JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# DESIGN AND FABRICATION OF SMART ELECTRIC VEHICLE

**[1]SAIRAM T S, [2]ANISH THAVAS B, [3]AKASH C S, [4]RAVI RAJ V.**

[1]*Department of Mechanical Engineering, Sri Sairam Engineering College, Chennai.*
[2]*Department of Mechanical Engineering, Sri Sairam Engineering College, Chennai.*
[3]*Department of Mechanical Engineering, Sri Sairam Engineering College, Chennai.*
[4]*Department of Mechanical Engineering, Sri Sairam Engineering College, Chennai.*

***Abstract :*** The demand for Electric Bikes in India is on the rise due to their potential to reduce air pollution, lower maintenance costs, and decrease noise levels. Structural Analysis plays a crucial role in validating and enhancing designs for Electric Bikes. As the use of batteries to power electric vehicles gains traction, it becomes imperative to mitigate the environmental impact caused by traditional fuel-based vehicles. The emissions from conventional vehicles contribute to global warming and climate change, underscoring the need for eco-friendly alternatives. With the escalating demand for coal and petroleum products, there is a foreseeable increase in the adoption of electric vehicles. An electric bicycle, also known as an e-bike or booster bike, integrates an electric motor for propulsion, offering an efficient and eco-friendly mode of transportation. To further enhance the functionality of e-bikes, an embedded system is proposed, which incorporates features such as calorie measurement, biometric lock security, and GPS tracking. This "smart e-bike" aims to promote a healthier and more sustainable lifestyle while enriching the user experience of bicycling.

***IndexTerms* - Electric Bike, Battery, Motor, Power, Torque, Speed, Solutions , Transportation, Load , Wheel , Climate Change, Environmental Design.**

## I. INTRODUCTION

- Climate change presents a formidable challenge for India. Escalating emissions, particularly in the transportation sector, stand as the most significant barrier to fulfilling our climate change commitments. It's imperative to shift our mindset: rather than viewing future transport provision as part of the emissions problem, it should be recognized as integral to the solution. Carbon emissions from transportation stood at 268 thousand tons in 2008, while nitrogen dioxide emissions from on-road transport reached 2.6 million tons in the same year. These figures are on a relentless upward trajectory, with forecasts indicating a rise to 268 thousand tons and 3.5 million tons, respectively, by 2015.

- To tackle this challenge, we must revolutionize our approach to emissions reduction policies in transportation. This entails fostering a symbiotic relationship between smarter energy generation and passenger car transport, primarily through the adoption of electric vehicles (EVs) charged on the electricity grid. Not only does this strategy offer substantial support for the renewable energy industry, but it also promises a more fuel-efficient, cost-effective, and power-efficient national vehicle fleet that emits zero carbon.

- Beyond the environmental concerns, the continued reliance on imported oil poses significant risks to India's energy security. Currently, India's dependency on imported fuels stands at around 70% (2004) and is projected to surge to 91.6% by 2020. This vulnerability is especially pronounced in the transport sector, which relies on fossil fuels for 99% of its energy needs. While it may seem ambitious, the long-term objective should be to eliminate the importation of fossil fuels for transportation entirely. This can be achieved through the development of innovative methods to power cars and heavier vehicles, thus reducing the nation's reliance on imported fuels to zero

**NOVELITY :**

- In the current landscape, there's a noticeable surge in the popularity of e-bikes, with numerous companies introducing innovative models. Our latest offering introduces a groundbreaking concept: a chain-sprocket-free e-bike design that allows the motor to directly power the wheel. This innovation relies on a uniquely engineered wheel driving mechanism.

- Our system utilizes two DC motors to propel the rear wheel of the bike. These motors are strategically positioned to drive the bike through two high-friction rollers, ensuring efficient power transmission. A similar mechanism, employing dummy bearing rollers, enables freewheel drive for added versatility.

- To enhance the riding experience, this mechanism is now integrated with the bike's main body using suspension shock absorbers. This integration ensures that the main body remains insulated from bumps and vibrations, contributing to a smoother ride. Furthermore, the mechanism is meticulously designed to prevent the wheel from being pressed under top loads while maintaining optimal balance, particularly at higher speeds.

**GOALS:**

1. Conventional vehicles predominantly rely on petrol or diesel as fuel sources.

2. Presently, there is a surge in demand for these fossil fuels.

3. Foreseeably, the cost of these fuels may escalate in the future.

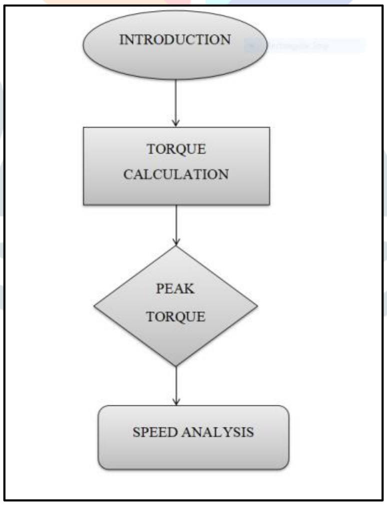
4. Hence, our project aims to develop a smart Electric Vehicle powered by batteries and solar energy, thereby reducing dependence on petrol and fostering renewable energy adoption in our country.

5. Substitution of traditionally fueled vehicles within the target demographic with E-bikes.

6. Promotion of E-bike market penetration.

7. Formulation of policies conducive to broader integration of E-bikes into urban transportation systems.

**DESIGN METHODOLOGY:**




(1.1) **Introduction**

When opting for a motor for the electric bicycle, particularly a Brushless DC motor (BLDC), various techniques need to be employed. These techniques include torque assessment, peak torque demand, RMS torque requirement, and speed spectrum analysis.

(1.2) **Torque Assessment:**

Before employing any motor for the electric bicycle, it is imperative to conduct a thorough torque assessment. This is vital because each motor has its unique torque constraints, which dictate its capability to manage specific loads. Neglecting to evaluate torque requirements could result in the electric bicycle being incapable of movement or only able to do so without any additional load or rider. Therefore, torque assessment plays a pivotal role in selecting a suitable motor for the electric bicycle.

(1.3) **Peak Torque (Tp) Demand:**

Peak torque, also recognized as maximum torque, is a crucial factor in the application. It can be computed by aggregating the load torque (TL), torque necessary for inertia (TJ), and the torque essential to overcome friction (TF). The formula for calculating peak torque is TP = (TL + TJ + TF). The torque due to inertia (TJ) signifies the torque required to accelerate the load from rest or from a lower speed to a higher speed. This can be determined by multiplying the load inertia with the rotor inertia and load acceleration.

(1.4) **Speed Spectrum Analysis:**

The speed spectrum denotes the range of speeds essential to operate the application and is determined by the specific needs of the application. Components capable of managing trapezoidal speed curves can accommodate high operating speeds, ensuring an average speed equivalent to the desired movement speed.
Our revolutionary e-bike concept represents a significant leap forward in electric transportation technology. By bypassing traditional chain sprockets, our design enables direct motor-to-wheel power transmission, resulting in enhanced efficiency and performance.

**PROCESS & BENEFITS OF INNOVATION:**

**CHARGING DURATION:**

Currently, all kick-bikes available in the market are equipped with lithium batteries. Charging time is determined by the formula:

T1 = (AH) * cp / A

Where:
T1: Charging time
AH: Battery capacity
cp: Charging efficiency (typically 90% for lithium batteries)
A: Charging amperage

Determining the charging time is challenging without first establishing the battery capacity. Conversely, we can work backward by setting the desired charging time first. The charging current is then adjusted accordingly; higher currents lead to shorter charging times. Through market analysis, we've identified charging times ranging from a maximum of 10 hours to a minimum of 4 hours, with most falling around 6 hours. To enhance our product's competitiveness, we aim to set the charging time between 4 and 5 hours.

By incorporating the specified charging time and battery capacity into the formula (4h - 5h = 130.9 / A), we can calculate the required charging current. The result indicates that a current between 2.925 A and 2.34 A is optimal for achieving a consistent charging duration of 4 or 5 hours.

**ENVIRONMENTAL ADVANTAGES:**

In contemporary product development, engineers prioritize assessing the environmental impact of their creations. This responsibility is particularly pronounced within the automotive sector. Presently, public consciousness regarding environmental conservation is on the rise. Conventional fossil fuels are gradually diminishing in relevance as the utilization of electric power expands. Motorcycles, once reliant on fossil fuels, are undergoing a transformation. Consequently, numerous companies are dedicating substantial resources to research and development aimed at minimizing carbon emissions. Many of these companies have already introduced or are on the brink of introducing electric vehicles to the market within the coming years.

**MOTOR SELECTION:**

- The electric motor serves as the vital component converting electrical energy from the battery into mechanical power to propel the bike forward. At Grin, our focus is primarily on hub motors due to their versatility and ease of installation. These hub motors are housed within either the front or rear bicycle hub, facilitating a straightforward conversion process where a conventional bike wheel is replaced with a motorized one.

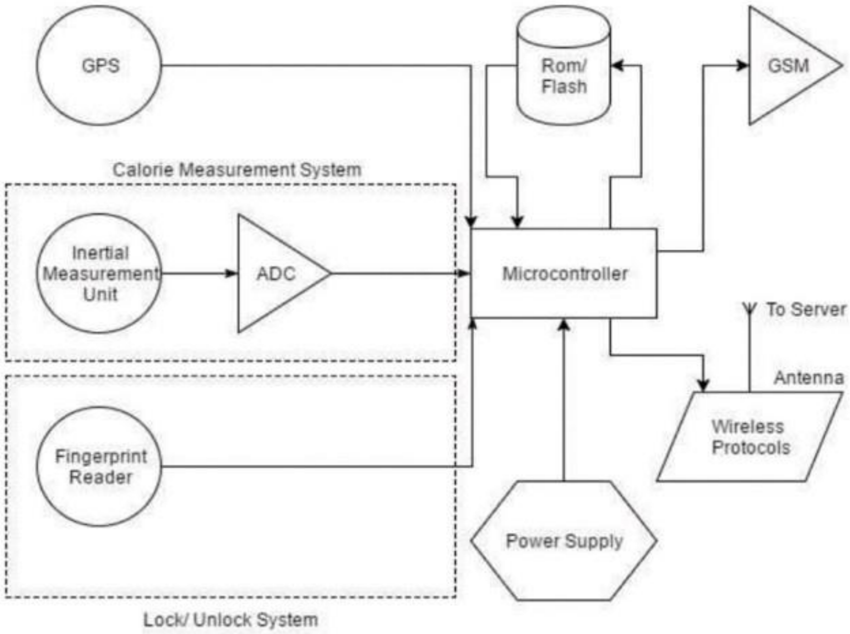
- Most electric bike (ebike) motors available today are permanent magnet Brushless DC (BLDC) motors, featuring three phase wires for supplying motor power. Additionally, they typically incorporate five hall sensor wires, enabling the electronics to accurately determine the motor's position and ensure smooth operation at low speeds. These wires may be organized into separate connectors or integrated into a single plug, incorporating both power and signal wires.

- Hub motors come in various configurations, including geared or direct drive, and range in size and power output. The selection of the optimal motor depends heavily on the intended application. For demanding tasks such as cargo hauling or navigating long steep inclines, larger and heavier motors are preferred, whereas individuals seeking a slight boost on predominantly flat terrain can opt for lighter and more compact motors.

- The key parameter defining a motor's behavior is its winding constant, denoted as Kv (RPM/V). This value indicates the maximum rotational speed of the motor for a given battery voltage, providing insights into the maximum speed at which it can assist a bike. Motor manufacturers often offer the same motor in various winding speeds, allowing for customization based on specific requirements. For instance, if a motor has a winding constant of 10 RPM/V, it would spin at a maximum of 120 RPM with a 12V battery pack, 240 RPM with a 24V battery pack, and 360 RPM with a 36V battery pack.

**FINAL DESIGN MODEL:**

**FLOW DIAGARAM FOR POWER SUPPLY:**




**FUTURE POTENTIAL:**

- With two DC motors strategically positioned to drive the rear wheel using high-friction rollers, our e-bike delivers powerful and smooth acceleration, ensuring an exhilarating riding experience.
- Furthermore, our freewheel drive mechanism, featuring dummy bearing rollers, adds versatility and reliability to the system, allowing for seamless transitions between powered and coasting modes.
- To guarantee rider comfort and stability, we've integrated the mechanism with the bike's main body using advanced suspension shock absorbers. This not only ensures a smooth and comfortable ride over various terrains but also minimizes the impact of bumps and vibrations on the rider.
- Moreover, our design prioritizes safety and stability, with meticulous engineering aimed at preventing wheel compression under heavy loads and maintaining optimal balance at high speeds.
- In summary, our innovative e-bike concept offers a compelling blend of efficiency, performance, versatility, and rider comfort, heralding a new era in electric transportation.

**BENEFITS OF E-BIKES:**

1. Accessibility: E-bikes are easier to ride than traditional bicycles, making them suitable for individuals of all ages and fitness levels.

2. Health Benefits: Riding an e-bike provides a form of low-impact exercise, helping to keep you fit and healthy while reducing the risk of sedentary lifestyle-related health issues.

3. Versatility: Even if the battery runs out, e-bikes can still be pedaled like regular bicycles, ensuring you're never stranded without transportation.

4. Environmentally Friendly: E-bikes offer a clean and eco-friendly mode of transportation, contributing to reduced air pollution and promoting sustainable living.

5. Enhanced Speed: With assistance up to 15.5 miles per hour, e-bikes allow for faster travel compared to conventional bicycles, without requiring significant physical exertion.

6. Extended Range: On a single battery charge, e-bikes can cover distances ranging from 40 to 70 miles, offering ample range for daily commuting or recreational rides.

7. Hill Climbing Capability: E-bikes make it easier to tackle hills and mountains, providing assistance when pedaling uphill and reducing strain on the rider.

8. Fashionable: E-bikes have become increasingly trendy and stylish, appealing to individuals seeking both functionality and aesthetics in their mode of transportation.

**DRAWBACKS OF E-BIKES:**

1. Higher Cost: E-bikes tend to be more expensive upfront compared to traditional bicycles, primarily due to the added electric components and technology.

2. Increased Weight: The integration of batteries and electric motors makes e-bikes heavier than conventional bicycles, which can affect maneuverability and portability.

3. Weight Without Motor Support: When the motor assistance is not engaged or the battery is depleted, e-bikes can feel noticeably heavier and more cumbersome to ride.

4. Theft Risk: E-bikes, particularly higher-end models, are more attractive targets for theft due to their higher resale value and increased desirability.

5. Regulatory Requirements: In some regions, faster e-bikes with higher speeds may need to be registered or comply with additional regulations, adding complexity and potential restrictions for riders.

**CONCLUSION:**

- With the escalating consumption of finite resources like petroleum and diesel, there's a notable shift towards renewable alternatives such as solar, hydroelectric power, and batteries. Various approaches exist for conserving energy, and one such sustainable transportation option is the electric bike. It emerges as a contemporary means of travel, offering convenience and simplicity for individuals of all ages. Moreover, it stands as a cost-effective mode of transport accessible to a wide demographic.

- Equipped with a highly efficient motor and a lightweight, fast-charging battery bank, the electric bike boasts several notable advantages. Foremost among these is its reliance on renewable energy sources, which not only conserves significant amounts of foreign currency but also mitigates environmental harm by eliminating fossil fuel usage. Additionally, its emission-free operation and silent performance contribute to its environmentally friendly profile.

- Utilizing an onboard electric bike emerges as a practical solution for curbing environmental pollution. Moreover, in case of emergencies, it can swiftly be charged using an AC converter, ensuring continued mobility and versatility.

REFERENCE:

1. Daniels M W and Kumar PR (2005), "The Optimal Use of the Solar Power Automobile", Control Systems Magazine, IEEE, Vol. 19,

2. John Connors (2007), "Solar Vehicles and Benefits of the Technology" ICCEP Paper

3. Mangu, R., Prayaga, K., Nadimpally, B. and Nicaise, S. (2010) Design, Development and Optimization of Highly Efficient Solar Cars: Gato Del Sol I-IV Proceedings of 2010 IEEE Green Technologies Conference, Grapevine, 15-16 April 2010, 1-6.

4. Zhang, Yancheng, et al. "Multifunctional structural lithium-ion battery for electric vehicles." *Journal of Intelligent Material Systems and Structures* 28.12 (2017): 1603-1613.

5. Kumar, Manoj, Ashmi Christus AT, and M. Gandhi. "Design and Fabrication of Electric Vehicles with Bluetooth Smart Battery Indication." *American Journal of Engineering, Mechanics and Architecture (2993-2637)* 1.6 (2023): 54-73.

6. Oyetunji, O. R., et al. "Design and fabrication of a pilot scale remote controlled electric car using additive manufacturing approach." *International Journal* 8.7 (2020): 3054-7.

7. Jeon, Deok Hwan, et al. "A lever-type piezoelectric energy harvester with deformation-guiding mechanism for electric vehicle charging station on smart road." *Energy* 218 (2021): 119540.

8. Mirjalili, Seyed Mohammad Amin, Alireza Aslani, and Rahim Zahedi. "Towards sustainable commercial-office buildings: harnessing the power of solar panels, electric vehicles, and smart charging for enhanced energy efficiency and environmental responsibility." *Case Studies in Thermal Engineering* 52 (2023): 103696.

9. Li, Wei, et al. "Intelligent optimization methodology of battery pack for electric vehicles: A multidisciplinary perspective." *International Journal of Energy Research* 44.12 (2020): 9686-9706.

10. Wazeer, Adil, et al. "Composites for electric vehicles and automotive sector: A review." *Green Energy and Intelligent Transportation* 2.1 (2023): 100043.