 in software. As mentioned earlier we designed this project so that it is powered by the mains using a step down converter. In this case we were very careful not to touch the 230 V. A simple amplifier is used to drive the 8 Ohm loudspeaker. Building the circuit can easily be done on a small breadboard with suitable housing.

G. Prototype modeling of smart stick

The project is done accordingly to the mechanical design and the block diagram. The project is successfully implemented with all the features. The proposed prototype modeling designed by AutoCAD is shown in Figure 5 and Figure 6. Assemble of IoT based smart stick is shown in Figure 6.

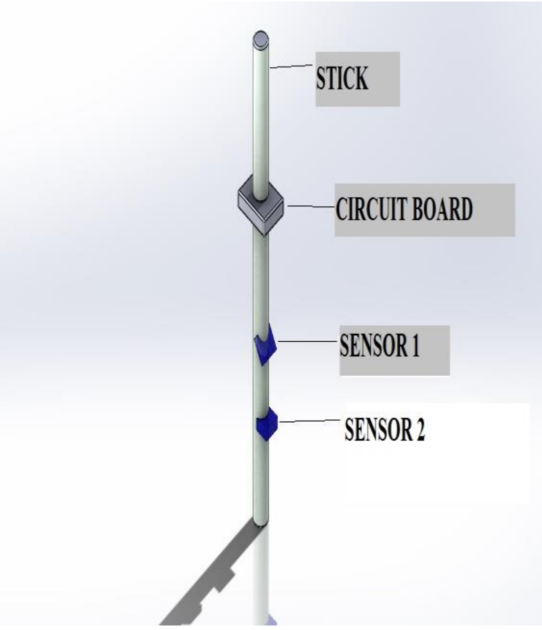

Fig. 5. *Prototype modeling of smart stick*

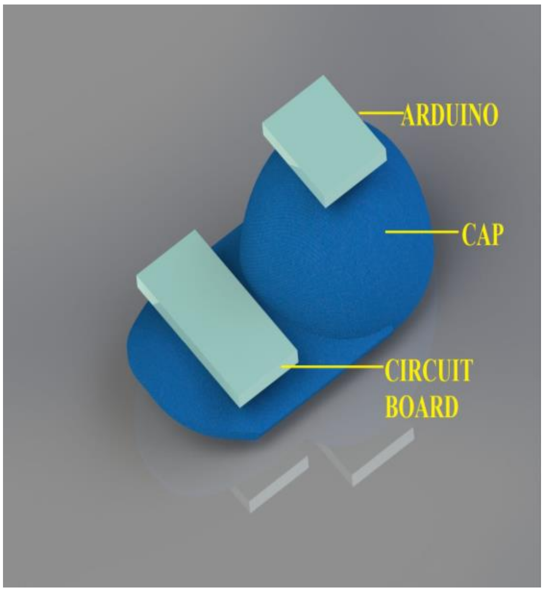

Fig. 6. *Prototype modeling of cap*

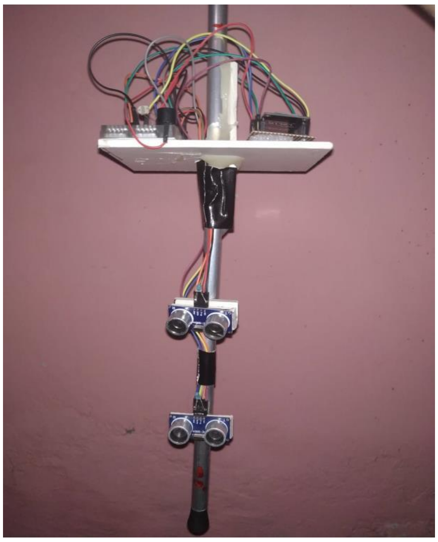

Fig. 6. *IoT based Smart Stick*

V. MATHMETICAL ANALYSIS STAIRCASE AND MANHOLE DETECTION

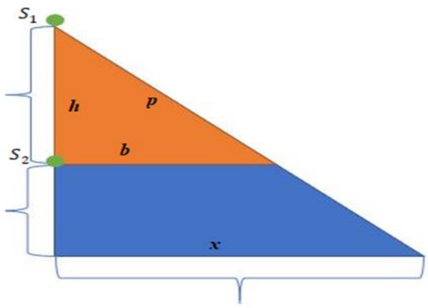

Fig. 7. *Structure of sensors waveform*

S_1 = Position Of the sensor 1

S_2 = Position of sensor 2

We know from the trigonometric law,

$\frac{\text{Sin}\alpha}{b} = \frac{\text{Sin}\beta}{h} = \frac{\text{Sin}\gamma}{p}$ ---------------(1)

h = Distance between the two sensors, S_1 and S_2 = 10 cm

we assume the base angle $\alpha = 90^0$

b = distance from sensor S_2 to staircase[assumed]

$\frac{\text{Sin}90^0}{10} = \frac{\text{Sin}\beta}{10} = \frac{\text{Sin}\gamma}{p}$

Then from this equation ,we have $\beta = \gamma = 45^0$ and $p \cong 14.14$ (approximately)

So therefore when the sensor S_1 get value about 15 cm and sensor get the value about 10 cm then it will be a staircase.As well as when the sensor S_1obtained value greater than 22cm approximately then there will be a manhole or a vent in the road.

VI. ANDROID APP

In this project the smart stick is tracked down by smart phone application. A Bluetooth module is used to create communication between smart phone and smart stick. As smart phone is an innovation of the modern world. It is very available and easy to operate. An android apk file has been created for this operation. It will work like a location tracker. By touching the ‘START LOGGING’, it will track the signal from the smart stick through Bluetooth module HC-05 and with the help of internet, the location from the app can be found in Google map directly. It is very useful feature if somehow the blind person gets lost then it is very easy to track him. GPS Logger mobile application lookout and the signal tracking system are shown the Figure 9 and Figure 10 respectively.

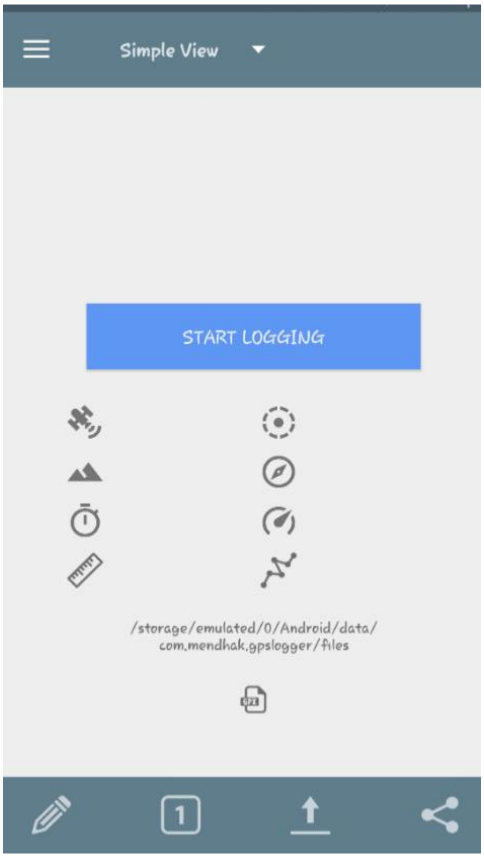

Fig. 9. *GPS Logger lookout*

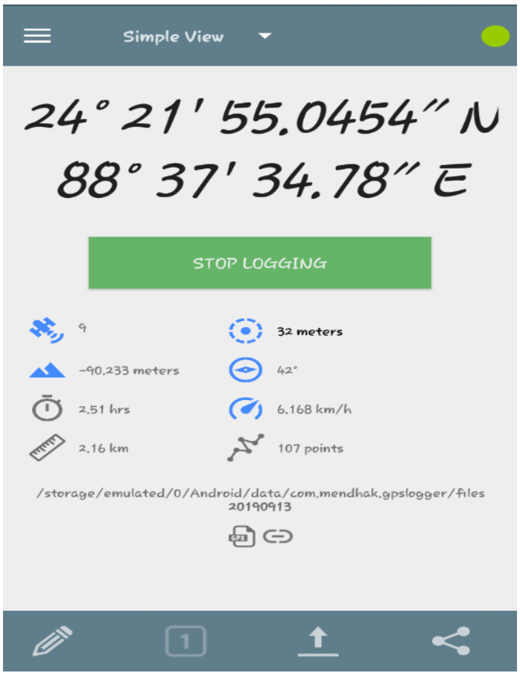

Fig. 10.: *Signal tracking system*

GPS Logger mobile application constantly tracks down the location of the smart stick when the system is online. An HTML code has been developed which links both GPS Logger application and Google Map. Using the tracking code shown is the GPS Logger, Google map directly locates the position of the user. A series of test was run. The following figure shows the satellite view and the roadmap view of the user’s location given by Google map in time of testing. The following Figure 11.

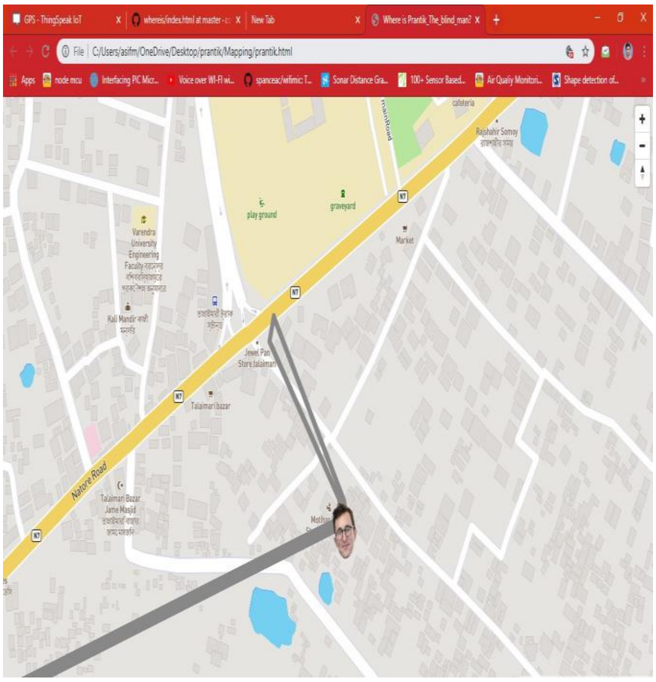

Fig. 11. *Road Map View of the user’s location*

Think Speak is an Open-Source IoT application and API to store and recover information from Hardware gadgets and Sensors. It utilizes HTTP Protocol over the Internet or LAN for its correspondence. The MATLAB investigation is incorporated to examine and envision the information got from your Hardware or Sensor Devices. Channels are made for every single sensor information. These channels can be set as private channels or anyone can share the information publically through Public channels. The business highlights incorporate extra includes. The following graphs Figure12, Figure 13, Figure14, Figure 15 and Figure 16 shows relationships of different variables such as Light intensity, Latitude, Longitude and Distance with respect to time.

Fig. 12. *Time vs Light Intensity Graph*

Fig. 13. *Time vs Latitude Graph*

Fig. 14. *Time vs Longitude Graph*

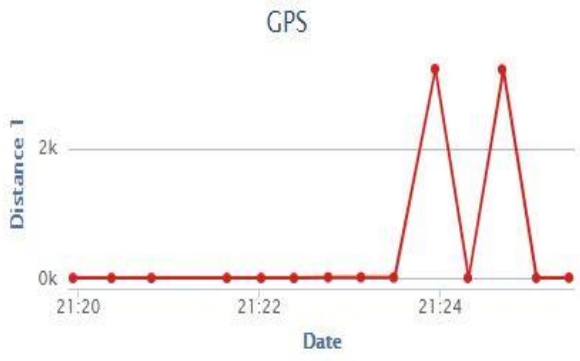

Fig. 15. *Time vs Sensor 1 Graph*

Fig. 16. *Time vs Sensor 2 Graph*

Decisively when the stick prompts and started seeing its ability these charts are made by its activities. Right when the power is off, no data is found and with the separation in time critical estimation of degree is aggregated.

VII. Performance Analysis

The keen framework had been tested practically for 56 times where in sewer vent discovery framework works effectively for 39 times and staircase detection works for 45 times accurately. The remote and buzzer framework as well as location tracking system work flawlessly in each trials. The object recognition arrangement of the stick works appropriately for 41 times and the object discovery arrangement of the cap works appropriately for 53 times. So the sensitivity of the system is as following-

Object detection system of the cap

Accuracy = $\frac{56-3}{56} \times 100\% \approx 95\%$

Object detection system of the stick

Accuracy = $\frac{56-15}{56} \times 100\% \approx 73\%$

Manhole detection system

Accuracy = $\frac{56-17}{56} \times 100\% \approx 70\%$

Staircase detection system

Accuracy = $\frac{56-11}{56} \times 100\% \approx 80\%$

and the accuracy of the remote and buzzer system as well as location tracking system was 100%.

VIII. Scope of the Project

Some of the scope where this IoT based smart stick can implement are as follows:

- It will lessen the sufferings of vision impaired people.
- It will create a wide range of safe mobility for a vision impaired person.
- It will reduce dependency on others for a vision impaired person.
- It makes a scope for smart wearable and bearable technology.
- It creates an economical blind stick and cap.
- It is very user friendly and vision impaired person of any age will be able to use it.

IX. Conclusions

Working with this undertaking was testing and the inspiration of this task has effectively done. The primary object of this venture was to make a keen visually impaired stick and cap for vision debilitated individuals, which can improve their capacity to portability. It has been finished by a base expense so that, nearly everybody can manage the cost of it. Working with Arduino, Ultrasonic Ranging Module HC – RS04, LDR, Arduino IDE, Think Speak API make this absolutely new encounter. In future, more element can be included like Infrared innovation, Mobile controlling, Wireless inter - associated hardware. We accept this shrewd framework would improve the viability of the movement of vision impaired individuals.

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