GPS TRACKING AND BATTERY MONITORING SYSTEM FOR ELECTRIC BIKE

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Abstract: This paper focuses mainly on incorporating tracking system and battery monitoring system on an Electric Bike. Global Positioning System (GPS) tracking technology tracks the location of the bike with which, vehicle status, distance covered, Speed, and stop summary is ascertained by using Global System for Mobile Communication (GSM). GPS tracking helps us to track the bike live by using any smartphone. GPS tracking acts as a layer of protection to the bike, if it is lost or stolen. Anywhere tracking is possible for easy recovery of the bike. GPS application is predominantly used in security of personal vehicles, public transportation systems, fleet management and others. Battery Monitoring System (BMS) plays a crucial role in safe operation and prolonged life of the battery of electric bike by monitoring the battery level and battery temperature. The battery level indicates the level of charge left out in the battery and the battery temperature indicates the temperature in degree Celsius. In case of battery failure, monitoring system helps in preventative maintenance in safe & orderly replacement. GPS tracking and battery monitoring system demonstrates the real-time tracking of vehicles and improved customizability, global operability and efficient battery maintenance.

***Index Terms*: GPS, GSM, BMS**

I. INTRODUCTION

The term 'Electric bike' in this paper refers to bicycles equipped with a small motor and battery where riders have the option to pedal or switch on electric assistance (usually with a choice of low, medium or high settings) whenever they wish. Nowadays majority of the vehicle uses petrol and diesel to energise the vehicle. But petrol or diesel is a non-renewable source and this means that it will probably run out in the upcoming days. Burning petrol and diesel will also produce greenhouse gas (carbon dioxide) leading to increase in pollution level. More over crude oil becomes expensive due to increased demand and reduced resource. Electric Bike can be the best solution to this problem. Because Electric Bike have a reserved rechargeable battery instead of using petrol or diesel. The Electric Bike can be operated in two modes. One is throttle mode and other is pedal assist mode. The throttle mode is similar to riding a motor cycle. When the throttle mode is enabled the motor provides the power and forwards the bike. When the pedal mode is enabled, the motor provides power only when the bike is pedalled. The electric bike has an additional regenerative feature where the pedalling effort never goes in vain instead the battery gets charged while pedalling. These e-bikes are often referred to as pedelecs. Electric Bike will be able to cover 0-25 kmph in 15 seconds. The Electric Bike is also equipped with a BLDC motor, battery and gears. The electrical assistance cuts out when pedalling ceases or the speed of 15 m/h (25 km/h) is exceeded.

GPS tracking is a device used to determine the location of the bike along with the information like vehicle status, the locations where the bike stopped and the interval of time at the stopping locations. Battery Monitoring System is used to monitor the bike's battery level and temperature continuously. Most of the tracking system uses a GPS module to locate the position of the bike. GPS tracking uses satellites for transmitting the location to the user .The GPS tracking system is adaptive for various applications such as children tracking, car or equipment tracking or any asset tracking and intelligent transportation system. The battery monitoring system finds applications in Electric vehicle (EV), Hybrid Electric Vehicle (HEV), Uninterrupted Power Supplies (UPS), Telecommunication.

II. LITERATURE SURVEY

In this paper [1], the vehicle tracking is done by Automatic Vehicle Location (AVL) method where any vehicle can be tracked and monitored by using a software unit. This software transmits and receives signals through GPS satellites.AVL provides the actual position of the vehicle by GPS and Geographic Information system(GIS).This system also has a tracking server where the location information of the vehicle is stored. It uses a Radio Frequency (RF) transmitter and receiver for transmitting the information to the server. But this system can transmit the data to the tracking server through RF transmitter only when the distance between the server and GPS device is less.

Here [2], the user's location can be obtained by using GPS and Network Location Provider of Android phone. The user's location is determined by using the cellular towers and Wi-Fi signals. So the position of the Android mobile is monitored continuously for 24 hours and the tracked positions are secured in a webpage. So the device can be prevented from entering prohibited areas and the histories of its previous positions are also stored in the webpage. But this system requires a android phone because it uses the Network Location Provider which is available only in Android mobile.

This paper [3], uses Android and the combination of GPS, GSM and processor for vehicle tracking system. This project is done to improve the service of the vehicle organization and for safety purpose. Whenever the vehicle is in motion, the location is updated to the server continuously using GPRS service. The vehicle organization receives the exact location of the vehicle in their mobile phones through the server. This system also has a monitoring device in which the location is plotted using Google map. But here, the location is sent only to the organization and there is no provision for the rider to know their location.

Here [4], vehicle tracking system is implemented for transport services and it uses a hardware device and an android application to track the vehicle. In this paper, the tracking information is uploaded to a server using GPS and GSM technology. The latitude and longitude values are uploaded to the server. With the help of internet and Android application, the information can be downloaded from the server and the exact location can viewed using the application. But this requires internet connection to track the vehicle.

In this paper [5] the battery monitoring is used to monitor the batteries in the battery bank continuously by using a microprocessor. Here the system calculates the battery capacity, temperature, charge/discharge cycles and efficiency in order to prevent the battery prior to failure. It focuses on the alerting the user when there is any battery failure so that preventive actions can be taken. The health and performance of the battery is also improved by this system.

This paper [6] uses microcontrollers to measure the temperature and level of electrolyte in the lead acid battery along with the number of backup hours. These battery parameters accounts for determing the life span and efficiency of the battery. The parameters of the battery can also be recorded and saved. The implementation of this project helps efficient working of battery.

Here [7], the automobile battery is monitored for computing its health state. It uses voltage divider, current and temperature modules for determining voltage, current and temperature of the battery by using a microcontroller on an arduino Uno R3 computing board. This also alerts the car user for timely replacement of battery or for necessary precaution of the battery.

III. PROPOSED SYSTEM

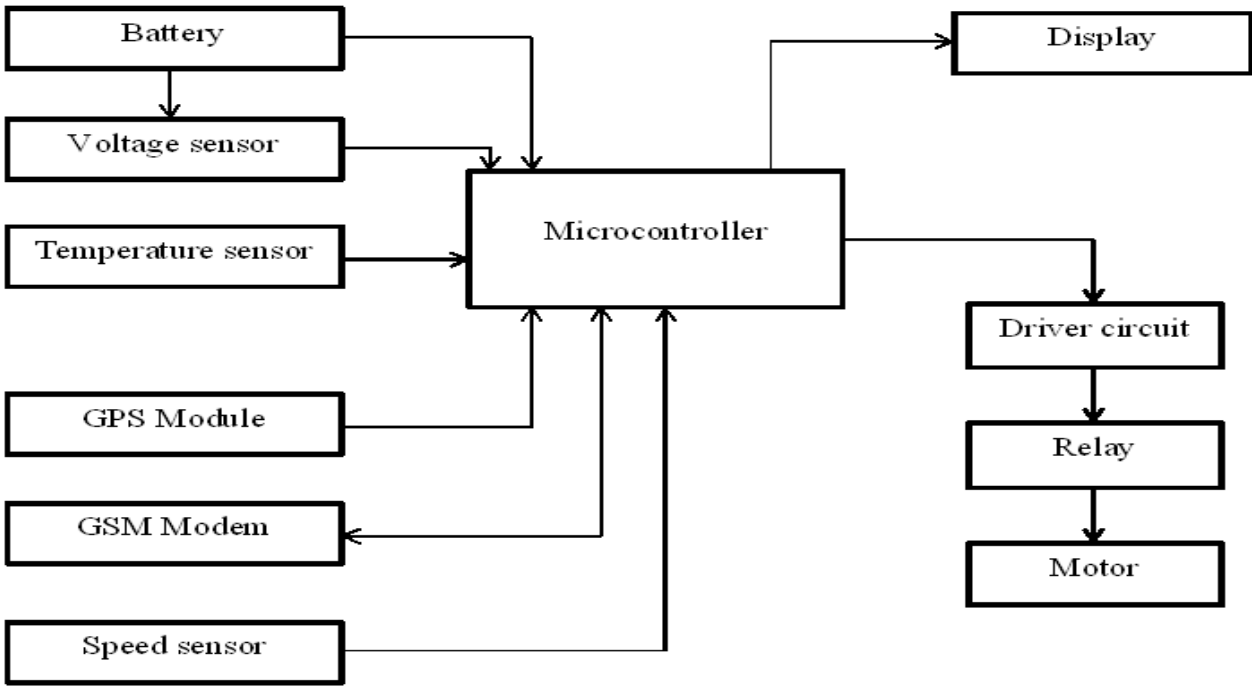

Fig 3.1 Block Diagram of the Proposed System

The block diagram of the proposed system is shown in Figure 3.1 and it consists of the following components:

a). GPS Module
b). GSM Modem
c). Microcontroller
d). Voltage Sensor
e). Temperature Sensor
f). Speed Sensor
g). Motor and its devices

IV. BLOCKS OF THE PROPOSED SYSTEM

a) GPS Module:

GPS module which is equipped in the vehicle receives the radio signals from the satellites at a regular period of time. There are 24 GPS satellites of United States around the Earth. The GPS module used in the proposed system is U-blox-G7020 for determining the exact and real time location of the vehicle. This GPS works in the baud rate of 9600 and its operating voltage is 5V.Since the operating voltage is low it doesn't need a separate power supply instead the GPS can be powered with the help of battery. GPS module has only 4 pins-Power supply, Ground, Transmitter and Receiver. The receiver of GPS is connected to Transmitter of microcontroller and transmitter is connected to receiver of microcontroller.

b) GSM Modem:

GSM (Global System for Mobile Communication) technology uses standards and protocols in and around 900 MHz frequency spectrum modules for data transmission to the server or database. Here we have used SIM 800C which is a Quad Band Module of various frequencies 850/900/1800/1900 MHz and its operating voltage is 3.4 V to 4.4 V. A SIM card is inserted in the GSM modem and it is interfaced with the controller as GSM transmitter and receiver are connected to receiver and transmitter of the microcontroller. The GSM modem is connected to the server through RS232 connector.

c) Microcontroller:

A Microcontroller is used to process and control the operation of the whole system.Here,32 bit microcontroller ARM LPC2148,a new version of ARM cortex core is used. ARM7 based LPC2148 is used to control and manage system operation. The microcontroller collects the data from the GPS module, temperature sensor and voltage sensor and speed sensor from the vehicle, processes the data and displays the location, battery voltage level, battery temperature, running speed. The microcontroller is also connected to the GSM modem so it can transmit the processed data to the server. The microcontroller can also be powered by the battery itself.

d) Voltage Sensor:

Here Voltage sensor is used to determine the amount of charge that is left out in the battery. The voltage sensor detects the changes in the battery level and provides an electrical output that is equivalent to the voltage change. The battery voltage changes when it charges and discharges. During the ride, when the user switches to throttle mode, the battery discharges and when the user pedals, the battery gets charged. The output of the sensor is programmed using microcontroller and the voltage level is displayed.

e) Temperature Sensor:

Temperature is one of the important factors in battery's performance and existence, so a temperature sensor is used to sense the surrounding temperature. Here LM 35 temperature sensor is used. The change in temperature is detected by the sensor and processed by the microcontroller which displays the present temperature. When an external memory is connected to the microcontroller the previous temperature can be stored for detailed performance analysis of the effect of temperature on battery.

f) Speed Sensor:

Speed sensor is used to determine the current speed at which the vehicle is running. Speed sensors can be accelerometer sensor, proximity sensor and hall sensor. In Electric Bike hall sensor is used to determine the speed. The hall sensor has 3 pins-power supply, ground and data pin. The speed sensor calculates the number of rotations of the wheel and it is converted to speed by the microcontroller. Usually the speed sensor is located near the motor and whenever the sensor detects the magnet in the rim cover of the motor ,the output data from the sensor is provided to the microcontroller. This output data is provided to the microcontroller and the speed is determined.

g) Motor and its devices:

The motor used in the electric bike is a hub motor which is energised when the bike starts. The motor needs a driver circuit and relay circuit and a controller to determine the amount of current that is to be provided to the motor. The motor and its related devices are already part of the Electric Bike.

h) Software Used:

The proposed system uses two software. One is Embedded C which is used for interfacing and controlling the ARM LPC2148 microcontroller to process the required data. The other software is Google Earth software for displaying the tracking and monitoring details on the Google Maps. This software helps to locate the vehicle coordinates on the Google Maps.

V. INTEGRATION OF THE PROPOSED SYSTEM

The proposed tracking and monitoring system focuses on continuous tracking of the Electric Vehicle's position along with vehicle's speed, stop summary and battery level and temperature. The stop summary will include data such as the location of the vehicle whenever the bike stops i.e. when the bike is turned off completely and the interval of time the bike stops. In simple words it can be referred as stoppages and stoppage time.

The proposed GPS tracking and Battery monitoring system for Electric Bike consists of four main components such as GPS module, microcontroller, and GSM module, a server and database. This system also includes sensors like temperature sensor, voltage sensor and speed sensor.

First, the hardware device GPS module is installed in the Electric Bike and is connected to the microcontroller. GPS receiver gets the location of the vehicle in the form of latitude and longitude. Latitude and longitude values are provided to the microcontroller to determine the vehicle location by further processing. Similarly the stoppage and stoppage time and vehicle status is also determined by the programing the microcontroller. After processing the values, the location, vehicle status and stop summary are uploaded to a server through GSM modem. The GSM modem is connected to the server through RS232.The server is generally a computer that receives the information and store it in a database (Microsoft excel).The information stored in the database can further be located on the map.

The Google Earth Software or a Google Map is used to display the location, status and stop summary in the form of map. Mobile is used to retrieve the required information by sending a request to the server through internet. So whenever the user requests the server, the details of tracking are send to the mobile through SMS (Short Message Service) or through any application.

The proposed battery monitoring system is necessary to maintain the battery's life and performance because it is considered as the heart of the electric vehicle. Battery monitoring system is implemented by using voltage and temperature sensor. The sensors are connected to the battery of the vehicle and the electrical output of the sensor is provided to the microcontroller. Generally the electrical output of the sensor is in digital or analog form of voltage or current. The microcontroller processes the electrical output of the sensor by programming and provides its equivalent temperature and battery level.

In addition to these sensors, the proposed system also has a speed sensor to determine the running speed of the vehicle. The speed sensor is also connected to the microcontroller. The microcontroller processes the data from the sensor and provides the present running speed of the vehicle.

A smart phone is used to view the tracking features and to display the battery temperature and battery level and the speed of the vehicle. The power supply to the microcontroller, GPS module, GSM modem and sensors can be provided from the battery itself with the help of a voltage regulator. So a separate power supply is not necessary in this system.

VI. PROTOTYPE MODEL

The prototype of the proposed system is shown in fig 2.The prototype model consists of GPS moduleU-Blox-G7020, GSM modem SIM800C, Microcontroller ARM LPC 2148,Temperature sensor LM35,Speed Sensor U slot, voltage sensor. In prototype model, 6 V 4.5 Ah battery, a DC motor along with driver circuit is used but in real model, 48 V battery is used and the electric Bike itself has a DC motor in its construction. Figure 6.1 shows the prototype model of the proposed system.

Fig 6.1 Prototype Model of the Proposed System

VII. RESULT

The result on the Google Earth software shows the tracking and monitoring details of the vehicle. The project is locating the position of the electric bike along with its speed , stop summary and it also displays battery level and temperature. There are some factors that affect the accuracy of the system like the delaying of signal. Figure 7.1 and Figure 7.2 shows the output of the proposed system.

Fig 7.1 Simulation output of the proposed system

Fig 7.2 Output of the proposed system on a webpage

VIII. ACKNOWLEDGMENT

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