ROAD CONDITION MONITORING AND GAS LEAKAGE DETECTION USING PIC16F877

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Abstract*—Roads are the dominant means of transportation in India .Pathetic road conditions of India arise mainly due to the natural events such as tropical rains and flooding that may lead to insecure driving. This paper proposes a new inexpensive system to avoid accidents on road due to humps and potholes. In this system ultrasonic sensors are used to detect and notify the height of humps and depth of potholes respectively. By using PIC16F877 microcontroller it gathers all the measured information about humps and potholes which are then displayed in 7 segment LCD display. The proposed system captures the geographical location of humps and potholes using Geographical Positioning System (GPS). This captured information is then send to the concerned authorities using Global Standard for Mobile communication (GSM) and the concerned authority will take necessary actions for the betterment of the roads. Furthermore this proposed system detects the leakage of gases in the vehicles using gas sensors and delivers the instructions to drivers to avert accidents.*

Keywords— PIC16F877, GPS, GSM SIM900, LCD display, MQ4 Gas sensors, Ultrasonic sensors

1. INTRODUCTION

India is said to be the fastest developing countries today only after China. Since roads indirectly contribute to the economic growth of the country it is extremely essential that the roads are well laid out and strong. India is also home to Fifty-three National highways which carry about 40 percent of the total road traffic. Although the figures look pretty impressive but the underlying fact is that 25 percent of villages in India still having poor road links. The other problems faced by the roads are bad riding quality, poor geometrics, and insufficient pavement thickness. Potholes and badly designed humps don't just irritate drivers and it damages vehicles.

Roads normally have humps so that the vehicles speed can be controlled to avoid accidents. However these humps are unevenly distributed with uneven and unscientific height. The potholes are formed due to the heavy rains and movement of heavy vehicles on the road.

According to the Road Accident Report (2014) published by the road transport and highways ministry 4,726 lives were lost in crashes due to humps, 6,672 people died in accidents caused due to potholes and humps. Sources said the actual figure could be much higher since the data was not properly captured by local police while registering accidents and in many cases these are recorded as any other road crash. Pathetic condition of roads is boosting factor for traffic congestion and accidents. At present gas leakage becomes a serious problem in vehicles.

Gas leakage leads to various accidents resulting into both financial loss as well as human injuries. To address the above mentioned problems, a cost effective solution is needed that collects the information about the severity of potholes, humps and gas leakage. The proposed system collects the information about the severity of potholes, humps and leakage of gases in vehicles and thus helps drivers to avoid accidents.

Fig.1. Pothole present in the road

2. RELATED WORK

This section gives a brief description about the existing solutions for detecting potholes and humps on roads.

Youquan et al.[2] developed a system to detect the potholes on road by using the three dimensional cross section The system uses a LED linear light as an auxiliary light and

transmits it ray on road surface vertically. Then, it uses two CCD cameras to capture the pavement image. It then explains various digital image processing technologies including image pre-processing, binarization, thinning, three dimensional reconstruction, error analysis and get the depth of potholes.

Rode et al. [1] have proposed a system in which, Wi-Fi well-appointed vehicles collect information about the road surface and pass it to the Wi-Fi access point. The access point then broadcasts this information to other vehicles in the area in the form of warnings. However, the system turns out to be an expensive one as all vehicles should be installed with Wi-Fi stations and more number of access points have to be set up Lin and Liu [3], have proposed a method for Pothole detection based on SVM (Support Vector Machine).This method differentiates potholes from other defects such as cracks. The images are segmented by using partial differential equations. In order to detect potholes, the method trains the SVM with a set of pavement images. However, the training model fails to detect the pavement defects if the images are not properly illuminated.Hegde et al. [8], have proposed an intelligent transport system to detect potholes. It makes use of ultrasonic sensors to detect the presence of potholes. This system also sends warning messages to all the vehicles in the range of 100 meters using Zigbee module. However, the system provides warnings after detecting the potholes which does not effectively help drivers to avoid potential accidents.Venkatesh et al. [7] have proposed an intelligent system that has made use of laser line striper and a camera to detect and avoid potholes. This system maintains a centralized database of the location of potholes. It also sends warning messages to the nearby vehicles about the occurrence of potholes using Dedicated Short Range Communication protocol.Rajeshwari Madli et al.[1] have proposed a system to detect and notify potholes, humps. It makes use of ultrasonic sensor to detect the depth and height of potholes and humps respectively. The geographical locations of potholes and humps was captured by GPS and it sends message to mobile phone by using GSM to give alert for divers to avoid accidents.

COMPONENTS USED IN THE PROPOSED SYSTEM

The proposed system describes the Road condition monitoring and gas leakage detection with a cost effective system. The components used in this system and block diagram are as follows:

PIC16F877 Microcontroller: Peripheral Interface control (PIC16F877) is a 40 pin microcontroller. This controller is widely used for experimental application because of its high quality and ease of availability. It is ideal for applications such as machine control applications, measurement device and so on.PIC16F877 comes with 3 operating speeds with 4, 8 or 20MHz clock input. Since each instruction takes 0.2 µs when 20MHz oscillator is used.

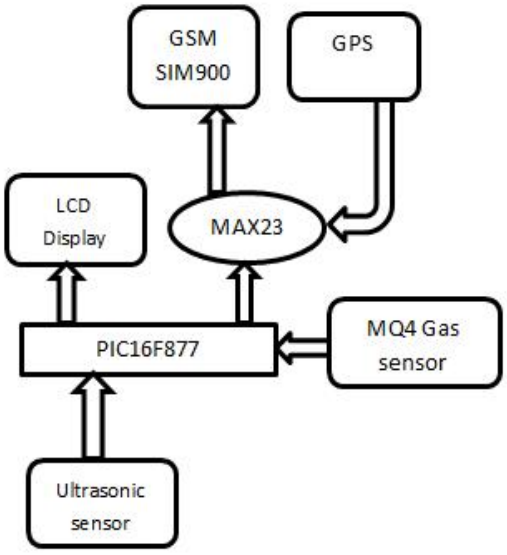

Fig.2. Block diagram of proposed system

It has 2 types of internal memories: Program Memory and Data memory. Program Memory is provided by 8k of flash memory and Data Memory has two source: one type of data memory is a 368 byte RAM and the other is 268 bytes EEPROM.The core feature includes interrupt capability up to 14 sources, power saving SLEEP MODE and single 5V in ICSP capability.

The sink/source current which indicates a driving power from I/O port is high with 25MA. The power consumption is less than 2MA in 5V operating condition. It has two capture compare PWM module for capturing, comparing 16 bit and PWM generation with 10 bit resolution. The PIC16877 Microcontroller have SSP with SPI (Master mode) and I2C2 (Master /slave) pins.

Ultrasonic sensor HC-S04: Ultrasonic ranging module HC – SR04 provides 2cm – 400cm non-contact measurement. The module includes ultrasonic transmitter, receiver and control unit. It used to measure distance at which objects are placed in front of it. Ultrasonic waves spread in the air and would return immediately when it encountered obstacles on the way. At last the ultrasonic receiver would stop timing when it received the reflected wave. The HC-S04 sensor transmits high frequency sound waves with frequency of 40KHz and can measure distances of the objects in the range 2 to 400cm with a 150 angle of detection.

GPS(Global Positioning System): The Global Positioning System is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. A GPS receiver calculates its position by
precisely calculating the signals sent by GPS.

The distances and satellite locations are used to compute the location of the receiver using the navigation equations. This location is then displayed, perhaps with a moving map display or latitude and longitude elevation information. Many GPS units show derived information such as

direction and speed, calculated from position changes. It obtains the GPS information from satellite in
National Marine Electronics Association (NMEA) format.
GSM SIM 900: Global system for Mobile Communication is a globally accepted standard for digital cellular communication. This module can be used to send and receive text message and to make receive voice calls. The GSM Networks is divided into three major system: the Switching System(SS), the Base Station System(BSS) ,and the Operation Support System(OSS).There are two basic types of services offered through GSM: telephony and data. GSM SIM 900 is a quad-band GSM Modem that functions at 850, 900, 1800 and 1900 MHz frequencies. The GSM Makes use of narrowband Time Division Multiple Access (TDMA) technique for transmitting signals.
MAX 232: MAX232 is an integrated circuit that converts TTL Logical level to RS 232 Level during the serial communication of microcontroller with other devices. The microcontroller which operates at TTL Logical level(0-5v) whereas serial communication in the device works on the RS232 Logical level(+25 to - 25v).This makes it difficult to establish a direct link between them to communicate with each other. The intermediate link is provided by using MAX232.
It is a dual driver/receiver that includes a capacitive voltage generator to supply the required voltage. The voltage level for RS232 is 5V. Each receiver converts RS232 I/O to 5V TTL/CMOS levels. These receiver can accept +30V to -30V input/output. The driver also called transmitter, convert the
TTL/CMOS input/output level into RS232"s receiver. The transmitters take input/output from controller"s serial transmission pin and send the output to RS232"s receiver. The receivers on the other hand takes input from transmission pin of RS232 serial port and give serial output to microcontroller"s receiver pins
MQ4 Gas Sensor: The MQ-4 gas sensor can detect the natural gas concentrations present anywhere from (200 to 1000) ppm .This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple with 5v power supply to the heater coil, add a load resistance, and connect the output to an ADC. MQ-4 gas sensor, is composed of micro AL2O3 ceramic tube, Tin di-oxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-4 have 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current as shown in Fig.3

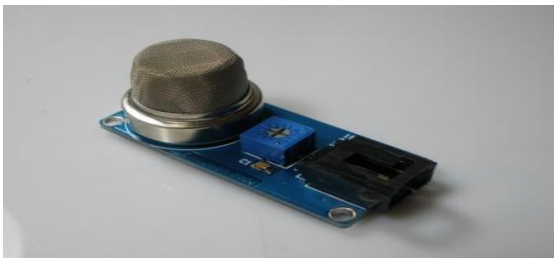

Fig. 3. MQ4 Gas sensor

3. ARCHITECTURE & IMPLEMENTATION

The block diagram of the proposed system is shown in figure 2. It consists of Microcontroller, Ultrasonic sensor, LCD Display, GPS, GSM and Gas sensor. The Microcontroller is the heart of the proposed system and is responsible for performing various tasks starting from processing all the sensor input to alerting the driver.
In this system the HC-S04 ultrasonic sensors are used to detect the depth and height of potholes and humps respectively. This sensor has both transmitter and receiver. The HC-S04 sensor is operated at a frequency of 40 KHz and measure distances of objects in the range 2 to 400cm with 150 angle of detection. Ultrasonic sensor will measure the distance between car and road surface and this information is gathered by using PIC16F877 Microcontroller. The distance between the car and road surface is called threshold value.
The figure. 4 shows workflow of humps and potholes detection. The flow chart explains that ultrasonic sensor is detecting the location of potholes and humps on the road and it is computing the distance between the road and vehicle. The distance between road and vehicle is known as threshold value. If the distance measured by ultrasonic sensor is greater than the threshold value it is a pothole. If it is smaller, it is hump.
The microcontroller is used to gather information about pothole"s depth and hump"s height.
The measured value of potholes and humps are displayed using 7segment LCD Display with an audio beep sound. Detection and notification of potholes and humps are not enough to avoid the accidents on roads. Repairing of roads is having a great impact in the field of transportation. In this system MAX232 interface is used. MAX232 is used to connect the GPS and GSM to Microcontroller in order to overcome these problems in roads.

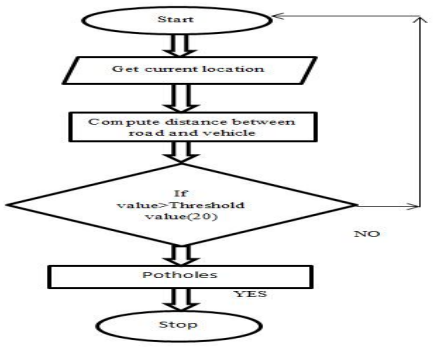

Fig. 4. Workflow of humps and potholes detection

The global positioning system (GPS) captures the location of the detected potholes or the humps and sends messages to the registered mobile SIM of concerned authorities in order to make them aware about the potholes and humps by using GSM module. There are many gas sensors which are used to detect the gases.MQ3, MQ4, MQ8 are some of the examples for gas sensors. Among this MQ4 Gas sensor is used to detect the leakage of the gases and it is connected to the PIC Microcontroller. In this system the MQ4 gas sensor is used to detect the CNG gases and microcontroller collects the information about the leakage and it will give notification to the driver with an audio beep sound.

4. EXPERIMENTAL RESULT

The working model of the proposed system is shown in figure 5.

PIC16F877 Microcontroller for gathering the information about pothole‟s depth, hump‟s height and gas leakage detection. The PIC16F877 Microcontroller architecture has 40 pins with 8k ROM Memory and 368 RAM Memory. It has a master synchronous serial port (MSSP) pin and Compare Capture PWM (CCP) pin.

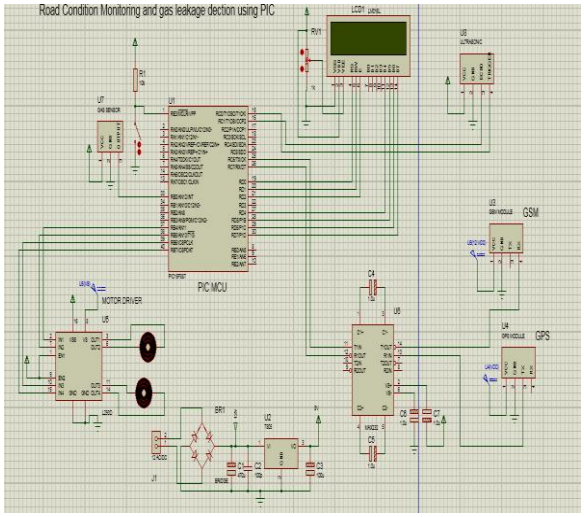

Fig .5. The proteous diagram of proposed system

In this system ultrasonic sensor is connected to CCP pin (15th pin) of microcontroller which can capture and compare the measured values. Ultrasonic sensor has 4 pins which are Echo, Trigger, VCC and Ground. The trigger pin of the ultrasonic sensor is connected to the 15th pin of microcontroller and Echo is connected to 16th pin of microcontroller. The Echo is used to store the reflected wave time. The ultrasonic sensor contains a transmitter and receiver. It transmits high frequency sound waves and waits until reflected wave gets hit on the receiver. The distance is calculated based on the time taken by ultrasonic pulse to travel a particular distance. The ultrasonic sensor is displayed in the LCD Display. The LCD is connected to port c pin of microcontroller. When the measured value is displayed in the LCD the driver will obtain a notification about the humps and potholes on the road.

The GPS and GSM is connected to PIC Microcontroller by using MAX232.The MAX232 is used to convert the TTL/CMOS Logical level to RS232 logical level during serial communication of microcontroller with other peripheral. The controller operates at TTL logical level (0-5v) whereas the serial communication in the other device works on RS232 standards. The GPS is connected to the receiver pin of the MAX232.The GPS which captures the geographical location of potholes and humps on the road. The GSM is connected to the transmitter of MAX232.It is used to send the messages about potholes and humps to concerned authorities for repairing the road. Furthermore the gas sensor is connected to interrupt pin of microcontroller. The MQ4 gas sensor is used to detect the leakage of gases in the vehicles. Here the motor driver is connected to the port B of pic microcontroller. The motor driver is used to produce sufficient voltage required for moving the wheels in the proposed system. This proposed system is very suitable for detection and notification of potholes, humps and gas leakages.

Fig. 6. (a) Detection of hump (b) Detection of pothole

Figure.6 shows the distance between vehicle and the road. The distance between vehicle and road is called threshold value. The threshold value varies for different vehicles.

TABLE I

INFORMATION ABOUT POTHOLES AND HUMPS

Sl. No	Obstacle type	Height/Depth in cm
1	P	23
2	H	9.3
3	H	6.3
4	P	22.5
5	P	21

Table I shows a set of measurements taken for various potholes and humps that are identified in the system. In this table P denotes the potholes and H denotes the humps

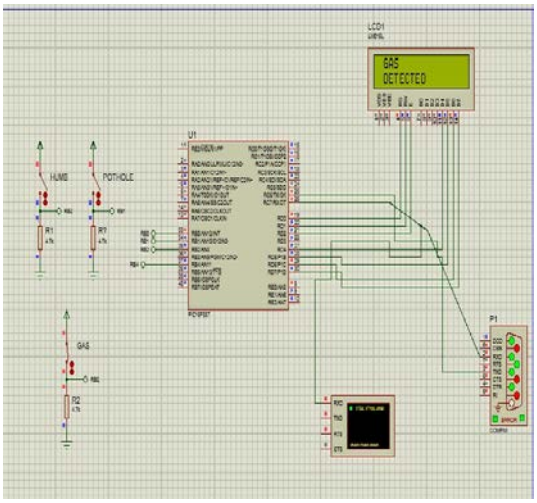

Fig. 7 Detection of potholes humps and gas leakage

The figure.7 shows the detection and notification of potholes, humps and gas leakage. For the detection and notification PIC microcontroller, LCD Display and GSM are used. MAX232 interface is used to connect the GSM Module to PIC Microcontroller.

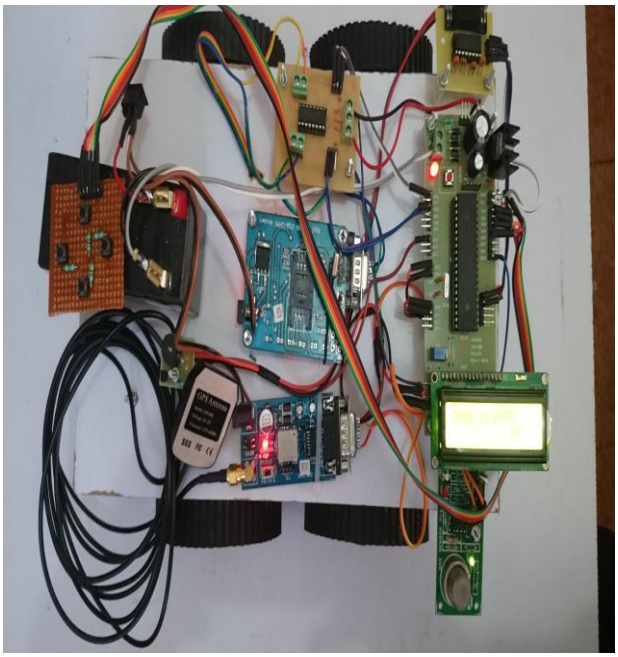

Fig.8 Working model of the proposed system

The figure. 8 shows the working model of proposed system.

Fig. 9. Notification of hump

Fig. 10 Notification of pothole

The figure.9 and Figure.10 displays the measured values of hump‟s height and pothole‟s depth in the LCD respectively.

5. CONCLUSION AND FUTURE WORK

The proposed system serves two important purpose; Automatic detection and notification of potholes, humps and gas leakage. In these days, humps are unevenly distributed with uneven and unscientific height. Potholes are formed due to heavy rains and movement of heavy vehicles. To overcome these problems, in the proposed system we are using ultrasonic sensor to detect the pothole „depth and hump‟s height and the detected information is notified to the driver using the LCD Display. The detected potholes and humps are repaired by sending messages to the concerned authorities. Also the MQ4 gas sensor will detect the leakage of gas in the vehicles.
The accuracy of the proposed system can be improved by integrating Google maps in the proposed system.

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