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Wireless alerting system using vibration for vehicles dashboard

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Abstract. This paper aims at improving the engine life of any vehicle through a continuous measurement and monitoring of vital engine operational parameters and providing an effective alerting to drivers for any abnormality. Vehicles currently are using audio and visible alerting signals through alarms and light as a warning to the driver but these are not effective in noisy environments and during daylight. Through the use of the sense of feeling a driver can be alerted effectively. The need to no other vehicle parameter needs to be aided through the mobile display (phone).Thus a system is designed and implements to measure engine temperature, RPM, Oil level and Coolant level using appropriate sensors and a wireless communication (Bluetooth) is established to actuate a portable vibration control device and to read the different vehicle sensor readings through an android application for display and diagnosis.

1. Introduction

In automobiles, the engine is the most crucial part and thus it needs to be strictly monitored effectively and efficiently. This calls for the need for an effective alerting system to the drivers for any abnormalities in and outside the engine. In this paper, we address to the improvement of alerting systems using vibration for the sense of touch. Though most vehicles use audio and visual alerting systems still these are not 100% effective as seen in areas where there excessive sound noise and during daylight when warning lights illumination is almost neutralized. This will create a situation whereby the driver will keep on driving whilst the engine is being damaged. Engine parameters like temperature, RPM, oil level and Coolant level are needed to be closely monitored [5]. Also, there are many other vehicle parameters which are not displayed on the instrument cluster due to limited space and these are vital to the drivers mostly when taking the car for service. Using Bluetooth protocol, a communication is established between the master sensing controller (Arduino UNO) and two other remote devices namely a mobile phone and a vibration device. The Android phone will save as a portable instrument cluster and on-board diagnostic display. In our work, a design and implementation of a system that uses the different sensor to measure different engine parameters will demonstrate the principles of operation[1-3].

2. Principle

2.1. Hall Effect Switch:

This is an IC that outputs a digital output with the change in the magnetic poles that come in its close proximity. With a supply of 5V dc, the switch can output either a 0V or 5V with either the north or south poles. Thus the output generated would be a square wave with a peak of 5V.

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2.2. Conductive Probes Sensing:
Water is not a 100% electric conductor but it conducts to some extent. With one probe immersed in water and when the other is connected in such a way that water will act as the switching medium, the level can be sensed to give a digital output [6]. This is achieved using transistor biasing circuit since water is not a pure conductor (fig. 3).

2.3. Bluetooth:
This wireless serial communication protocol used radio frequency waves in the ISM range. The maximum range of communication is limited to 10M and above this, the signal strength will be below the detectable threshold. Using Bluetooth modules (HC-05) master-slave communication can be established by configuring the different modules to be either master or slave [4]. These are connected to the microcontrollers and set to operate at the same baud rate.

3. Experimental setup
An electric motor is being used as a vehicle engine a bar magnet was attached to the output rotating shaft. This provided sensing capability using a Hall Effect sensor (182502) producing square pulses. A DS18B20 temperature sensor measuring engine temperature from -55°C to +125°C was connected to the digital input pin of Arduino. Using conductive probes and suitable transistor conditioning circuit, engine coolant level was sensed and a pressure switch for oil level. The master Arduino communicated to the portable vibration device and android phone through Bluetooth at 19200 baud rate (2.5 GHz) [7]. Android application displayed the measured parameter and the portable device for alerting the driver when any of the parameters exceeded the set threshold (90°C, 4000 RPM, Oil pressure 34.5 kPa, etc.)[5].

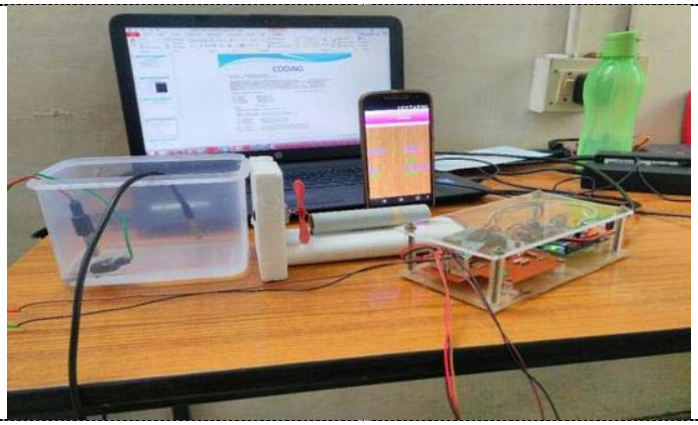

Figure 1. Experimental setup of wireless alerting system

4. Materials and methods

4.1. Hardware System

4.1.1. Sensors
Hall Effect switch was used for RPM measurement. This gave a square wave output alternating from 0V – 5V. For oil level measurement a pressure switch is used as a sensor. It outputs a digital output to the Arduino that is 5V for high oil level and 0V for low oil level. Conductive probes are sensing the engine coolant (water) level giving also a digital output. For the measurement of engine temperature, a DS18B20 sensor suited the application.

4.1.2. Controllers
Arduino UNO is used for the master tasks that is collecting the measured variables and processing the data. It then communicates the data to the slave devices through HC-05 Bluetooth module. An Arduino Nano is used as the controller for vibration actuation due to its smaller size and low power consumption. It also uses an HC-05 for communication. The Android phone saved as the portable remote display device that receives the measured data from the master controller and using an android application it displays the different values and states.

4.2. Software System
Embedded C is a programming language that uses already installed libraries in the Arduino IDLE. This project uses C-programming for the Arduino. For reading the sensors like the DS18B20 it uses the library from Dallas Semiconductor. It is a one-wire Digital Thermometer that gives a 9–12 bit temperature readings for measured temperature.
Mit app inventor is programming software that uses drag and drops boxes for creating an Android application that runs on any Android device. This is used for designing the user interface for the display of measured parameter on an android mobile phone. For PCB design Eagle software is used for the interface circuit (fig. 3).

5. Block diagram and methodology
The block diagram shown in Fig 2, gives an insight as to the overall operation of the system. As seen the sensors are hardwired to the master controller sending measured signals for processing. The master Arduino will then communicate through Bluetooth to the slave vibration device and the mobile phone. The communication is achieved by setting the same baud rate for all the devices (19200 in this case). When the slave Arduino Nano receives data from the master it actuates the vibrator signaling that an attention is needed to the vehicle that is the driver must check the instrument cluster or Android display to see which parameter has exceeded the threshold value. For example, when engine temperature exceeds 90°C an alerting will be activated through vibration. For oil level measurement a pressure switch is used and the threshold pressure is set on it as to at which pressure level the switch has to change its state. Having connected it in the normally open state the pressure switch will send a 5V level to the controller as a signal for normal or high oil level. A low or 0V for low oil level which is a condition for a warning to the driver to either stop the car and top up oil or take the car for service. Coolant level is sensed in the coolant reservoir tank by adjusting the sensing probe to the desired level for “high coolant level”. This will be sensed as a minimum required coolant level for no warning[6].

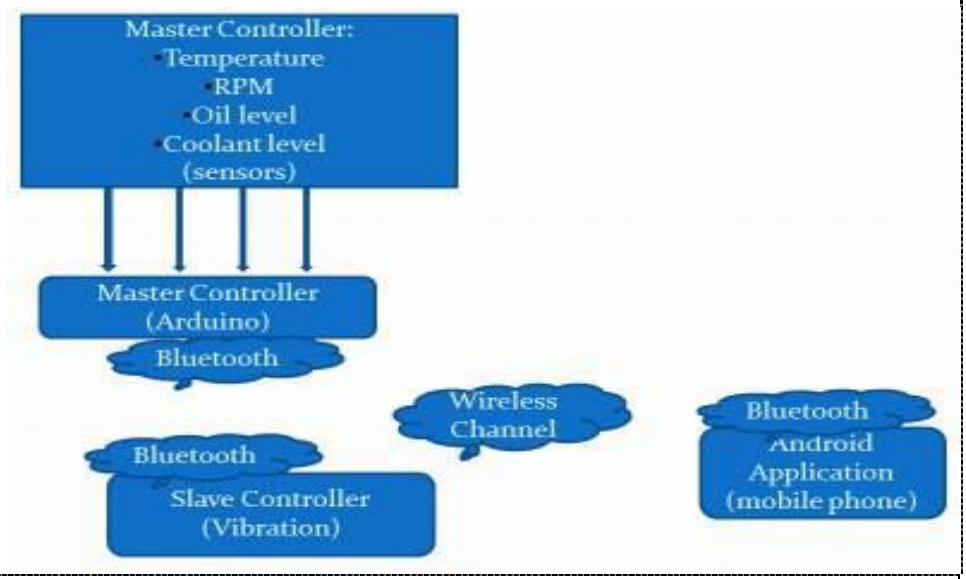

Figure 2. Block diagram of overall system

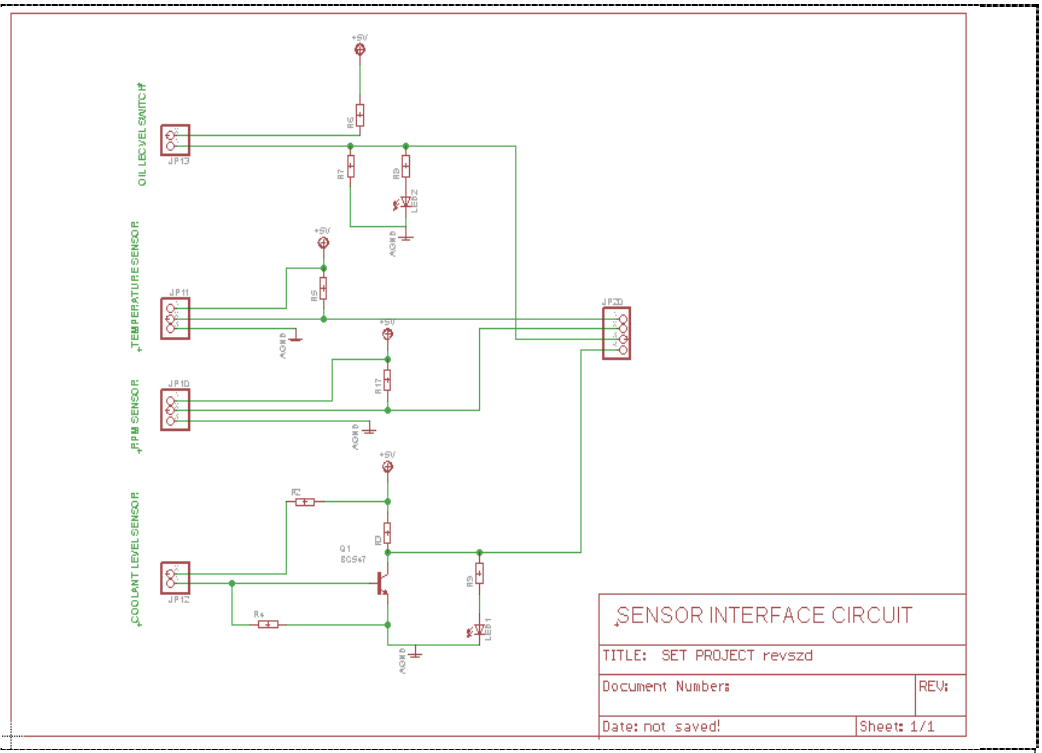

Figure 3. Sensor interface circuit

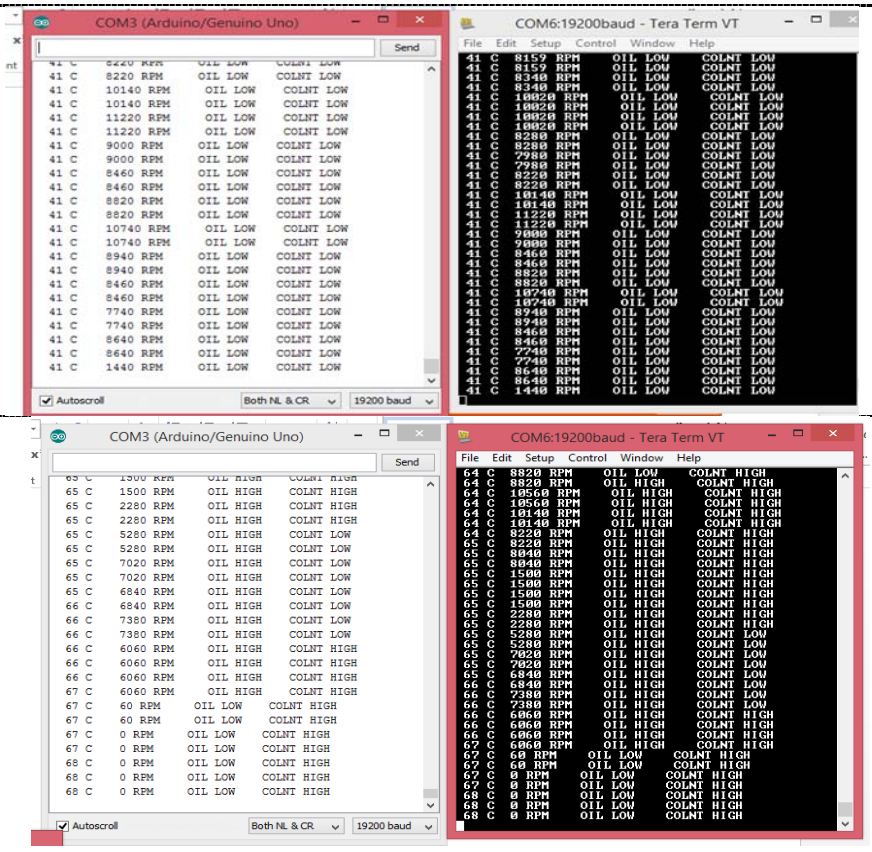

Figure 4. The terminal window showing results for various conditions

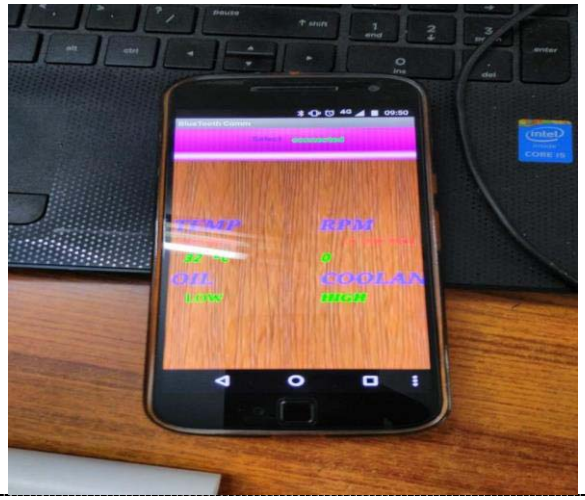

Figure 5. The Android application used to view the results

6. Result and discussion

We notice that the RPM of engine increases in steps of 60 rpm. This is a reasonable resolution since the engine does not accelerate abruptly. It is sufficient enough to control the engine rotation speed and the increments have no much effect on the final result. Using a Hall switch to measure the engine RPM output a perfect pulse signal which is easier to process and the sensor is capable of detecting quasi-static speeds as it depends on the alternating magnetic poles (Fig.4). Using a pressure switch for oil level measurement is a suitable sensor. This will easily be mounted on the engine cylinder block and most cars use this principle which allows easy integration of this system to the already existing

cars. For communication between wireless devices Bluetooth some benefits as seen in the frequency band of operation, ISM band which is free. Also, the range of operation suited the automotive applications. With the Android application, the measured engine parameters could be displayed on the mobile device by only selecting the master device name and this will automatically establish a communication between the two. Also, the allocation allowed for an addition of other data to be added and displayed. This is only changed in the coding. The application suited for any android phone regardless of the version it is using.

7. Conclusion and future work

By using the different sensors for different engine parameter the master controller can do data manipulation and make a decision before communicating it to any remote devices. A Bluetooth communication protocol can communicate up to a radius of 10m [7]. Using a vibration device the driver can be effectively alerted through the sense of feeling even when driving in a noisy environment. At any given time the parameter of the vehicle can be viewed using the mobile phone. These can be any other parameters are not displayed on the instrument cluster. This will help people before taking their vehicles for services. Due to magnetic interference in the vehicle caused by motors and spark plugs Bluetooth need to be substituted by other RF protocols that filter the interference noise. An application of this work could be configured into a Wireless Sensor Network which can be further developed into IoT through the use of Wi-Fi protocols. Here the vehicle parameters can be uploaded to the cloud and accessed from any distance by relevant users. Also, replacement of Arduino with lower power microcontrollers like ARM and MSP430 that serves power need to be done in future.

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