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DESIGN AND FABRICATION OF BATTERY COOLING SYSTEM IN ELECTRIC TWO-WHEELER

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ABSTRACT

E-vehicles are becoming increasingly important in transportation as technology advances. Cars and bikes are the two types of electric vehicles. When compared to vehicles, e-bikes coshornfront several challenges. The main disadvantage of an E-bike is battery heating while charging and in use. This can be decreased by adding heat-absorbing materials such as lead, graphite, and air to cool the battery. The heat created by the battery is absorbed by absorption materials, and ambient air is also fed into the battery chamber, and an exhaust fan pulls the hot air from the battery chamber, reducing the heat of the battery. It will extend the battery's life and reduce battery burns. Every kilometre of running, the temperature of the battery is monitored and recorded. Deep learning processes capture this data. The Internet of Things principles are applied in the E-bike, and the battery temperature is checked every second using a Smartphone to establish understanding and communication between the user and product.

Keywords: E-Vehicle, Battery, IOT, Two-Wheeler

I. INTRODUCTION

The E-bike is quite popular among the general public. Electric bikes are continuing growing around the country in this century, where industrial 4.0 is playing a critical role. Despite its popularity, it has the most dangerous problem when compared to electric vehicles. The explosion of an electric two-wheeler was caused by overheated batteries in the vehicle. This is caused by continual battery charging and driving large distances during the day without considering battery temperature. In today's evolving technology, everything is linked to IOT (Internet of Things), even smartphones. The ISO is currently working on standardising the 42 V Power. A fuel cell may replace the ICE, however this will not change the working conditions of the battery[1]. An exclusive analysis of EV using CFD found that Parallel configuration with smooth coolant path was the optimum model for higher heat transfer rate, with a Nanoparticle concentration of 0.3% being the optimum. PCM concentration shows good heat transfer, but is costlier[2].To test the thermal response of a Li-ion battery module with air-cooling and Al-fins, a complete design method was carried out. The simulation findings revealed that the PCM's heat dissipation performance was inefficient due to its low thermal conductivity. To address this issue, aluminium fins were added to the existing battery module, and numerical simulations were run to create a stable temperature profile[3].

II. PROBLEM STATEMENT

The main disadvantage of an E-bike is battery heating. The increase in temperature occurs in two areas. The first is when continually charging the battery. The second is operating the battery for an extended period of time without providing cooling time for the battery. The user is unaware of the battery's temperature. This is another reason for battery abuse without the user's knowledge. There is no continuous monitoring of battery technology while in use.

III. DESIGNS

3.1. Battery Compartment

This particular battery holder was designed using the Solid Works Designing Program. The rechargeable battery is contained within this box, which is easily removable. The box is mostly formed of fibre material, with airflow slots on the front and other two sides to allow airflow through the battery, and the back side of the box ventilated with an exhaust fan to evacuate hot air from the battery box. The top of the battery box is removable for battery installation, while the bottom of the battery box is completely sealed with no air leakage.

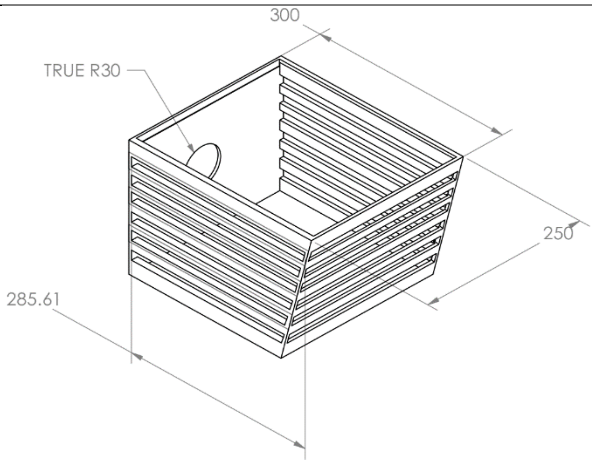

Fig. 1. Design of Battery Compartment.

3.2 Method of Chassis design of a Two Wheeler

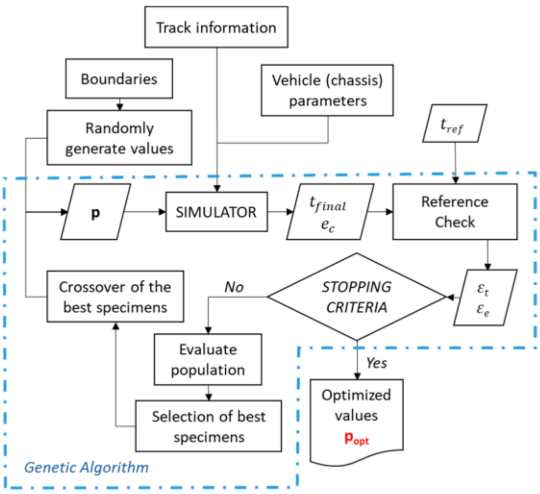

Fig. 2. General flowchart of the proposed methodology.

The broad approach for fine-tuning the chassis of electric cars along any route or group of itineraries. Several parameters of the vehicle and track, such as geometries, inertial values, forces, resistances, grip, and powertrain, have been taken into consideration in an approximate mathematical model. This technique was applied and proven in the optimization of a race vehicle, with the design factors being battery pack mass and gearbox ratio. As compared to typical design approaches, the suggested methodology provides for a 20% weight reduction in the battery pack. Future work should be able to deal with uncertainty in the obtained data and the vehicle's status.[4]

IV. STRUCTURE AND COMPONENTS

4.1 Transmission System

Fig.3. Components used for power transmission

4.1.1 Parts of the Transmission System

- 5M-1350 T-belt
- CNC Aluminum T-belt Drive Pulley
- CNC Aluminum T-belt Rear Wheel Pulley
- Aluminum Belt Tensioner Wheel

In E-two wheeler energy produced from the motor is transmitted to the rear wheel by using chain transmission. Highly efficient chain drives give the advantage of more power compared to belts. It can be applied to centre distances of various sizes. Chain drives have low maintenance cost. With up to 98 percent efficiency, they provide high transmission. Between 0.8 and 3 m/s is the sluggish speed at which the conveyor belts move. When the distance between the shaft centres is close, these chains are used for power transfer. The T belt has the benefit of reducing engine torque considerably more gently and smoothly than its chain drive equivalent. When you twist the throttle on a belt-driven motorised bike, there won't be a sharp tug; instead, the bike will accelerate smoothly. No more noisy metal chains. When in use, the belt-driven design makes relatively little noise. When compared to chain-driven designs, T-belts also require far less maintenance, such as lubrication, and do not collect dust or dirt. A 5M-1350 T-belt, a CNC aluminium T-belt drive pulley, a CNC aluminium T-belt rear wheel pulley, and an aluminium belt tensioner wheel are all included in each package (replaces standard chain tensioner wheel) Specs: Push Pulley Dimensions: 39 mm (11-12T sprocket equivalent) Back Wheel Pulley Dimensions: 190mm (50T sprocket equivalent) Type of T-Belt: 5M-1350; Diameter: 1350mm; Number of "Teeth": 270.

4.2. Contactless Temperature Sensor

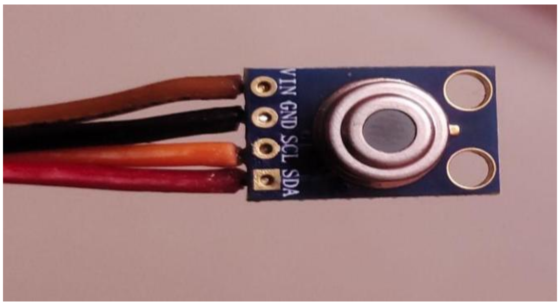

Fig.4. Contactless Temperature Sensor.

Temperature sensors are rapidly gaining popularity as a contactless solution for measuring temperature. With the help of innovative technology, these temperature sensors can accurately record temperatures without any physical contact. Their ability to read temperatures from a distance makes them ideal for applications in healthcare, industrial automation and other areas that require the monitoring of temperatures. It is used for measuring the temperature over the battery without any physical interruption.It detects the accurate thermal expansion of the battery by passing the IR waves. And it converts the received signal to the digital signal and shows on the display by the given temperature units.this sensor having high precision,high accuracy and high resolution.It is faster than other temperature sensors.

4.3 Structure of Sensor Information Transferring

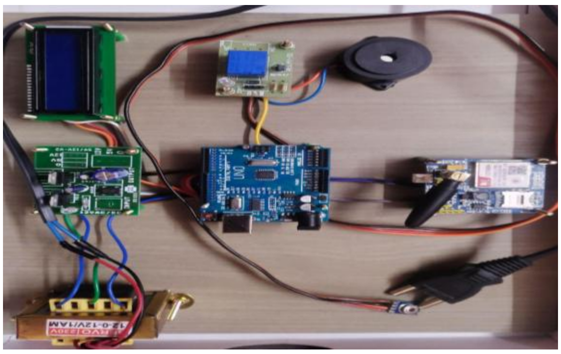

Fig.5. Sensor Information Transferring System

The concept and execution of an Arduino-based smart home warning system are presented in this study. It makes use of multiple suitable sensors, actuators, and GSM as a wireless communication channel to allow users to interact with the proposed system. The experimental findings suggest that a number of undesirable occurrences, such as temperature change may be recognised quickly and information passed to the end user.[5]

- Arduino board

- Atmega328 Microcontroller
- 7-12 V Input Voltage and 6 PWM Out
- 14 Digital I/O pins
- 16 Mhz Clock Signal and 32 kB FlashMemory
- 6 ADC In

- Buzzer

One advantage to an active buzzer is that you can still produce a sound from the buzzer connected to a microcontroller, such as an Arduino, by just driving a standard high output on the connected pin. The benefits of this are that you don't need to use processing power, hardware timers, or additional code to produce sound.

- GSM board

- Compatible with - Arduino STM32 AVR MCU
- Frequency - 850/900/1800/1900 MHz
- Operating Temperature Range - -40°C to +85°C
- SIMCARD - Micro SIM CARD Holder
- Supply Voltage - 5 - 12 V
- Interface Type - TTL level serial Interface

- LCD display

- 16 Characters x 2 Lines
- 5x7 Dot Matrix Character + Cursor
- HD44780 Equivalent LCD Controller/driver Built-In
- 4-bit or 8-bit MPU Interface.

V. FLOW CHART

5.1 Complete Working of Vehicle

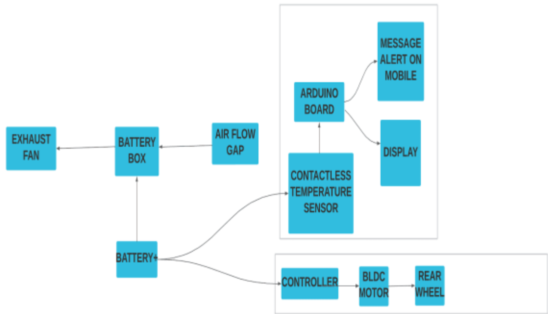

Fig. 6 . Working of Two-Wheeler

The battery used in the E-two wheeler is put within the battery box, which has an air flow gap on the front side of the box and an exhaust fan arrangement on the back side of the box to dissipate the extra heat created over the battery. The contactless temperature sensor is positioned above the battery for heat detection and for the alarm system to the user end. For power transmission, the BLDC motor is connected to the battery via a controller, which is connected to the bike's back wheel via a belt and sprocket.

5.2 Working of Sensor information transferring

The battery of the E-two wheeler is attached to one end of the transformer, and the other end of the transformer is connected to the arduino board, which is connected to the temperature sensor. In addition, the sensor signal is presented on the LCD display. The LED and buzzer system is linked to the arduino board for alarm sound and temperature change indicator. And a GSM module is installed on the board, which sends SMS alerts to the user's mobile phone.

5.3 Working of Power Transmission

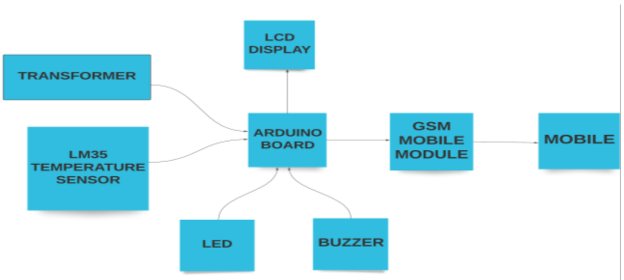

Fig. 7 Working of Sensor information transferring

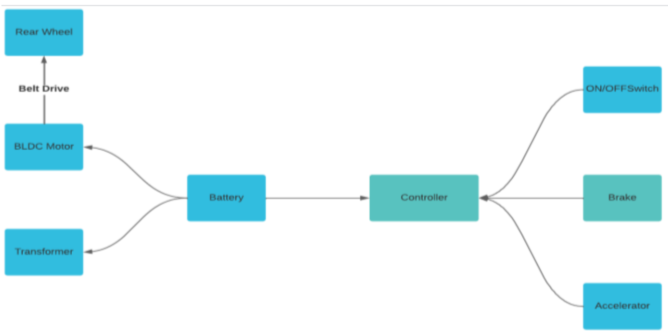

Fig. 8. Working of Power Transmission

In the transfer of power in an electric vehicle, the controller is crucial. The Controller is linked to the transmission's major components. The battery is linked to the controller so that the energy stored in it can be used. The ON/OFF switch in the bike controls the controller. When the accelerator (throttle) is depressed, the signal is sent to the controller, who then sends it to the battery. The battery is then connected to the BLDC motor, and power is supplied to the back wheel via the belt drive, and the bike moves.

VI. RESULT AND ANALYSIS

6.1. Battery Temperature While Charging

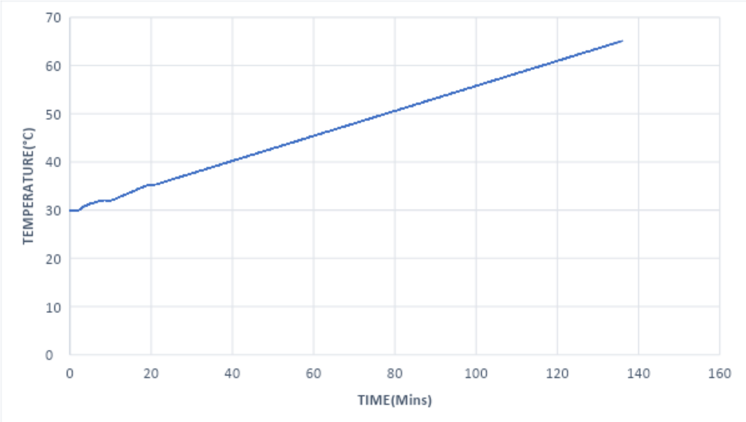

Fig. 9. The temperature variation of battery while Charging (Before implementation of idea)

A number of variables, including the temperature during charging, can affect how effectively electric bikes, commonly referred to as e-bikes, are recharged. The performance, charging speed, and general efficiency of an e-bike battery can all be considerably impacted by the temperature at which it is charged. Although e-bike batteries can be charged in a wide range of temperatures, studies and practical experience indicate that charging e-bike batteries within the temperature range of 10 to 50 degrees Celsius is generally more efficient than charging at other temperatures. A number of variables, including the temperature during charging, can affect how effectively electric bikes, commonly referred to as e-bikes, are recharged. The performance, charging speed, and general efficiency of an e-bike battery can all be considerably impacted by the temperature at which it is charged.Despite the fact that e-bike batteries can be charged in a variety of temperatures, studies and real-world experience indicate that charging e-bike batteries within the range of 10 to 50 degrees Celsius is typically more effective than charging at other temperatures.

In-depth discussion of the benefits of e-bike battery charging at temperatures between 10 and 50 degrees Celsius will be provided in this article. The impact of charging at extreme temperatures, the ideal temperature range for charging, and the best practices for charging e-bike batteries in various temperature ranges will all be covered.

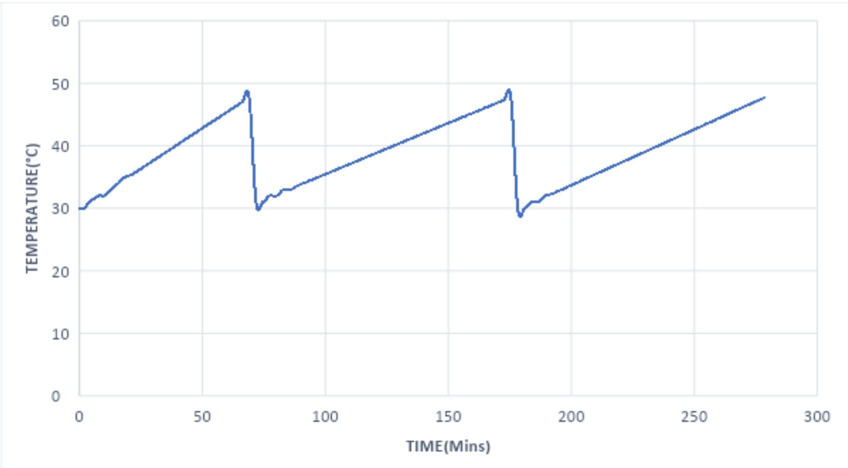

Fig. 10. The temperature variation of battery while Charging

(After implementation of idea)

Understanding the Effects of Temperature on E-Bike Battery Charging

The charging of e-bike batteries is greatly influenced by temperature. The lithium-ion or lithium-polymer chemistry used in most e-bike batteries is well known for being temperature-sensitive. The chemical processes that take place with in-depth discussion of the benefits of e-bike battery charging at temperatures between 10 and 50 degrees Celsius will be provided in this article. The impact of charging at extreme temperatures, the ideal temperature range for charging, and the best practices for charging e-bike batteries in various temperature ranges will all be covered.

1. Optimal Temperature Range for Charging

   The ideal temperature range for charging e-bike batteries is normally between 10 and 50 degrees Celsius, according to research and real-world experience. In this temperature range, compared to charging at temperatures below 10 degrees Celsius or above 50 degrees Celsius, the battery's charge efficiency is often higher.

   The chemical reactions inside the battery slow down at colder temperatures (below 10 degrees Celsius), which reduces charging efficiency. Moreover, the capacity of the battery might be momentarily diminished, and charging might take longer. The capacity and general performance of the battery may be impacted over time by charging at extremely low temperatures because lithium plating may develop on the electrodes of the battery.

   Nevertheless, charging the battery at high temperatures (over 50 degrees Celsius) can potentially shorten its lifespan and decrease its charging effectiveness. The battery may overheat when being charged in high temperatures, increasing internal resistance and possibly harming the battery's cells. High-temperature charging can also speed up the depreciation of the battery, shortening its life and capacity.

2. Impact of Charging at Extreme Temperatures

- The performance and longevity of e-bike batteries can be significantly impacted by charging them outside of their ideal temperature range. Charging at temperatures above or below 10 degrees Celsius can have a number of detrimental impacts, such as:
- Decreased charging efficiency: Charging the battery at temperatures above or below 10 degrees Celsius can cause it to charge less quickly and may leave the battery partially charged.
- Decreased battery capacity: Charging at extremely high or low temperatures might momentarily lower the battery's capacity, reducing its range and performance when riding.
- Deterioration of the battery cells is accelerated by high temperatures while charging, which over time reduces the battery's lifespan and overall performance. The capacity and performance of the battery can also be harmed by lithium plating, which can happen at low temperatures.
- Safety issues: There are safety dangers associated with charging e-bike batteries at extremely high temperatures, such as the possibility of thermal runaway, in which the battery heats up rapidly and may potentially catch fire or explode.

6.2. BATTERY TEMPERATURE WHILE DRIVING

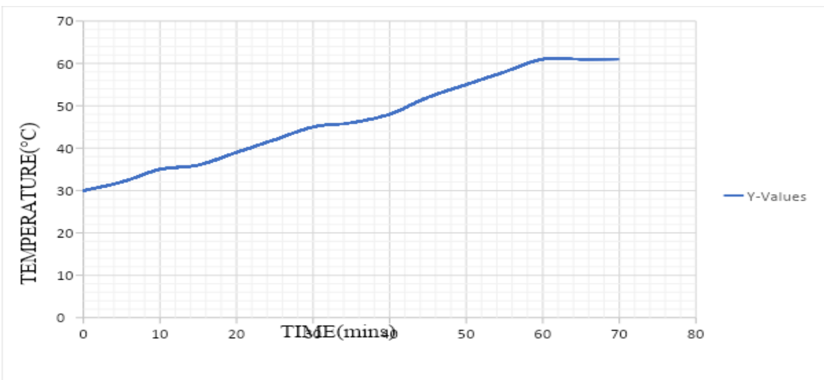

Fig. 11. The temperature variation of battery while driving (Before implementation of idea)

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Due to its eco-friendliness and cost-effective advantages, electric bikes have become increasingly popular as society moves towards more environmentally friendly modes of transportation. Making ensuring that the battery temperature stays within the advised range of 20 to 45 degrees Celsius is an essential part of electric bike maintenance. Let's examine why this temperature range is crucial for an electric bike battery's optimum performance and longevity.

1. Efficiency: Batteries for electric bikes are made to operate at their best in a certain temperature range. The battery can convert more of its stored energy into usable power for the motor when it is run within this range, which leads to improved energy efficiency. Longer rides and longer battery life result from this.
2. Battery Life: Hot and cold extreme weather can shorten the life of an electric bike's battery. The battery can overheat at high temperatures above the advised range, which accelerates the deterioration of the battery cells and lowers capacity and overall performance. On the other hand, extremely cold conditions might lower the battery's capacity overall as well as its capacity to hold a charge. You can reduce the expense of battery replacement by extending the battery's lifespan by keeping its temperature within the specified range.
3. Safety: Riding an electric bicycle with a heated battery can be dangerous. The battery can become unstable due to overheating, raising the possibility of a thermal runaway incident or perhaps a battery fire. The possibility of potential safety risks when riding is thus reduced by maintaining the battery temperature within the prescribed range.
4. Performance: The overall performance of an electric bike is also impacted by battery temperature. When the battery becomes too hot, it might not provide as much power, which would restrict speed and range. On the other side, the battery's functionality may be hampered in cold weather, reducing power and range. The best and most constant operation of the electric bike is ensured by keeping the battery temperature within the advised range.
5. Warranty: The majority of manufacturers of electric bikes offer warranties on their batteries, which frequently include temperature requirements. If you go outside of these temperature ranges, the guarantee might be void, and you'd then be responsible for any battery-related problems or replacement expenses. You can safeguard your warranty and make sure you qualify for any potential battery-related claims by adhering to the advised temperature range.

An electric bike battery will operate best, last the longest, be safest, and have its warranty protected if the temperature is kept within the advised range of 20 to 45 degrees Celsius. It contributes to greater energy efficiency, longer battery life, reliable performance, and a lower chance of safety risks. To get the most out of your electric bike, be sure to adhere to the manufacturer's recommendations for battery temperature management.

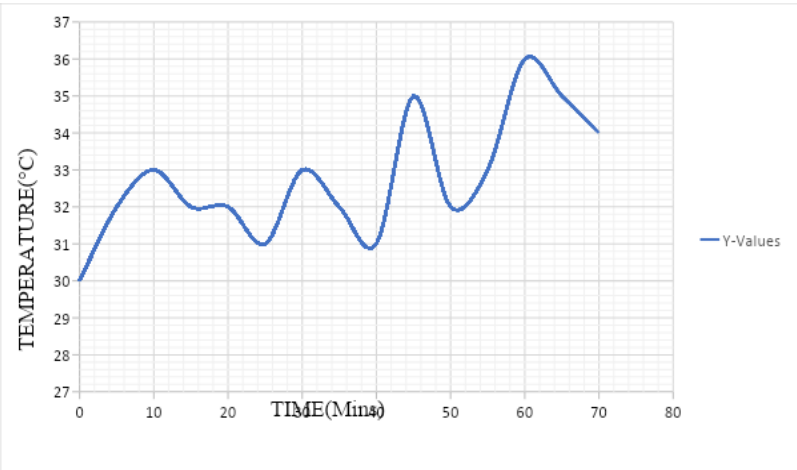

Fig. 12. The temperature variation of battery while driving (After implementation of idea)

Challenges of Managing Battery Temperature in Indian Climate

The difficulties of controlling battery temperature in the hot climate of India The summers in India are frequently hotter than 40 degrees Celsius. Effective cooling systems must be put in place since the intense heat makes it difficult to control the temperature of an e-battery. bike's

1. High Ambient Temperature: During long-distance rides, the battery may heat up quickly due to India's high ambient temperatures, increasing the chance of overheating and performance impairment.
2. High amounts of humidity brought by India's tropical environment can further reduce the efficiency of conventional cooling techniques. Natural convection is less effective in humid environments, which makes it more difficult for heat to escape from batteries.
3. Heat Soak: Heat soak is a condition when the battery temperature keeps increasing long after the e-bike has stopped because of trapped heat inside the battery casing. In hot climates like India, this can further contribute to battery overheating.
4. Restricted Airflow: The airflow surrounding e-bike batteries is frequently restricted by enclosures or compartments, which can hamper heat dissipation. Battery performance may suffer as a result of higher temperatures.
5. Battery Position: An e-battery bike's position has an impact on how well it manages temperature. The risk of overheating is further increased when the battery is frequently put on the downtube or the rear rack, both of which can bicycle exposed to direct sunlight.

VII. CONCLUSION

The implementation of the monitoring system helps in various aspects like battery charging time, efficiency of battery, life of battery and to avoid explosion. By implanting our idea, the charging time can be improved to 11.16% comparing with the traditional charging method. The efficiency of battery usage in electric two-wheeler also increases by 7.87% comparing with the traditional way of consumption of energy and driving the vehicle. Achieving optimal battery performance, extending battery life, and improving charging efficiency may all be achieved with proper temperature maintaining while charging and driving. So impending our idea can be both effective and increases the battery life.

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