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Virtually Assisted E – Bike with Smart Connectivity

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Abstract - The main objective of the project is to develop a Smart Electric Bike which is achieved by incorporating various prominent technologies. The specifications that transform an electric bike into a smart one are Global Positioning System (GPS), General Packet Radio Service/Global System for Mobile Communication (GPRS/GSM), Bluetooth connectivity, obstacle detection and vehicle friendly mobile application. In the project GPS is utilized to accomplish speed monitoring, to remotely access the vehicle location and alert the owner with GSM in case of theft. The smart electric bike is equipped with obstacle detector which triggers the UI of mobile application to intimate the driver about the vehicles in the blind spot of the electric bike and helps the driver to have a safe journey. The mobile application can provides great assistance while driving on the road by delivering proper local information, enhancing the navigation with right direction, informs about traffic, alerts the driver at odd scenario and maintains the vehicles stats. Therefore these features enhance the way a person commute in this digital era.

Keywords **– GPS, GPRS/GSM, Bluetooth, Obstacle Detection and Mobile Application.**

I. INTRODUCTION

Transportation is considered to be a massive contributor to global climate change, and a very effective and fun alternative to single-occupant car trips may be a personal electric vehicle like an electrical bicycle, e-scooter, or other small electric vehicle platforms. Electric vehicles are poised to rework nearly every aspect of transportation, including fuel, carbon emissions, costs, repairs, and driving habits. The first impetus now is de-carbonization is to deal with the global climate change emergency, but it soon may shift to economics because electric vehicles are anticipated to be cheaper and higher-performing than gasoline cars.

A battery electric vehicle (BEV) has far fewer moving parts than a standard gasoline powered vehicle. There's no need for liquid fuels or oil changes. In fact, most of the upkeep costs related to an indoor combustion engine are eliminated thus acting as a serious advantage. Electric cars are certainly an eco-improvement over gas-powered cars, but they still use the maximum amount as 10-20x the energy of micro mobility alternatives sort of a personal electric vehicle.

Electric motorcycles and scooters are considered as plug-in electric vehicles with two or three wheels. The electricity is stored on board during a rechargeable battery, which drives one or more electric motors. The smart e-bike came onto the scene not too way back, and already has seen many iterative improvements. The intelligent assistance is formed possible with the utilization of smartphones and wireless features.

II. LITERATURE SURVEY

[1] Frauke Behrendt (et al), [2011] as discussed in the paper the smart e-bike monitoring system (SEMS) is a platform for the real-time acquisition of usage data from electrically-assisted bikes (also called pedelecs or e-bikes). It is autonomous (runs off the bike battery), replicable (open source and open hardware), scalable (different fleet sizes) and modular (sensors can be added), so it can be used for further research and development. The system monitors location (global positioning system), rider control data (level of assistance) and other custom sensor input in real time. The SEMS data feeds an online interface for data analysis, for riders to view their own data and for sharing on social media.[1]

[2] Durga K Prasad Gudavalli (et al), [2017] It states that according to the World Health Organization (WHO) reports, India is prone for road accidents and most of the cases are of two wheeler accidents. Hence to provide safety and security system for bike riders we came up with a solution which is a Helmet Operated Smart E-Bike. It is having two operating modes which are Security Lock System (SLS) and Safety Engine System (SES), the first operating mode (SLS) having one RFID reader and two RFID tags. When a particular unique identity tag matches to the RFID reader value the handle lock mechanism will be operates like ON & OFF key. The second operating mode (SES) uses Force Sensing Resistor (FSR) which is fixed inside to the helmet and when some pressure applied on the sensor by helmet wearing on the user head, the motor (Engine) will be starts otherwise motor will be in off state.[2]

[3] M. M. Hossain; M. S. Islam (et al), [2017] This paper proposes the design of a low cost anti-theft sensor for motorcycle security based on detection of the rotation of its handlebar. An advanced motorcycle security device has also been developed on the basis of this proposed sensor. Currently, vibration sensors are used for motorcycle security purpose, which are very infuriating. In case of security device using vibration sensor, sometimes the jerking of a bike leads detection of thievery situation even though it is not the actual thievery case. But our designed sensor detects the thievery situation only when the handlebar rotates from left to right at a certain angle or vice-versa which really needs to be done to run a bike.[3]

[4] Ruben A. Sousa; Vitor Monteiro; Joao C. Ferreira (et al), [2018] This paper presents the development and test of an Internet of Things (IoT) system for monitoring and control of electric vehicles. The IoT architecture, which was developed using the Firebase platform, allows the synchronization of the vehicles' data to the online server, as well as the access to the data outside of the vehicle, though the Internet. The smart charging system proposed in this paper allows the control of the electric vehicle's battery charging current in real time, based on the demand at the residence (home current), which is measured using a residential wireless sensor network (WSN).[4]

[5] Akshaya U Kulkarni; Amit M Potdar (et al), [2019] Target/object detection, recognition, position, movement speed, etc. is easy when the object is near or easily visible. But, the same doesn't stand true especially when the object is far or not visible due to so many factors like weather conditions, day/night cycle, etc. Therefore, Radio Detection and Ranging (RADAR) was invented, which uses radio waves to determine the range, angle, or velocity of objects. But, it uses long time to detect, has short detection range, not target specific because of wide range, oversensitive, costly, etc.[5]

III. PROPOSED SYSTEM

The proposed system is designed to overcome the drawbacks which were found in the existing system. In the projected system the GPS is utilized to accomplish speed monitoring, to remotely access the vehicle location and alert the owner with GSM in case of theft. The smart electric bike is equipped with obstacle detector which triggers the UI of mobile application to intimate the driver about the vehicles in the blind spot of the electric bike and helps the driver to have a safe journey. The mobile application can provides great assistance while driving on the road by delivering proper local information, enhancing the navigation with right direction, informs about traffic, alerts the driver at odd scenario and maintains the vehicles stats.

IV. IMPLEMENTATION DETAILS

In the development of this proposed project the following hardware and software components are required.

1) Hardware Requirements

A. Arduino – Atmega2560 Microcontroller

The embedded system of the proposed project is controlled using the ATMega2560 microcontroller. The ATMega2560 is mainly selected for it's four UARTs (hardware serial ports), 54 digital input/output pins and processing speed thus satisfying the proposed system requirements. The first serial communication port TX1 & RX1 are interfaced with GPS, second serial communication port TX2 & RX2 are interfaced with GPRS/GSM and third serial communication port TX3 & RX3 are interfaced with Bluetooth. The obstacle detection is implemented by ultrasonic sensor through pin 9 and pin 10. A software program to control them is written in C++ programming language, compiled and then saved into the microcontroller's flash memory.

B. GPS module – u-blox NEO-6M

The Global Positioning System (GPS) is a satellite-based navigation system made up of at least 24 satellites. GPS is destined to work in any weather conditions, anywhere in the world, 24 hours a day, with no subscription fees or setup charges. GPS satellites revolve the Earth twice a day in a precise orbit. Each satellite transmits a unique signal. The orbital parameter allows GPS devices to decode and compute the precise location of the satellite. GPS receivers use this information and trilateration technique to calculate a user's exact location.

In the projected system the GPS is utilized to accomplish speed monitoring, to remotely access the vehicle location and to extract subtle details like date and time using a library called TinyGPS++ which decodes the received GPS signal in the microcontroller.

C. GPRS/GSM module – SIM800A

The SIM800A is a Quad-Band, GSM/GPRS Module with RS232 Interface. It is a complete Quad-band GSM/GPRS solution in an LGA (Land grid array) type which can be embedded in the customer applications to establish communication. SIM800A support Quad-band 850/900/1800/1900 MHz, it can transmit Voice, SMS and data information with utmost efficiency. With a tiny size of 100 x 53 x 15 mm, it can fit into slim and compact demands of custom design. Featuring and Embedded AT, it allows being cost effective and fast time-to-market for customer

applications. SIM800A integrates TCP/IP protocol and extended TCP/IP AT commands which are very useful for data transfer applications, thus improving communication.

The theft alert system is accomplished in the project by interfacing GPS and GPRS/GSM with the microcontroller. An SMS containing the coordinates of the bike's location appended with Google maps accessible link is received on request thus making it easy to track the location using maps.

D. *Bluetooth Module - HC-05*

The communication between the vehicle and the mobile application, to display the processed data and to log the information into cloud is established using Bluetooth. Bluetooth protocol is an affordable communication method in PAN network, with a maximum data rate of 1Mb/S, working in a nominal range of 100 meters using 2.4 G frequency is a common way of wireless communicating. The connection established, can be point-to-point or multi-point where the maximum range is 10 meters. HC05 module is a Bluetooth module which establishes serial communication and mostly used in electronics projects. It is an IEEE 802.15.1 standardized protocol, through which one can establish a wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data in free space.

E. Ultrasonic Sensor – HC- SR04

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm and effectual angle is < 15°. A 5V power supply is used to power it. The modules comprises of a ultrasonic transmitters, receiver and control circuit. To achieve obstacle detection in the proposed project ultrasonic sensor is used. Ultrasonic sensors use sound waves to detect objects. Generally, ultrasonic sensors detect objects and measure distance by listening for the return echo of an emitted sound wave reflecting off of a target or background condition. In this system an obstacle found at the proximity below 3m distance is notified. On detecting an obstacle using ultrasonic sensor, intimation is given to the rider's digital dashboard stating the presence of the obstacle through Bluetooth.

2) Software Requirements

A. *Ionic Framework*

Ionic Framework is an open source UI tool for building high performance, high-quality mobile and desktop apps using web technologies — HTML, CSS, and JavaScript with integrations for popular frameworks like Angular and React. Ionic Framework focuses on the frontend UX and UI of an app — UI controls, interactions, gestures, animations.

B. Node.JS

Node.js is a platform built on Chrome's JavaScript runtime for easily building fast and easily scalable applications. Node.js uses a non-blocking I/O, event-driven model, which makes it lightweight and efficient. It is suitable for data-intensive real-time applications that run across distributed devices.

C. Apache Cordova

Apache Cordova is an open source framework, which lets the web developers to use their JavaScript, HTML and CSS content to create a native application for a variety of mobile platforms. Cordova takes the web application and renders it within a native Web View. A Web View is an application component (like a button or a tab bar) that is used to display web content within a native application.

D. Visual Studio Code

Visual Studio Code is a source-code editor. It was developed by Microsoft for Windows, Linux and macOS. It comprises of support for debugging, embedded Git control and GitHub, syntax highlighting, intelligent code completion and code refactoring. It is easily customizable, allowing users to change the theme, keyboard shortcuts, preferences, and install extensions that add additional functionality.

E. Git Bash

Command Prompt is a command line interpreter application available in all Windows operating systems. It's used to execute entered commands. These commands automate tasks via scripts and batch files, perform advanced administrative functions, troubleshoot or solve different kinds of Windows issues. Command Prompt is legally called Windows Command Processor, but it is also sometimes referred to as the command shell or cmd prompt, or even by its filename, cmd.exe.

F. Arduino IDE

Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino microcontroller. It is an official Arduino software, which makes code compilation too easy that even layman with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with an inbuilt functions and commands

that play a vital role for debugging, editing and compiling the code in the environment.

V. MODULE DESCRIPTION

A. Hybrid Mobile Application

The crucial part of the software side is the Hybrid mobile application which deals with vehicle telematics. Since it is hybrid, the application can be deployed in any mobile operating system thus making it cross-platform. The application is designed in such a way that it can assist the rider with navigation instruction using Google maps, intimation of the charge level of the battery, able to transform into digital dashboard and presentation of vehicle stats for future reference and analysis. The application is accessible only for the registered user after successfully completing the authentication. It is designed to be user-friendly with rich UI features and appreciable UX using Ionic framework. The development phase of the application is made easy because of the use of well-known web development languages the HTML, CSS and JavaScript. The application consists a home page, register page, log in page and a tabs page with user's profile and three tabs with unique functionalities namely, the navigation tab, dashboard tab and a settings tab. Finally this cross platform application is converted into APK file which is later on installed in the User's mobile phone.

B. Cloud Module

Firebase cloud storage is an efficient, quick, and cost-effective object storage service designed to scale the project. In the proposed project firebase cloud storage is used for authenticating user for logging in and to store vehicle telematics which can be referred by the user in future to extract some useful data for improvising the way of driving.

VI. SYSTEM DESIGN AND SPECIFICATION

The specifications that transform an electric bike into a smart one are Global Positioning System (GPS), General Packet Radio Service/Global System for Mobile Communication (GPRS/GSM), Bluetooth connectivity, obstacle detection and vehicle friendly mobile application. In the project GPS is utilized to accomplish speed monitoring, to remotely access the vehicle location and alert the owner with GSM in case of theft.The smart electric bike is equipped with obstacle detector which triggers the UI of mobile application to intimate the driver about the vehicles in the blind spot of the electric bike.The mobile application can provides great assistance while driving on the road by delivering proper local information, enhancing the navigation with right direction, informs about traffic, alerts the driver at odd scenario and maintains the vehicles stats.

The outcome of the proposed project is divided into two sections, the input side and the output side. The input side consists of the hardware setup that is cased in the front panel of the electric bike. The output side is the hybrid mobile application that runs in a digital device. This digital device acts as the dashboard in the smart electric bike, therefore replacing the analog dashboard with digital dashboard acting as an interactive UI.

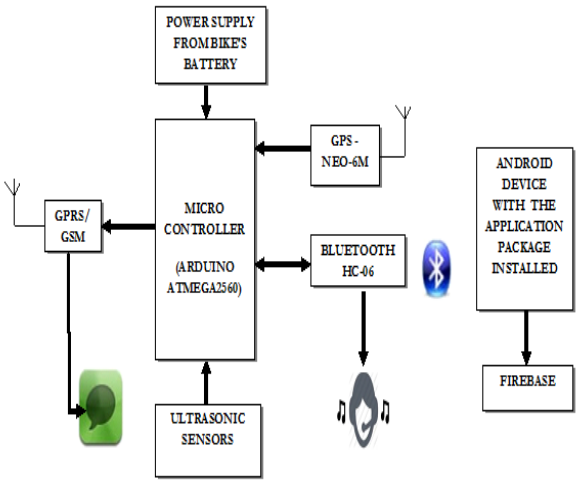

Fig. 1. Block Diagram

The hardware side performs various functionalities like, obstacle detection through ultrasonic sensor, speed monitoring and location input for navigation system through GPS and GPRS works in combination with GPS to alert the owner in case of theft with the location tracking functionality. The Bluetooth bridges the gap by providing the connectivity between the hardware side and mobile application by logging the collected real time data from sensors to the rider viewable digital dashboard.

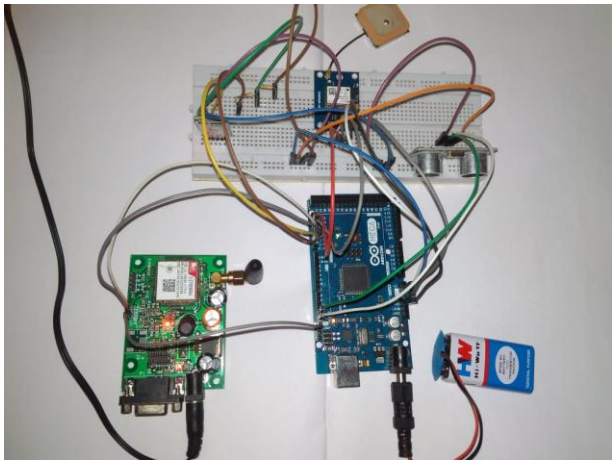

Fig. 2. Hardware Setup

The personalized mobile application acts as the output side with an interactive UI. The application is user authenticated therefore it is highly secure. It can provide you with great assistance while you are driving on the road by delivering proper local information, enhancing the navigation with right direction, inform about traffic, alert the driver at odd scenario and maintain the vehicles stats.

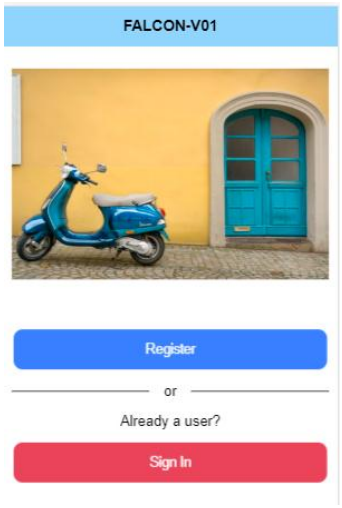

Fig. 3. Home Page

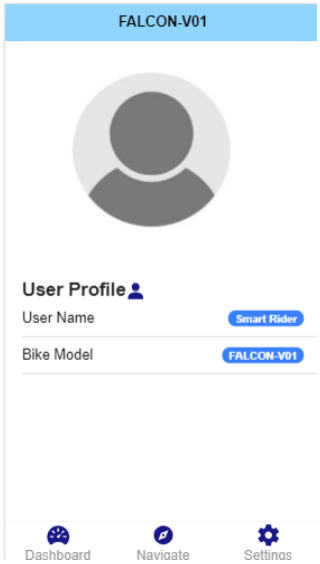

Fig. 4. User Profile Page with Tabs Menu

VII. CONCLUSION AND FUTURE ENHANCEMENT

The way people commute can be drastically enhanced on incorporating this system in an electric bike. The stated hardware setup is completely fabricated into a PCB using the generated gerber file of the proposed system, thus making it a compact device which can be mounted in the electric bike. The hardware setup is powered from the vehicles battery. The power extracted is given to a voltage regulator to bring down the voltage to 5V and 12V which is the operating voltage of microcontroller and separately powered GPRS/GSM. As an alternative power generated from dynamo can be used effectively to power the hardware setup. On the whole the owner of the bike is assured of his safety by the presence of obstacle detection and speed monitoring, bike's security by the presence of theft alert system, a user friendly mobile application to keep track of the vehicle telematics and super assistive navigation system.

In future the system can be further upgraded with a parking assist system to make parking in tight spots very easy.

A traffic sign Recognition system can be developed as traffic signs assist the drivers to drive more carefully and professionally. It instantly assists drivers in detecting and recognizing traffic signs effectively.

The mobile application can be further improved with rich UI & UX features, customizable reminders and notification and analyzed data of the bike's usage to help the owners stay informed.

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