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Lora Technology Based Potholes and Humps Detection for Smart City Transportation

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Abstract: ***In view of developing smart cities, all the infrastructure of the city should be integrated with intelligent system. Transportation is one of the main constraints to the development of cities. Roads maintenance is one of the key factors for transportation system. In developing countries due to the increased vehicular population the maintenance becoming a complex task. Here we propose a system which detects potholes and humps on roads and send the information to higher authorities using LoRa technology. We designed a system with three modules like user module, gateway module and cloud module. User module includes an ultrasonic sensor and Lora GPS shield which should be deployed on vehicles. Through sensor we can detect the pothole and humps on roads, Lora GPS will capture the location and the information will be sent to the gateway using LoRa communication. Gateway can be anywhere in the range of 15km as LoRa module can send the information throughout this range. This information is uploaded to cloud which will be available for higher authorities to repair and maintain the roads effectively.***

Keywords: Smart city, LoRa, Transportation, Potholes, Humps, Roads, Ultrasonic sensor, Arduino.

I. INTRODUCTION

INDIA is one of the heavily populated Country in the World and a fast growing economy, is known to have a massive network of roads. Roads are the foremost means of transportation in India today. They carry 90 percent of country's passenger traffic and 65 percent of its goods. One of the increasing problems the roads are facing is worsened road conditions. Wretched condition of roads is a supporting factor for traffic congestion and accidents. This is the prime motivation behind making a transport system intelligent enough to detect potholes and humps on roads. Because of many reasons like rains, oil spills, road accidents or inevitable wear and tear make the road difficult to drive upon. Pot holes, unexpected hurdles on road may cause more accidents and fuel consumption of the vehicle [1]. It is important to get the information of such bad road conditions. Then this information must be forwarded to higher authorities for immediate action and this information will be useful for future drivers in that particular way. Present competitive world have offering many technologies for every approach, it is the responsibility of developer to choose the best one, as this system is part of smart city transport we have selected the cost effective and efficient method like sensors to detect potholes and LoRa for communication. If near field communication technologies such as Bluetooth and Zigbee are used for any smart application, the administrator needs to undergo complex procedure for gateway and end devices communication but LPWAN solves this problem to connect directly. LoRa is one such LPWAN protocol [2] which targets the two types of devices such as battery powered devices which have limited energy and the devices which only transmit a small number of bytes at particular time. For many smart sensing applications like health monitoring, smart metering, environment monitoring and also for industrial applications LoRa becomes the most prominent choice because of its great features of low power and long range. Long Range Radio communication (LoRa) is the wireless modulation or the physical layer utilized to create the long range communication links. Frequency shifting keying (FSK) modulation is utilized by numerous different remote frameworks as the physical layer since it is an extremely capable balance for getting low power. Base adjustment for LoRa is Chirp spread spectrum, it has similar low power feature as FSK, however apparently increases the communication range. LoRa is one of the most competent wide-area IoT technologies proposed by Semtech and further endorsed by the LoRa Alliance. LoRa's success is depended on its adaptive data rate chirp modulation technology which allows for flexible long-range communication with low power consumption and low cost design.

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II.SYSTEM DESIGN

The system designed to detect potholes and humps on roads will be collecting the information from roads and transmits the same to database. This can be achieved by the design of three modules like user, gateway and cloud as shown in fig.1.

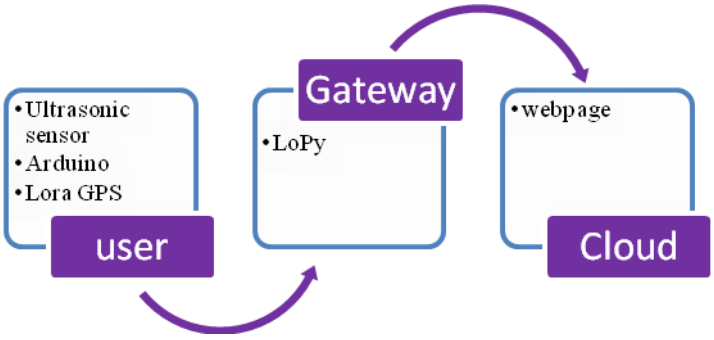


Fig.1 Design Module Stages

User Module: This module consist of an ultrasonic sensor , Lora GPS shield mounted on Arduino board. This part will be deployed on vehicles.

When vehicle is moving on the road, sensor will detect the pothole based on the distance between vehicle and road. The Lora module will detect the location and transmits the details to the gateway.

Ultrasonic sensor HC-SR04: The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver is shown in the fig.2.[3].

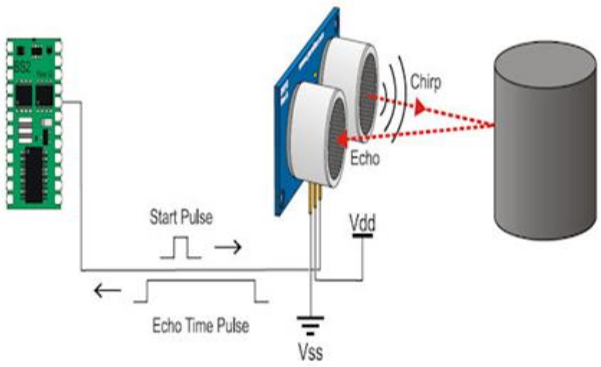


Fig.2 Ultrasonic sensor HC-SR04

Arduino Uno : Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins.

Dragino LoRa GPS Shield:

The Dragino LoRa/GPS Shield is an expansion board for LoRa/GPS for utilizing with the arduino. This device is created for the users who are implementing the applications in which the requirements will be fulfilled by LoRa/GPS. The LoRa/GPS Shield is made out of LoRa/GPS Shield mother board and Lora BEE.

In the LoRa part, the LoRa/GPS Shield depends on the SX1276/SX1278 chip. The handsets of the LoRa/GPS Shield include the LoRa long range modem that gives ultra-long range spread spectrum correspondence and high impedance resistance while limiting current utilization. LoRa additionally gives noteworthy favourable circumstances in both blocking and selectivity over regular balance procedures, unravelling the customary outline trade off between range, interference immunity and energy utilization.

In the GPS part, the extra L80 GPS (base on MTK MT3339) is intended for applications that utilization a GPS associated through the serial ports to the arduino, such as timing applications or general applications that require GPS data. This GPS module can ascertain and foresee orbits consequently utilizing the ephemeris information (up to 3 days) put away in interior flash memory, so the shield can settle position immediately even at indoor flag levels with low power utilization. With Always Locate innovation, the Lora/GPS Shield can adaptively modify the on/off time to accomplish adjust between situating precision and power utilization as indicated by the natural and movement conditions. The GPS additionally underpins programmed reception apparatus exchanging capacity. It can accomplish the exchanging between inward fix radio wire and outside dynamic reception apparatus. In addition, it continues situating during the exchanging procedure.

Gateway module:

LoRa: The term LORA stands for Long Range. It is a wireless Radio frequency technology introduced by a company called SEMTECH. This LORA technology can be used to transmit bi-directional information to long distance without consuming much power. This property can be used by remote sensors which have to transmit its data by just operating on a small battery. Typically Lora can achieve a distance of 15-20km and can work on battery for years [4].

In LORA we can achieve high distance communication without using much power, thus overcoming the drawback of Wi-Fi and BLE communication. In order to achieve high distance with Low power LORA compromises on Bandwidth, it operates on very low bandwidth. The maximum bandwidth for Lora is around 5.5 kbps

LORA to be more like cellular communication. Signal from one LORA Node reaches another Node through a LORA Gateway as shown in the image below. These Gateways then take the information to the internet and finally to the end user through an application interface. Similarly the data from the user will also reach the node through the network server and the Gateway.

A LORA Node usually operates on a Battery and consists of a Radio Module and Microprocessor. The Microprocessor is used to read the data from the senor and send it in the air through the Radio module which will then be picked up by a LORA Gateway. The LORA Gateway also has a Radio Module and a Microprocessor but is normally operated over AC mains since they require more power.

A single LORA Gateway could listen to multiple LORA nodes, while a single LORA node could also send information to multiple gateways, this way the information from the node will be picked up gateway without it being lost. When information id is sent from the node to the gateway it is called as uplink and when it is sent from gateway to node it is called as down link.

In this system we are using the LoRa Gateway for communication between client module and cloud module. The information from the end devices presented at client module is transferred to web server in cloud module through LoRa Gateway.

LoPy: With LoRa, Wifi and BLE, LoPy is the main triple conveyor MicroPython empowered smaller scale controller available today – the ideal undertaking grade IoT stage for your associated things. With the most recent Espresso chipset the LoPy offers an ideal mix of energy, amicability and adaptability. Make and interface your things all over the place.

Cloud module: In this system Cloud module is used to maintain the data about the potholes. Web page is created in personal cloud which will store the location details about where the potholes and humps are detected. This information is useful for the repair and maintenance of the roads. And the same information will be useful for the drivers to avoid the potholes or drive carefully.

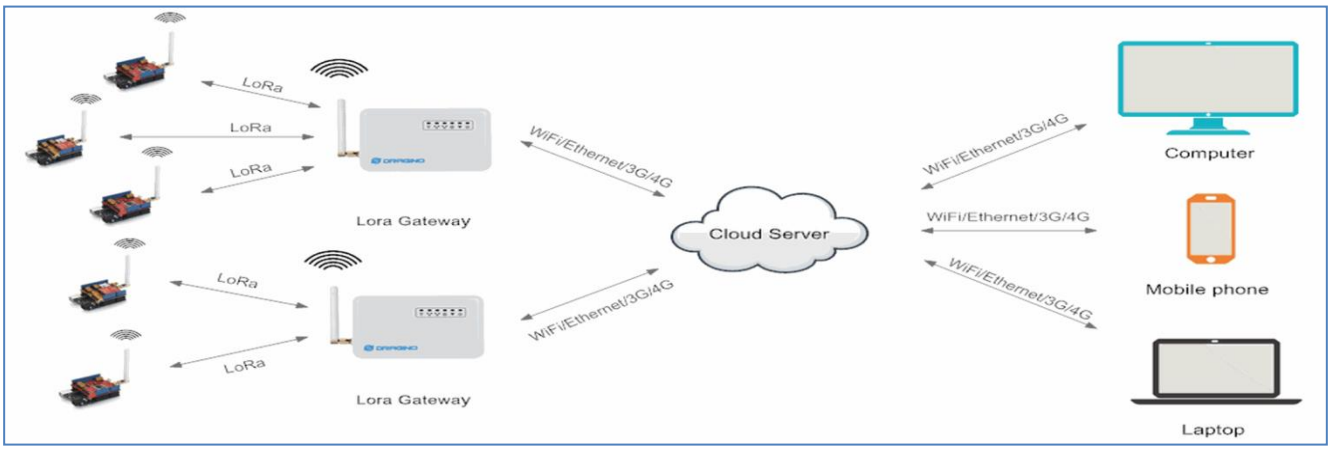


Fig 3. LORA Gateway

ID	NAME	STATUS	TIME
935	Hole atLAT, LON	78.607704,17.215076	03/04/19 10:03:35 am
934	Hump atLAT, LON	78.607704,17.215076	03/04/19 10:02:41 am
933	Hump atLAT, LON	78.642365,17.205795	03/04/19 10:00:30 am
932	Hole atLAT, LON	78.642365,17.205795	03/04/19 09:59:29 am
931	Hole atLAT, LON	78.642365,17.205795	03/04/19 09:59:00 am
930	Hole atLAT, LON	78.642365,17.205795	03/04/19 09:58:27 am
929	Hole atLAT, LON	78.642365,17.205795	03/04/19 09:57:58 am
928	Hole atLAT, LON	78.413094,17.482124	02/04/19 11:29:57 pm
927	Hump atLAT, LON	78.413094,17.482124	02/04/19 11:28:27 pm
926	Hump atLAT, LON	78.413094,17.482124	02/04/19 11:25:33 pm

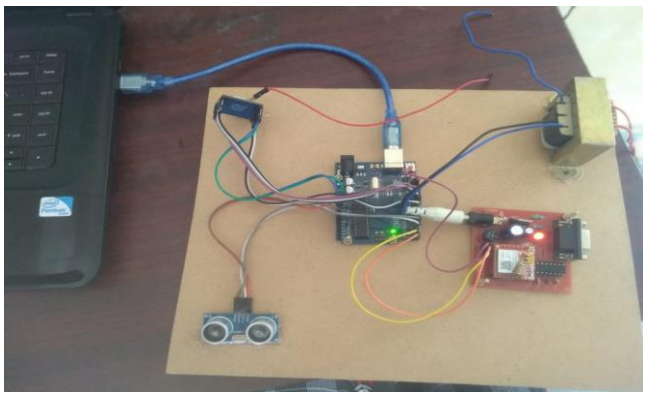
Showing 11 to 20 of 945 entries Previous 1 2 3 4 5 ... 95 Next

Fig.5 Results

III. IMPLEMENTED PROPOSED WORK & RESULTS

The user modules need to be deployed on every vehicle in the city, the sensors on vehicle will detect the potholes and humps and Location will be sent to the gateway. Gateway will receive detected locations from various users, all this information is stored in database which will be helpful to repair and maintain the road and the same information can be used to send alerts to the drivers about potholes. The ultra sonic sensor will detect the potholes and humps on roads. In ultrasonic sensor, the transmitter will transmits a wave and waits for the reflected wave. So it estimates the length of pothole based on the time it takes to reflect back. if the distance is 10cm it is identified as hump and if the distance is 20cm or high then it is identified as pothole. LoRa GPS module will capture the location in terms of longitude and latitude.

Fig.4 Implementation Setup



This information will be sent to gateway using Lora communication. Lora Gateway can receive information from multiple Lora modules this information updated in cloud.

IV. CONCLUSION AND FUTURE WORK

The model proposed in this paper is an effective approach for detection of potholes and humps as it is using Lora communication.

One Lora gate way in each city can receive information from thousands of end nodes which decreases the deployment cost. Gateway can be anywhere in the range of 15km as LoRa module can send the information throughout this range. This information is uploaded to cloud which will be available for higher authorities to repair and maintain the roads effectively. Then this information must be forwarded to higher authorities for immediate action and this information will be useful for future drivers in that particular way. This solution also works in rainy season when potholes are filled with muddy water. This system can be advance improved to consider the above fact and update server system and can be integrated with Google maps for driver safety.

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