An Innovative and Inventive IoT-Based Navigation Device—An Attempt to Avoid Accidents and Avert Confusion

Chennuru Vineeth, Shriram K. Vasudevan, J. Anudeep, G. Kowshik, and Prashant R. Nair

Abstract Many routes being created each day; it is a very tiresome job to remember every route. This is the reason maps are created for making our job easier. Due to an increase in technology and lowering of data rates in many countries, these maps are accessible to most of the people in the daily commute. When we want to go to a new route, we cannot remember the whole route by seeing the route provided by the map. Therefore, we need to check the route at regular intervals. This method of the commute is very much suited for pedestrians because they can hold their mobile phone in hand and can follow the route, and for some type of four-wheeler drivers as they can dock it to the dashboard and can drive the dour wheeler. The problem comes in the case of two-wheeler riders because they cannot hold their phone and drive or cannot dock the phone to their bike as it causes serious distraction from the traffic. So, to solve this situation, we have designed a device that can show the directions of the upcoming turn without using a mobile phone while driving.

Keywords Navigation checks · Intel UP^2 board · IoT and smart devices

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1 Introduction

These days many people started using two-wheelers instead of four-wheelers in most of the developing countries. This may be due to an increase in traffic in metropolitan cities or due to an increase in the cost of four-wheelers or may be due to an increase in awareness of pollution caused by large vehicles. In any case, the usage of two-wheelers is increasing day by day. With the increase in the usage of two-wheelers, there is a sufficiently similar increase in the number of accidents. It may be due to distraction, drowsiness, or reckless driving, etc.

Among the accidents caused by distraction, one of the main reasons is due to the usage of mobile phones while driving. Mainly, the riders use mobile phones for navigation purposes when going to new or unknown routes. According to the recent reports by India times, it is reported that 2100 people have died and many injured last year on roads mainly due to the usage of phones [1]. The statistics in Fig. 1 indicates the use of phones while driving in different parts of the globe.

Not only general two-wheeler commuters but also the food delivery and cab services face the same problem of delayed delivery or delayed service. Many people who order food online complain that their food is being delivered late. On enquiring the delivery personnel about the delay, the common reason they hear is that they were stuck in a traffic jam because of going to the wrong route or unable to find the route [3, 4]. For avoiding delayed delivery, many delivery personnel risk their life by jumping signals or riding the two-wheeler at over speed. These things pose risk not only to their life but also to others going on the same road. Most of the delay is caused to the two-wheelers due to navigation checks, so to reduce these risks and

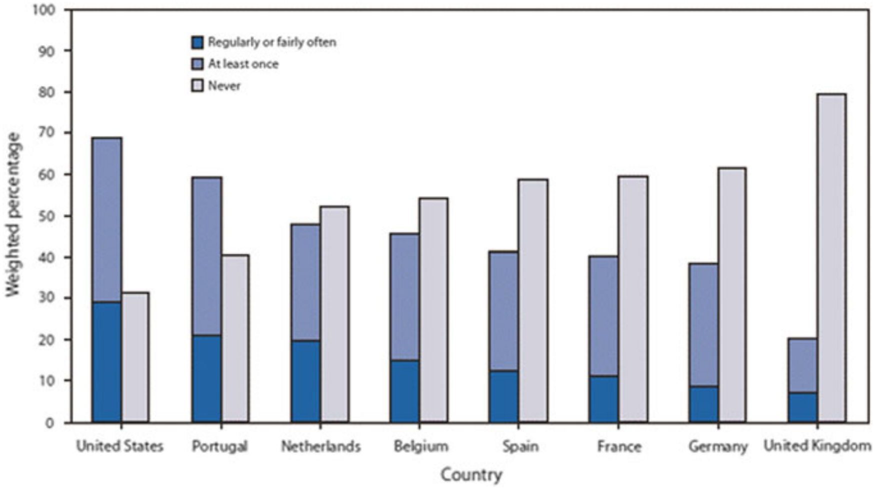


Fig. 1 Statistics about the use of phones while driving [2]

confusion; we have developed a device with the help of IoT, which helps the riders in navigation without opening the mobile phone while driving.

2 Problem Statement

To design a system, which can eliminate the checking of map details and navigation updates by the drivers by picking their mobile phone out while driving, and to make the process of driving with more concentration oriented to avoid unnecessary accidents.

3 Existing Solutions

Here are some of the existing methods for navigation to new or unknown routes by the riders while driving.

One of the widely used technologies for navigation is maps. Many people use Google Maps, Apple Maps, etc. for navigation purposes. These applications have a feature of reading out the next turn and distance of turn through the speaker. Therefore, the two-wheeler riders use their earphones for hearing the navigation directions. This method is not at all recommended because it is against law to use earphones while driving, and it reduces the rider ability to listen to the horns and external traffic sounds while driving.

Some of the two-wheelers have a mounting device for their phone for seeing the upcoming turns and distance of turns. This is a very convenient way for the riders but this is the most dangerous way as this poses a greater risk for accidents. It distracts the drivers not only through hearing but also visually.

Ahire, D. and Patil, H. proposed a smart helmet that displays the route and directions on the helmet's visor. It is built with the help of augmented reality. The major drawback of the system is projecting the light onto the visor can obstruct the view of the driver and the vehicles heading toward him cannot be known, which is a major problem by wearing this helmet. This helmet also has a pair of earphones using this will, even more, slacken the hearing of the driver toward horns or indications [5] (Table 1).

4 Architecture

The designed system consists of a pair of small hardware that can be placed on both sides of handles or can be stuck to the hand of the rider. The hardware consists of an LED, microcontroller, and Bluetooth for communication between the microcontroller of the hardware and the main processing unit placed in front of the bike.

Table 1 Comparison table of the existing systems with the proposed system

	Does not obstruct hearing	Does not obstruct driving view	Mobile applications	Virtual reality	Wireless communication
Earphones	×	✓	✓	×	×
Mounted device	✓	×	✓	×	✓
Smart helmet	×	×	✓	✓	✓
Proposed system	✓	✓	✓	×	✓

The code in the main processing unit is written in python and uses Google APIs for getting the upcoming direction of the turn. We have placed a display unit on top of the Intel UP2 kit for entering the origin and destination.

Figure 2 shows the workflow of the proposed system. The Intel UP2 board is the processing unit in which a python code is written for getting the direction and distance details of upcoming turn from Google. We have utilized Google Maps API for getting the appropriate details. Depending on the distance of turn, the blink rate of LED varies. For prototype purposes, we have used a processing unit like Intel UP2 board but other boards like Raspberry Pi 4 or even the system can be pre-integrated with the two-wheeler itself. A display is provided on top of the Intel UP2 board for entering the source and destination of the route to be traveled (Fig. 3).

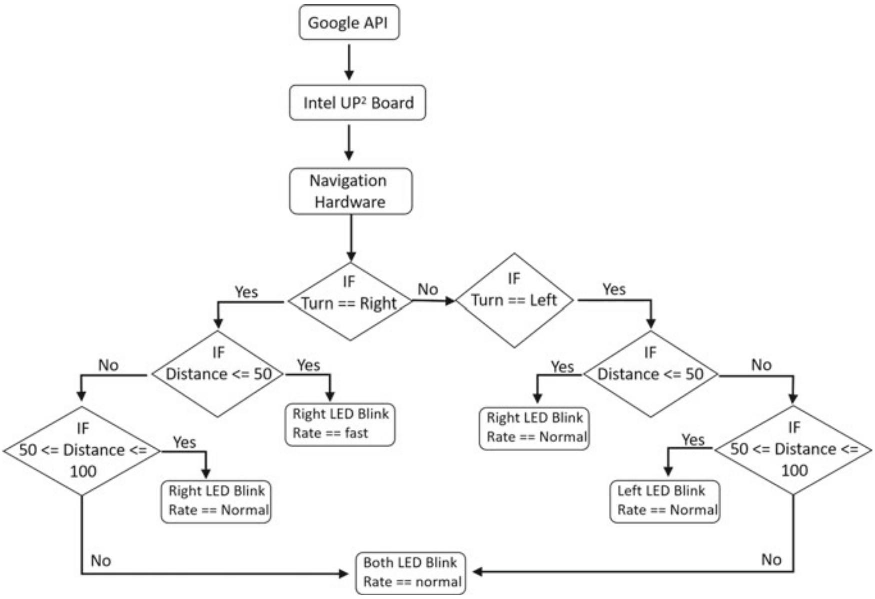


Fig. 2 Workflow of the proposed system

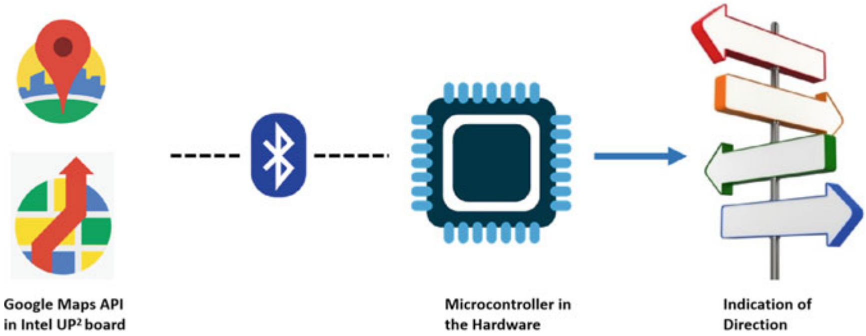


Fig. 3 Architecture of the proposed system

4.1 Intel UP2 Board

Nowadays, mobile phones are available with most of the people who ride two-wheelers because it has become handy and easy to use. However, to minimize the distraction of users while driving for navigation information, we are using a processing unit known as the Intel UP2 board. The main reason for using an external board is that the user need not use his mobile phone for the navigation purpose. In addition, we cannot have the whole processing in the navigation hardware, as these are small microcontrollers and have very little power supply. Therefore, we have attached a GPS module and display to this board, which must be kept at a comfortable place before the rider. As this is a prototype, we have used the Intel UP2 board or else it can be directly integrated into the vehicle itself. The designed interface of the board is explained below. Figure 4 shows the initial page of the application, in which the user must enter the source and destination of his route. Similar to Google Maps App, he can choose walking or driving. Walking can be chosen when the two-wheeler is a cycle.

On clicking the source or destination text input field, the user will be redirected to the area of the Google Maps around his location. The user can use the red pin for selecting the location or use the nearby places for selecting the source or destination. We have used Google places API and Maps API for better user experience (UI) (Fig. 5).

After entering the source and destination, the user will be redirected to the page, where the user needs to select the glove hardware to which the Intel UP2 board needs to send the data. The page consists of all the available nearby Bluetooth devices. Select the navigation glove (name of the Bluetooth on the hardware). On clicking the Bluetooth name, the Intel UP2 pairs with the hardware for sending the navigation details (Fig. 6).

After the Intel board successfully pairs with the hardware, it starts sending the direction and distance of the upcoming turn details in the form of JSON. It uses the GPS location from the GPS module attached to it and the Google Geolocation

Fig. 4 Source and destination field in the display

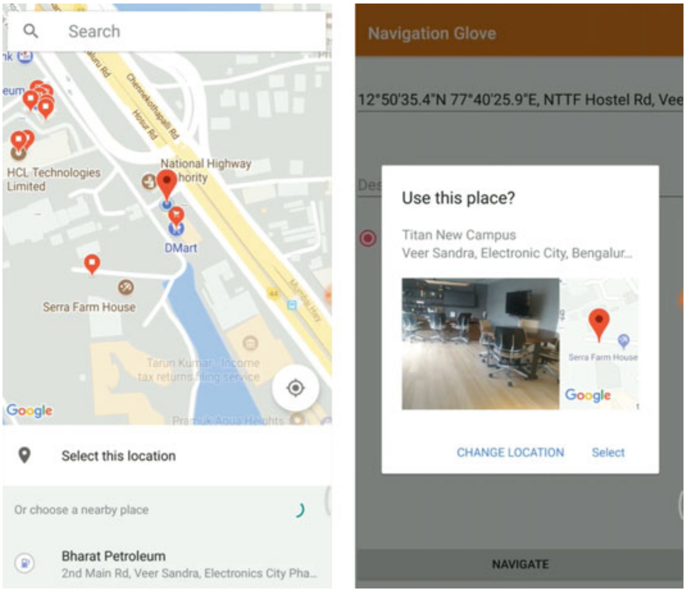


Fig. 5 Screen for selecting the custom source and destination

Fig. 6 Display screen for showing and connecting with the available Bluetooth

and direction APIs for getting the required information. For debugging purposes, a toast kind of message is shown at the bottom of the screen. At this point, the user has finished the configuration and they can start the journey. The same information shown in the toast will be transferred to the hardware through Bluetooth (Fig. 7).

4.2 Internal Working

Immediately after pairing the hardware with the Intel UP2 board, the board gets the user present location and pings the Google Maps API along with the destination location for getting the details of the upcoming turn. The returned data will be in the form of JSON. It consists of a lot of information regarding the direction of a turn to be taken, the distance of the upcoming turn, etc. It uses the link for pinging the Google Maps API for getting the information.

The received JSON data consists of start and end location coordinates, travel mode selected, the distance for the upcoming turn in kilometers and meters, the direction of the turn, time taken to reach the turn, etc., (Figs. 8, 9, and 10).

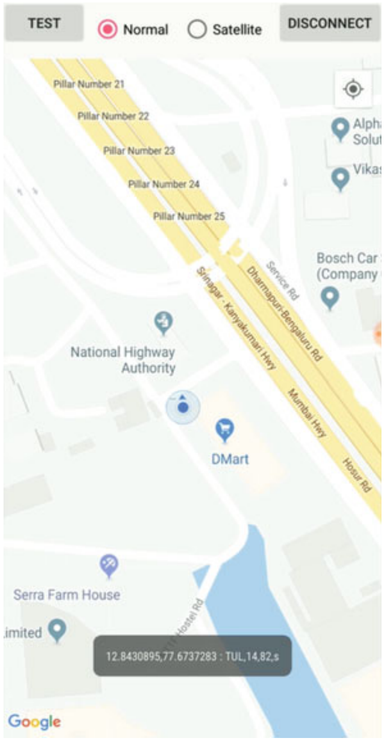


Fig. 7 Display screen for debugging purposes

Fig. 8 Intel UP2 board for getting the direction and distance information

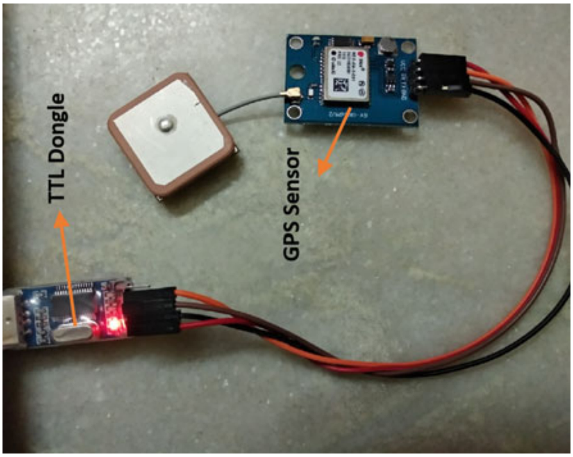


Fig. 9 GPS sensor attached to Intel UP2 through TTL dongle

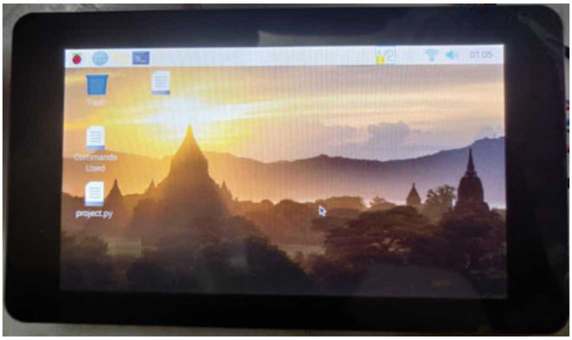


Fig. 10 Display for providing the user Inputs

4.3 Hardware for Navigation

The hardware for navigation mainly comprises a microcontroller, Bluetooth module, power regulation circuitry, and LEDs for indication. ATTiny85 is the microcontroller used for processing the data obtained from the application. ATTiny85 is used due to its small size, which can minimize the circuitry, but it can neither process huge data nor accept heavy codes since its flash memory is only 8 KB. HC-05 Bluetooth module is used for receiving data from the board, and another pair of Bluetooth modules is used to communicate between the gloves. For regulating the 9 V voltage across the circuit, we have used LM7805 MOSFET, 1 μF ceramic, and 10 μF capacitors. The data received by the Bluetooth is sent to the microcontroller on the respective glove, which will parse the data to determine the direction, the distance of turn; depending on this information, the LED blink rate is executed (Figs. 11 and 12).

The below code is used to parse the obtained coded data and extract direction of the turn, distance in which turn is to be taken, etc., information from it (Fig. 13).

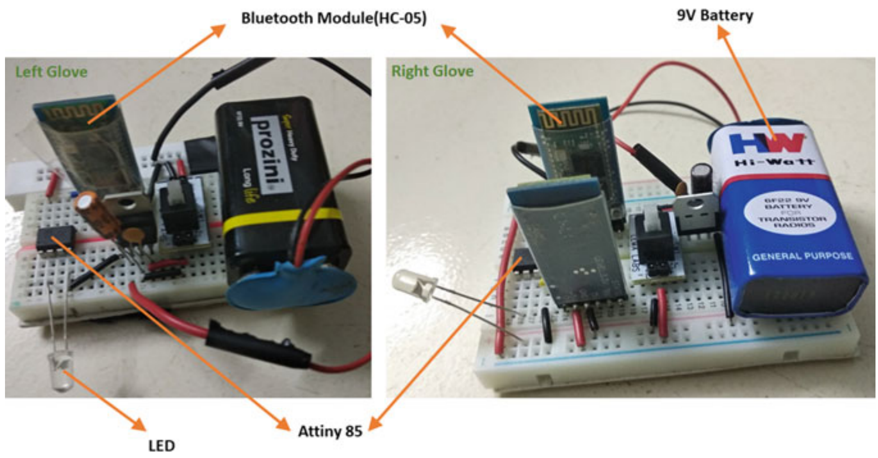
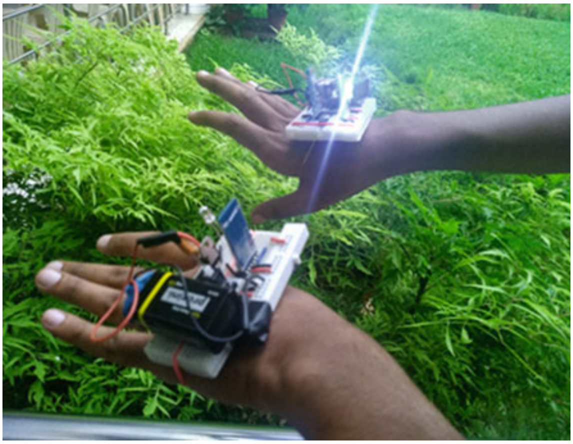


Fig. 11 Experimental setup of the proposed system

Fig. 12 Experimental setup visualized as a wearable



```
for (int i = 0; i
< input.length(); i++) {
  if (input.substring(i, i + 1) == ",") {
    pieces[counter] = (input.substring(lastIndex, i)).trim();
    lastIndex = i + 1;
    counter++;
  }
}
```

In Fig. 11, the experimental setup of our proposed system, which can be attached to the user's hand, or the handle of the two-wheelers is shown. The visualization of

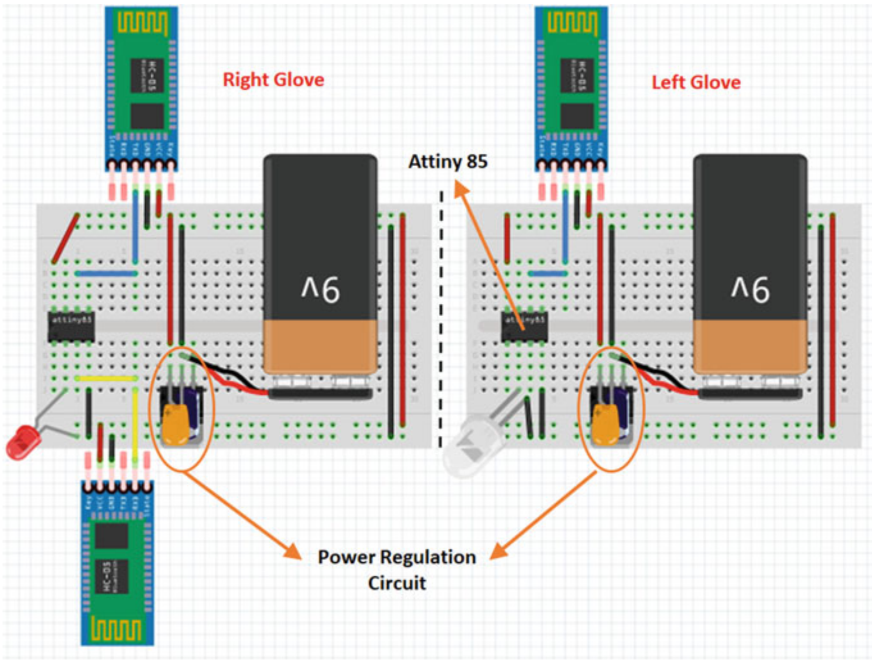


Fig. 13 Connection diagram of the navigation hardware

this experimental setup as wearable can be seen in Fig. 12. The complete connection diagram, a schematic diagram is shown in Fig. 11.

5 Component Table

See Table 2.

6 Results

The complete testing and results are obtained in real time. Figure 14 shows the blinking of right LED and left LED when obtained a similar format JSON code as explained in Sect. 4.2.

Figure 15 shows the blinking of left glove LED at a normal rate indicating a left turn to be taken when there is a left turn indication by the display. Figure 16 shows the simultaneous blinking of both LEDs for the indication of straight movement for the driver. Figure 15 shows the blinking of the right glove LED at a faster rate indicating

Table 2 Cost of each component and their respective quantity

S. No.	Component name	Quantity	Price
1	Attiny85	2	$6
2	Bluetooth module (HC-05)	3	$23
3	LM7805 MOSFET	2	$1
4	9 V battery	2	$2
5	GPS module	1	$10
6	1 µF ceramic capacitor	2	$0.5
7	10 µF capacitor	2	$0.5
8	LED's	4	$1
9	Switches	2	$2

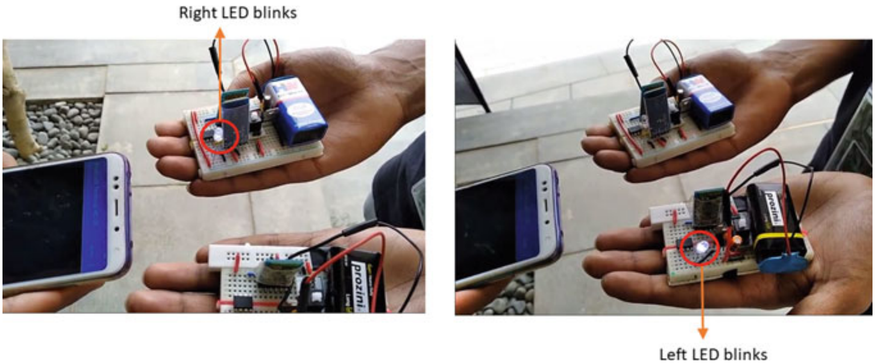


Fig. 14 Demonstration of working of the navigation hardware

a right turn to be taken when there is a right turn indication by the app, where the turn is less than 50 m (Fig. 17).

7 Conclusion and Future Enhancements

IoT has been growing in the present day in a very appreciable manner. We have used the same for developing a useful product, which minimizes the accidents and confusion of drivers regarding the navigation while driving [6–10]. Although these days' mobile applications have become abundant sources for navigation, even then they are not able to overcome the inconvenience in navigation for the drivers while driving. With further research, we can develop a cost effective solution of the same idea by using a mobile application instead of Intel UP2 board or even integrate the same methodology in the two-wheeler itself. The proposed system can be readily implemented in the market, but the following enhancements can improve its market value.

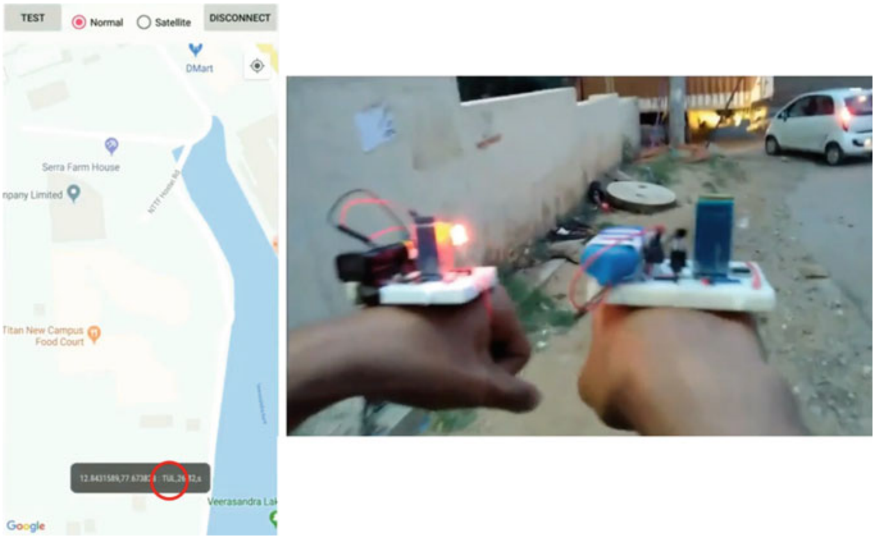


Fig. 15 Indication of left turn by our proposed system

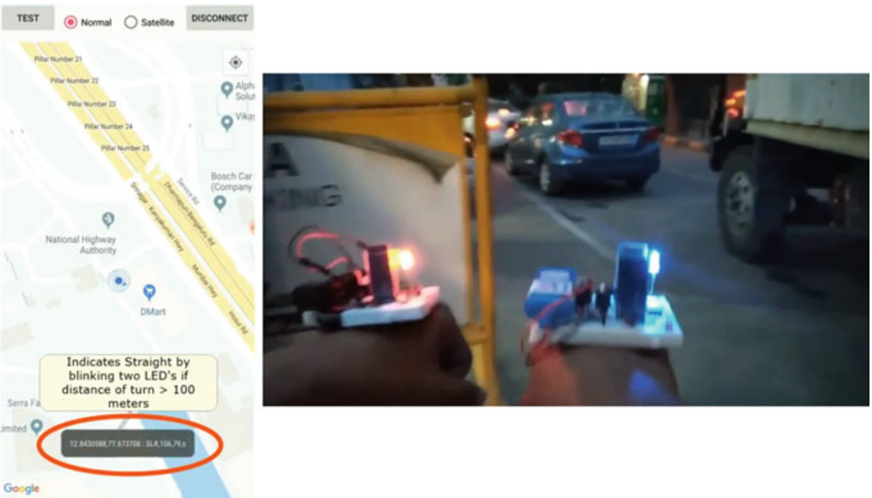


Fig. 16 Indication of straight by our proposed system

- There are many cases where the driver misses LED indication due to improper visibility. Therefore, by introducing the vibration motors, indication can be notified properly even in bad light ambiance conditions.
- In many countries, pavements are provided separate tiles for visually challenged people so they do not feel difficulty while walking straight but they usually face difficulty during turnings, and mostly, they take external help. These turns can be

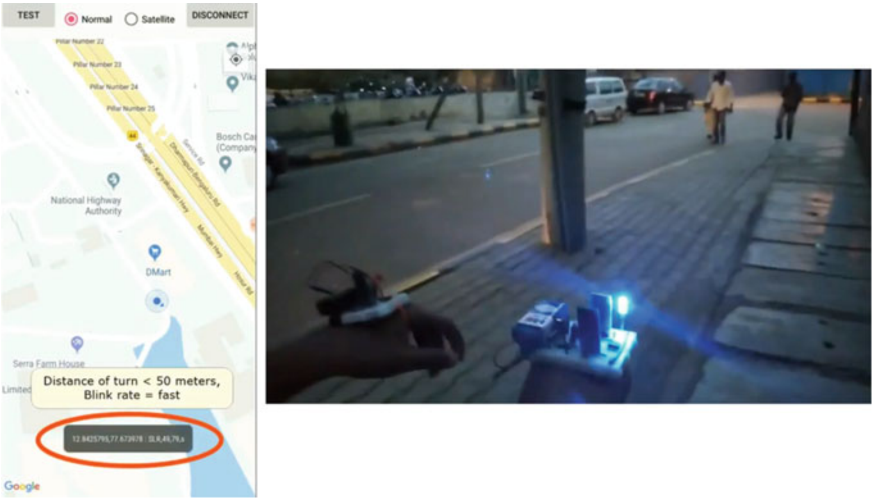


Fig. 17 Indication of right turn by our proposed system

indicated by vibration at the turn, and voice assistants can be added in the mobile application for assisting blinding people in selecting various features like source, destination.

- If the hardware is used in the form of glove, then the food delivery and cab drivers personnel's glove can be integrated with NFC to support faster payments.
- For rugged usage of a glove, it must be made waterproof and shockproof which can protect the circuitry from water, the driver from shock during a rainy day.
- Presently, we are representing only some of the Google maneuvers. In the future, a smart user interface is to be developed like OLED, hologram for effective representation of all the available maneuvers.

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