Regenerative Electric Bike With Cloud Connect Feature

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Abstract- *A government of India has launched "MISSION EV" to make all the vehicles electric as soon as possible. However the major drawback faced by the automobile manufacturers and government is the hurdle of battery life and setting up of charging stations. The proposed paper discusses with the concept of electric bike with regenerative system to maximize the battery life. The proposed concept involves development of electric bike with regenerative system which charges the battery when the vehicle moves using the generator connected to the front wheel of the electric bike. The proposed concept also involves smart intermittent triggering system to save the battery life, which monitors the state of the electric bike as well as its inertia and silently switches off the motor at regular intervals thereby saving the battery life or maximizing the battery life. Additionally, the electric bike is made smart by implementation of cloud connect, a feature to monitor the health and other parameters of the electric bike and send it to the cloud based application. This will help analyze the e-bike well in advance before breakdown and reduce the breakdown maintenance time. In addition it can also help to notify the concerned authorities automatically in case of emergency such as accidents using inbuilt GPS.*

Keywords- Regeneration, intermittent triggering, battery life, inertia, smart, cloud connect, GPS.

I. INTRODUCTION

A large number of travelling vehicles has increased the problems such as air pollution, noise pollution and to the use of petroleum. The human sensibility and awareness for the energetic and environmental problem is encouraging the research in alternative solutions for the automotive field, as multiple-fueling, hybridization and electrification. At the same time the systems are modified considering the current problems. For this the solution is the electrically assisted as well as hybrid bikes. The electrically assisted bikes are normally powered by rechargeable battery, and their driving performance is influenced by battery capacity, motor power, road types, operation weight, control, and particularly, by the management of the assisted power. The activity carried out on a prototype of an innovative power-assisted bike, a pedelec characterized by an innovative layout of the electrical assistance and a new low cost measurement system of the total driving torque (rider torque + electrical motor torque).

The charging stations are being setup up, but the charging time required is another major hurdle which makes it difficult for complete transition to EVs. Thus the focus should be on increasing or boosting battery backup as this is the only available solution at present time to implement EVs on large scale .Heavy weight due to the batteries also the problem of electric vehicles so it powered by a lithium-ion battery pack used for utility of wheel traction [1-7].

Most of the new electric bike uses sensor less power assists which improves work ability of the bike .The study to investigate the factors affecting the travel time and frequency of e-bike trip. This study has the potential to contribute to the field of e-bike travel demand modeling by investigation of contributing factors, effect of acceleration This study fills the knowledge gap in understanding the variable affecting the e-bike trip travel time and frequency as well as the in e-bike usage pattern [9-11].

The power plays a major deciding criterion in the real world wide scale implementation of the electric vehicles. With limited and constrained battery backup it is very difficult to achieve the complete transition from gasoline based vehicles to electric vehicles. In case of solar photovoltaic electricity generation characteristics, location characteristics, load demand, meteorological data, and economical data are utilized as contribution for the improvement of solar photovoltaic energy. Solar photovoltaic hybrid system with electrical charging method is also known as solar photovoltaic model. Hybrid system synchronizes with grid utilization, solar photovoltaic generator, and battery charger [12-15]. A conversion of hybrid electric vehicle into plug in hybrid electric vehicle is beneficial for all driving factors. By using this conversion type power can drawn from the grid but some critics are there regarding of power utility. In general, there exist various un-measurable uncertainties and disturbances in dynamic systems. A disturbance observer (DOB) is widely used to make the control system robust against those model uncertainties and disturbances. It is used for realizing robust control by removing the estimated disturbances [16-20].System based design and architecture for portable key, which communicates with an electric bike and implementation so that vehicle user can access all the data regarding of vehicles [21-24].

The paper discusses the concept of electric bike with cloud connect for emergency safety. The bike is also designed in such a way that regeneration of power occurs from front wheels with intermittent triggering. And the vehicle is connected to cloud, using IoT protocols to send the real time vehicle parameters to the cloud.

II. WHAT IS E-BIKE?

This is a bike which is driven with the help of battery which is coupled to electric motor.

The principle responsible for working is that the electromotive force of an A.C. motor which receives electrical energy from a D.C. battery, which is converted with the help of D.C. to A.C. converter.

The motivation of prime mover the chemical reaction takes place from which an energizing current is produced which is responsible for the working. The working medium contains Sulphuric acid which is separated into columns of positively charged H+ ions and negatively charged SO4- ions when both are mixed with water (i.e. H2O). If the poles of the cell are connected by a load, the flow of the electrons is from negative side to positive side. A bivalent positively charged lead is produced from neutral lead which combines with bivalent negatively charged of SO4- ion to form Lead Sulphate. This result is because of scarcity of electrons at negative side. Through the electron supply a bivalent positive lead is produced at positive side from quadravalent positive lead. A combination of SO4- comes into formation thereby ruling the combination of O2 which leads to formation of PbSO4. The atoms of oxygen and hydrogen from electrolyte are released together and they combine to form water responsible for decreasing the density of battery acid.

A DC waveform is obtained sinusoidal because of operational transistorized D.C. to A.C. amplifying circuit by switching the electric energy in the form of electric current which flows from battery to D.C. to A.C. converter circuit. By using amplifier circuit the small A.C. current is amplified again. In order to drive the circuit through the condenser, the amplified current is fed in the stator winding of the A.C. motor. The condenser used acts as a storehouse of electrical energy and it delivers energy at the time of requirement. The sprocket wheel installed on motor shaft is driven by the motive power of the electric energy. The rear sprocket wheel rotates by the chain drive mechanism on which the other two remaining sprocket wheels are installed. The wheel is driven by the rear wheel installed on the rear sprocket. Thus the electric bike is mobilized by using electric power.

Electric bike having following advantages and some disadvantages - 1. Better for the environment. 2.Electricity is less expensive than other petroleum. 3.Less maintenance at lower cost. 4. E-bike tend to be quiet. 5.Potential for tax credit. And there are some disadvantages also 1. Short ranges for driving .2.Changing takes a lot of time than other petroleum refill. 3. Charging stations are not available .4. Initial investment is steep.

III. PROPOSED METHOD

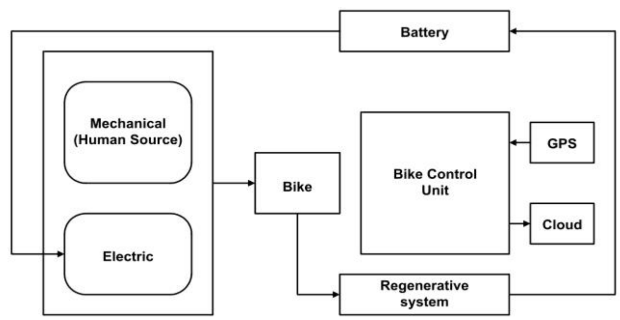

Fig.3-Block diagram of E-vehicle with regenerative system

As shown in the block diagram, it consists of the concept of regenerative electric charging with cloud connectivity. Also it is consists of development of an electric bike which can be powered by two sources, human energy as well as electric energy. The Innovation is done in the way the bike manages to help boost the battery back up by monitoring the current state of the bike using MEMS (Micro Electro Mechanical System) sensors. The bike control unit will monitor the inertia of the bike using the IMU (Inertial Measurement Unit) and when the bike has sufficient inertia, intermittent triggering system will be activated which will just keep the bike running without using continuous power from the battery. This helps to achieve better battery backup and hence longer range. Further regenerative charging system is implemented which will continuously charge the battery which the bike is in motion. The bike control unit is also interfaced to the cloud connect system which sends the bike health stats to the cloud and can receive immediate help during breakdowns.

Energy Regeneration System:

In this project the energy regeneration system is implemented. The major problem associated with the electrical vehicles is the limited battery range. The battery range can be extended by using inertia intermittent triggering system which is already implemented in our project .This adds the battery backup. Also project implements the regenerative energy generation system. For this purpose added a generator in the front wheel of the vehicle and the battery is connected to the generator using the charging circuit. When the vehicle is moving, the energy of the rear tire is used to drive the vehicle. The front axle wheel is connected to another hub motor which acts as a generator which is used for generating the energy or part of the energy lost in moving the vehicle and the same it is used to charge the battery. This way the vehicle not only uses inertia intermittent triggering system to boost the battery backup but also uses the regenerative system to recover a part of the energy.

IV. DESIGN CALCULATIONS

Speed and Regeneration Calculations-

The total power (P total) required to drive the bicycle is given by the sum of power required to overcome the oppose caused by the air (P drag), the power required to overcome the slope of ground (P hill), and the power required to overcome the friction (P friction).

P total= P drag + P hill+ P friction
P hill = 9.81 × G × Vg × m,
P friction = 9.81 × m × Rc × Vg.

Where , G is Slope Gradient ,Vg is speed or surface velocity , m is mass or the total load of the vehicle and Rc: rolling coefficient. Different materials have different rolling coefficient.

The three cases that can be distinguished according to Wilsons Bicycle Science correspond to the following riding conditions:

Case 1: At speed greater than 3 m/s, the majority of the power required to overcome the air drag. For flat ground and high speed: P drag , P hill = 0, P drag > P friction

Case 2: At speed less than 3 m/s and at level surface, the majority of the power is used to overcome the rolling resistance. For flat ground and low speed: P friction , P hill = 0, P friction > P drag

Case 3: For higher slope, the power required to overcome air drag and rolling resistance is small when it is compared with the power required to overcome the lower slope. For hilly ground and low speed: P hill , P hill > P drag , P hill > P friction

ii) Battery Calculation:

The selected batteries are 3 of 12V, 35AH batteries. Three Batteries are connected in series to make a 36 V system which supplying power the motor and power rating , P=VI

Therefore the range or backup of the battery nominal is given by, battery backup=3.6 hrs Consider a constant speed of 25km/hr.The system has a working range of approx.range in kms: 90 Kms on single charge

iii) Motor Selection:

Considering internal Gearing ratio of 11 so power is approximately 373 Watt.

Table 1- Data calculation

Battery calculation- P=VI	P=36*35= 1260 Watt	**Battery Backup=** Total power / Motor power	Battery backup=1260/ 350 =3.6 hr.
Off time =Percentage of off time * Battery backup time	Off time =0.3*3.6 = 1.02 hr	**Total battery backup** = Actual backup of battery+ off time battery backup	Total battery backup = 3.6+1.08 =4.68 hr
Weight of system =Weight of the person + Weight of the structural components.	Weight of system = W=70kg +30kg =100kg	Total Force = F=9.81*W	F=9.18*100 F=981 N
Motor torque = Force * radius	T =981*400 T=392400 N-mm T=392.40 0 Nm	Motor selection- Power of the motor= 2πNT / 60	P = (2*3.14*100*3 92.4)/60 P=4107.12 W

BLDC motor speed controller-

Specifications

Voltage-48V
Wattage-48V,350W
Throttle-1-4V
Short voltage protect- 31.5±0.5V/42±0.5V
Dimension-105x65x32mm/4.13x2.56x1.26
Casing material - Aluminum

Dimensions of bike –

The mechanical structure and dimensions of bike is as shown in following line diagram.

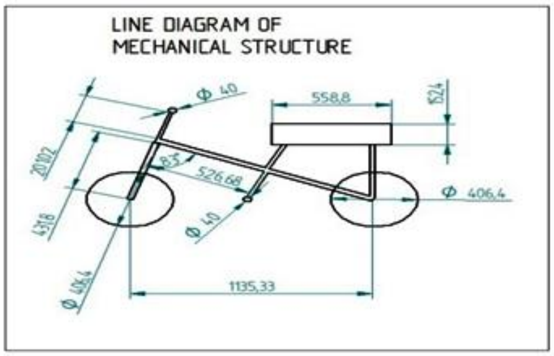

Fig.4- Mechanical structure of E - bike

V. HARDWARE, SOFTWARE AND ASSEMBLY

The complete assembly is shown in the image below. As shown it consists of developed electric bike with cloud connect. The front wheels generate the power when the bike is in motion and charge the battery. The rear wheels are used to power the bike. The cloud connect system connects to the cloud based portal to upload the bike data to the cloud. The Inertia intermittent triggering system monitors the inertia and switches the same to boot the battery backup.

Fig.5- Implemented System

The hardware schematics are given below ,

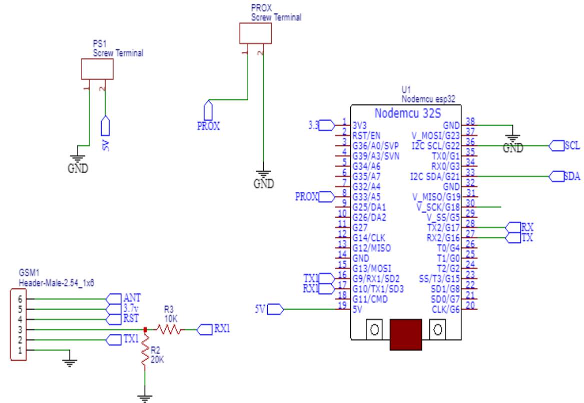

Fig.6- Hardware schematic (a)

In fig 6, power supply of 5V is given. PROX screw terminal is used for the speed measurement. Nodemcu 32S is the is duel core 32- bit processor with built-in 2.4 GHz Wi-Fi and Bluetooth . It has 4MByte flash memory .

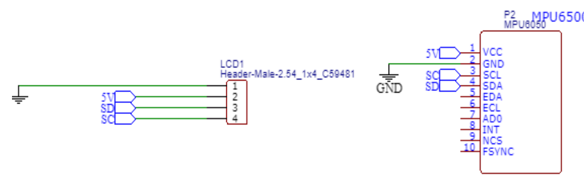

Fig.7- Hardware schematic (b)

In fig.7, LCD is of 16X2 and powered with 5V. MCU is the compact microcontroller having dual core 32-bit processor with built-in 2.4 GHz Wi-Fi and Bluetooth . And having 4 Mbyte flash memory.

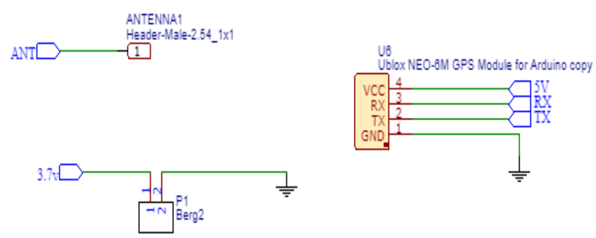

Fig.8- Hardware schematic (c)

In fig. 8, Antenna is of GPS module and power supply is of 3.7 V. Geographical Position System can updates 5 locations in a second with 2.5m horizontal position accuracy.

A following case, taken into consideration while development of the software part of the system.

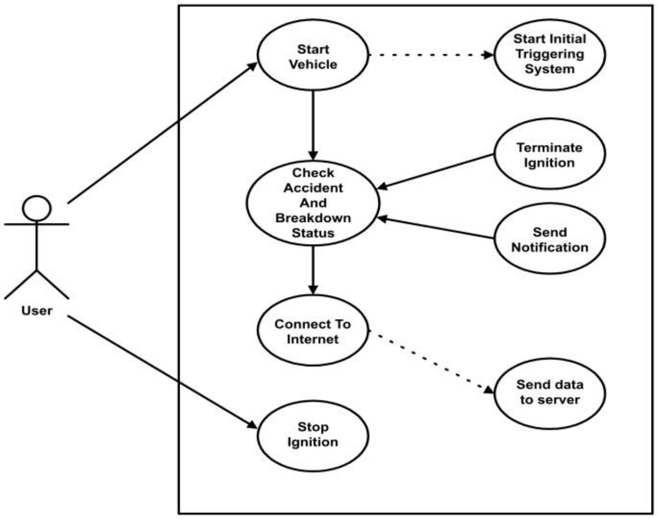

Fig.9-User- system interaction

Above user - system interaction figure plays important role for the new user. From user - system interaction figure , user can understands how user should interact with the system.

The cloud application is developed using HTML, bootstrap and PHP. This fetches the real-time data from the bike and displays on the IoT based application. The system is hosted on cloud server and can be accessed from anywhere in the world over internet.

The snapshot below shows the developed cloud system.

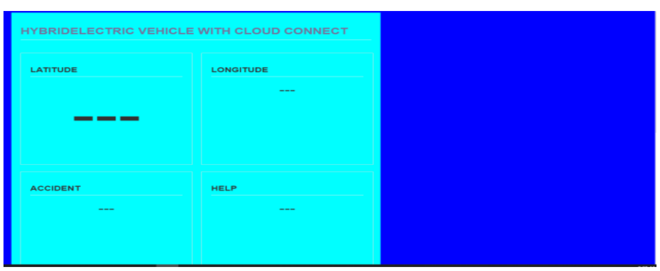

Fig.10- Developed Cloud Software

In case of emergency, accurate geographical position got in the form of latitude and longitude . Total number of accident count automatically counted in accident. And bike gets help as per situation.

The figure below shows the flow chart of the working logic of the system.

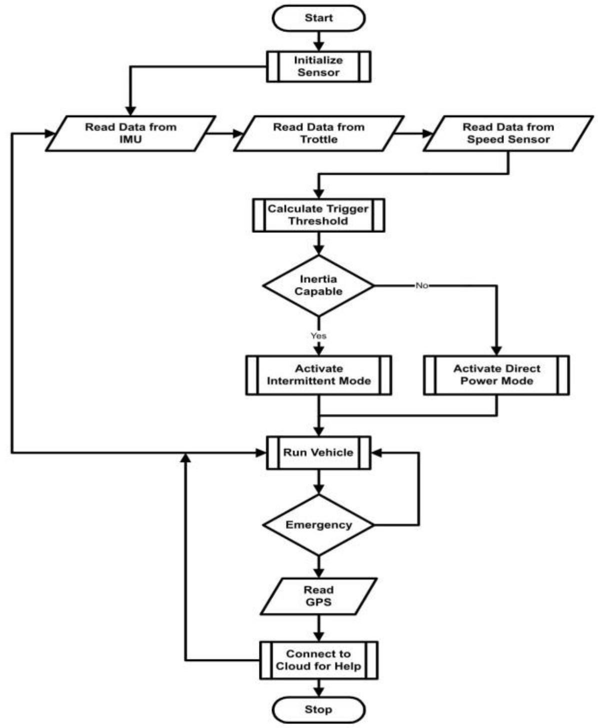

Fig.11- Flow Chart

Step 1- It is starting of system.
Step 2- After the starting of system all sensors gets initialized (i.e. inertia unit, speed sensor).
Step 3- Then the primary task is calculations of inertia by taking readings from IMU.
Step 4- Throttle is directly proportion to the acceleration . In this controller takes reading from the IMU (e.g. throttle= 0 means vehicle has zero speed and throttle = 0.5 means vehicle has 50% of total speed.
Step 5- Read data from speed sensor .
Step 6- In this triggered threshold and threshold set value of this system is 35-38 km/hr .
Step 7- In inertia capability , checks whether inertia is capable to take supply from the wheel then it activate intermittent mode or not capable then the battery provides the supply by activation of power mode.
Step 8- After this all data collection bike runs.
Step 9- Now in running condition, emergency cases occurs , vehicle stops and read location by GPS.
Step 10- And by using cloud connectivity it sends message to the provided phone number. .

This is all the algorithm step by step process which user should be known.

VI. RESULTS

The following tabular shows the results conducted on the test of the entire system.

Table 2 -Software Results

Sr.no	Parameter	Description	Value
1	Emergency Support	Maximum time for support to arrive using IoT system when triggered	4 seconds
2	GPS Accuracy	7 Satellites Lock	5 mtrs
3	GPS Accuracy	>10 Satellites Lock	2 mtrs
4	GPS Accuracy	< 6 Satellites Lock	No /weak signal
5	SMS Notification Time	Time to Get an SMS notification	<10seconds based on network

The system was observed for different reading and the data was recorded. The table below shows the efficiency of IoT system.

Table 3- Internet of Thing data

Data	Data set	Readings actually Recorded	Efficiency
Latitude	50	50	100
Longitude	50	50	100
Accident	20	20	100
Help	20	20	100

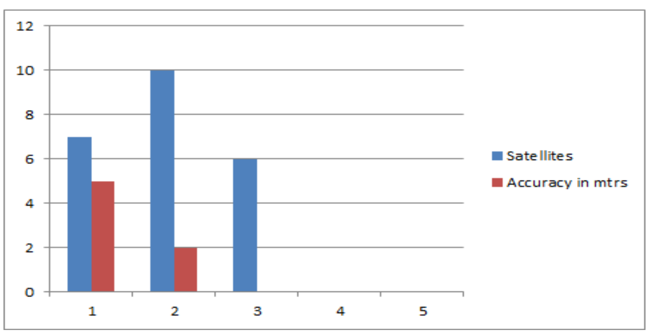

Fig.12- Satellite reading Vs actual distance-

As we can see there is no any reading lost and data was effectively delivered to the server hence reliability of the system. The system was also monitored for network related issues for 8 minutes and the results are shown below. The system was monitored for 8 minutes taking 50 sets of readings and the following was observed ,

Table 4 – Observed reading from server

No of Readings	Time interval	Total time of observation
50	10 sec	8.3 mins
Readings recorded by server	**Readings expected**	**Efficiency**
48	50	96%

From the above table we can conclude that the readings are being triggered to server reach at 96 percent. There was loss of 2 readings every 50 readings recorded. However this loss is due to the network problem . Therefore the system is expected to work at 96 percent.

Table 4 – Reading of bike

Load	Km/hr
Without load	50-55 km/hr
With load (one person of 67kg)	40 km/hr

Above table gives the reading of bike.Without load, reading of bike is within 50 to 55 km/hr and if person upto of 65kg driving ,then reading of bike is approximately 40 km/hr.

VII. CONCLUSION

The paper discusses with the unique concept of electric bike with cloud connectivity. The bike is regenerative in nature which can help the boost up of battery backup and provided extended range. The bike also implements innovative concept of inertia intermittent triggering system which will cut of the bike power when not required providing extended backup. The cloud connect system helps bike to keep connected to the cloud and solve the problems which may arise when the vehicle breaks down. Thus proposed concept provides complete solution to the problems faced by the implementation of EVS.

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