IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Smart Battery Switching And Regenerative Breaking System For Electric Vehicles With Boost Converter"

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Abstract:

The project Smart Battery Switching and Regenerative Braking System for Electric Vehicles with Boost Converter‖ is designed to enhance the efficiency, performance, and energy recovery capability of electric vehicles (EVs). In this system, two dynamos are mounted on the front wheels to generate electrical energy during vehicle motion and braking. The generated voltage is processed through a charging circuit and stored in Rechargeable Battery Pack-1. A PIC microcontroller continuously monitors the battery voltage, current, and dynamo-generated voltage through sensors and displays these values on an LCD display for real-time monitoring. The system employs an intelligent switching mechanism to automatically alternate between Battery Pack-1 and Battery Pack-2, ensuring uninterrupted power supply. The switches are used to control the EV's movement, while Battery Pack-2 powers the two DC motors mounted on the rear wheels for vehicle propulsion. During braking, the regenerative braking mechanism converts kinetic energy into electrical energy, which is boosted through a boost converter and stored back into the batteries to improve charging efficiency. The system also includes LED indicators for status indication. This smart and sustainable design improves battery life, optimizes energy usage, and supports the advancement of efficient electric vehicle technology.

Index Terms – Electrical vehicle, Dc-Dc Boost Converter, Regenerative Breaking system

1. Introduction

Electric vehicles are becoming more popular because they are eco-friendly and reduce fuel consumption.This project focuses on improving the efficiency and performance of electric vehicles using smart battery switching and regenerative braking. Smart battery switching helps in automatically selecting and managing multiple batteries to ensure continuous power supply and longer battery life. It improves reliability and reduces the chances of sudden power failure.Regenerative braking is a technique that converts the vehicle's kinetic energy into electrical energy during braking Instead of wasting energy as heat, this system stores it back in the battery. A DC–DC boost converter is used to increase the voltage level efficiently so that the recovered energy can be properly stored. By combining these technologies, the overall energy efficiency of the vehicle is improved. This project aims to enhance driving range, battery life, and overall performance of electric vehicles.

2. Importance:

This Project Plays An Important Role In Improving The Overall Efficiency And Reliability Of Electric Vehicles. By Enhancing Regenerative Braking Through A Boost Converter, It Increases Energy Recovery, Particularly At Low-Speed Conditions Where Conventional Systems Are Less Effective. The Smart Battery Switching Technique Ensures Balanced Charging Among Battery Modules, Which Reduces Uneven Aging And Extends Battery Lifespan. It Also Minimizes Thermal Stress, Improving Safety And System Durability. The Proposed System Maintains Stable Voltage And Smooth Power Flow, Leading To Better Vehicle Performance. Additionally, It Contributes To Increased Driving Range And Optimized Energy Utilization. Overall, The Project Supports The Development Of More Efficient, Safe, And Sustainable Next-Generation Electric Vehicles.

3. Methodology

System Design and Over:

The system consists of three main functional modules:

1. Regenerative Braking Unit – captures kinetic energy during braking and converts it into electrical energy using dynamo generators.
2. Boost Converter Stage – steps up the variable voltage from the dynamo to a stable level suitable for charging the batteries.
3. Smart Battery Switching System – Automatically alternates between two batteries based on their state of charge (SoC), ensuring uninterrupted p.ower supply and balanced battery utilization.The entire system is controlled by a PIC Microcontroller, which continuously monitors voltage, current, and SoC levels using sensors. Based on the readings, it performs switching operations, displays information on an LCD module, and manages the regenerative charging process

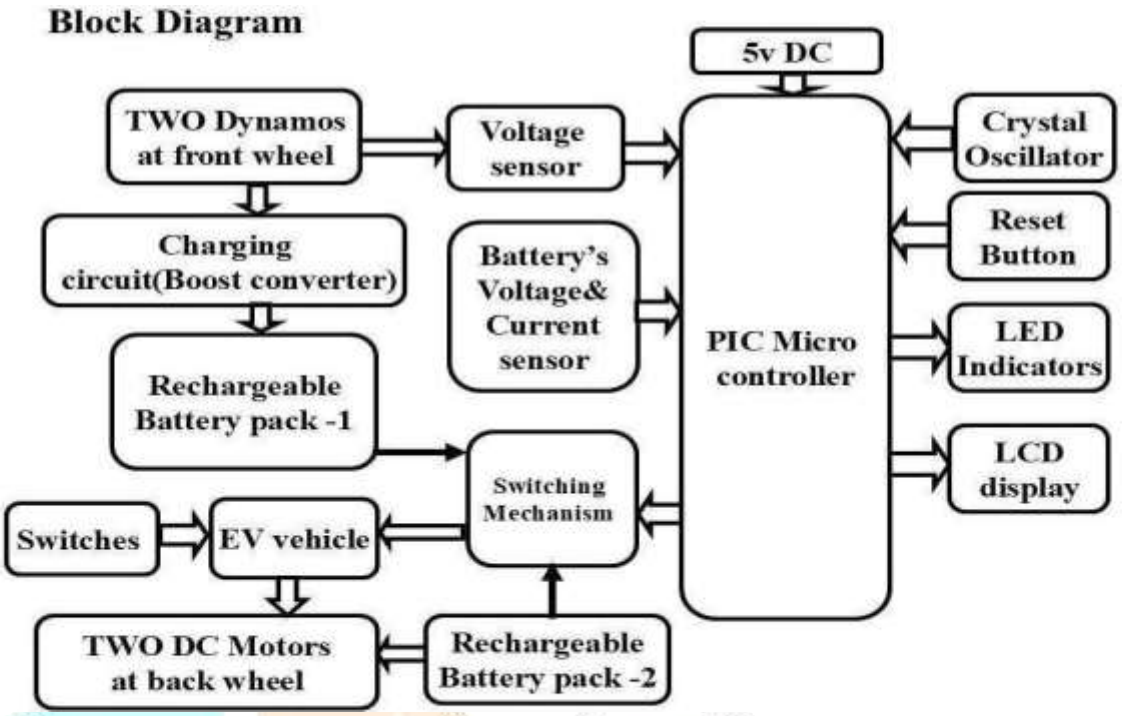

Fig 1. Block Diagram

4. Connection Diagram

The Components Mainly Used In Above Figure Are:

- 230v Ac Mains
- Transformer
- Bridge Rectifier(Diodes)
- Capacitor
- Voltage Regulator(Ic 7805)
- Resistor
- Led(Light Emitting Diode)

The Detailed Explanation Of Each And Every Component Mentioned Above Is As Follows:

Transformation: The Process Of Transforming Energy From One Device To Another Is Called

Transformation. For Transforming Energy We Use Transformers.

Transformers: A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors without changing its frequency. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (emf) or "voltage" in the secondary winding. This effect is called mutual induction. If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. This field is made up from lines of force and has the same shape as a bar magnet.

If the current is increased, the lines of force move outwards from the coil. If the current is reduced, the lines of force move inwards. If another coil is placed adjacent to the first coil then, as the field moves out or in, the moving lines of force will "cut" the turns of the second coil. As it does this, a voltage is induced in the second coil. With the 50 hz ac mains supply, this will happen 50 times a Second. This is called mutual induction and forms the basis of the transformer.

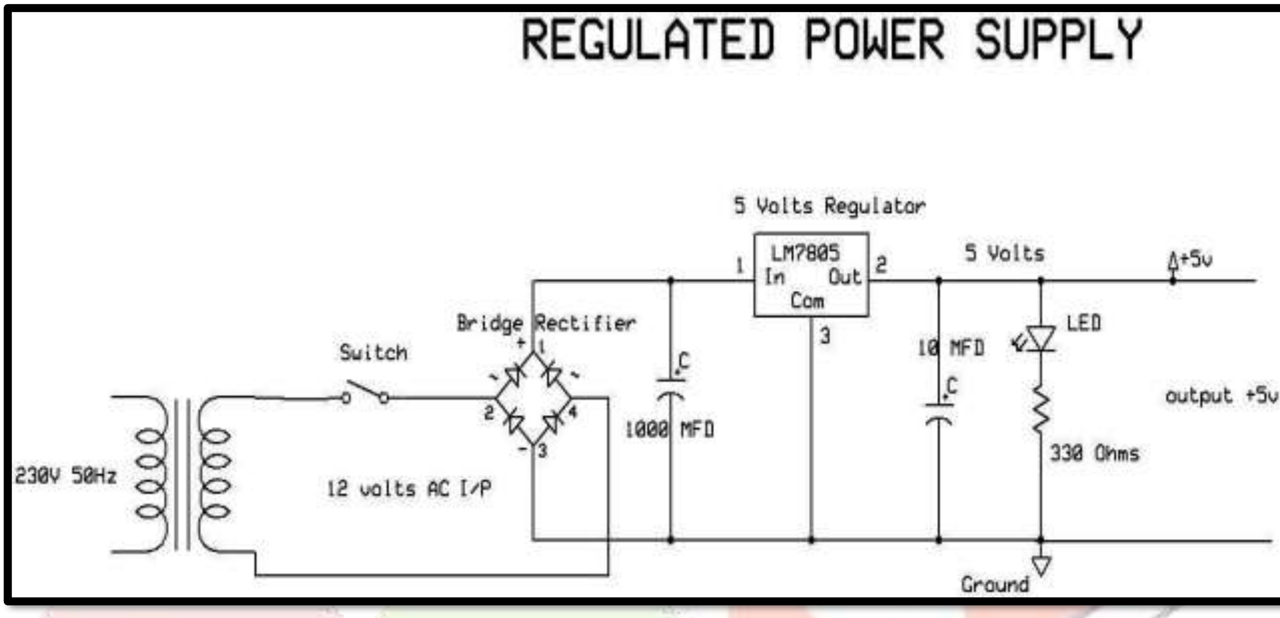

Fig 2: Regulated Power Supply

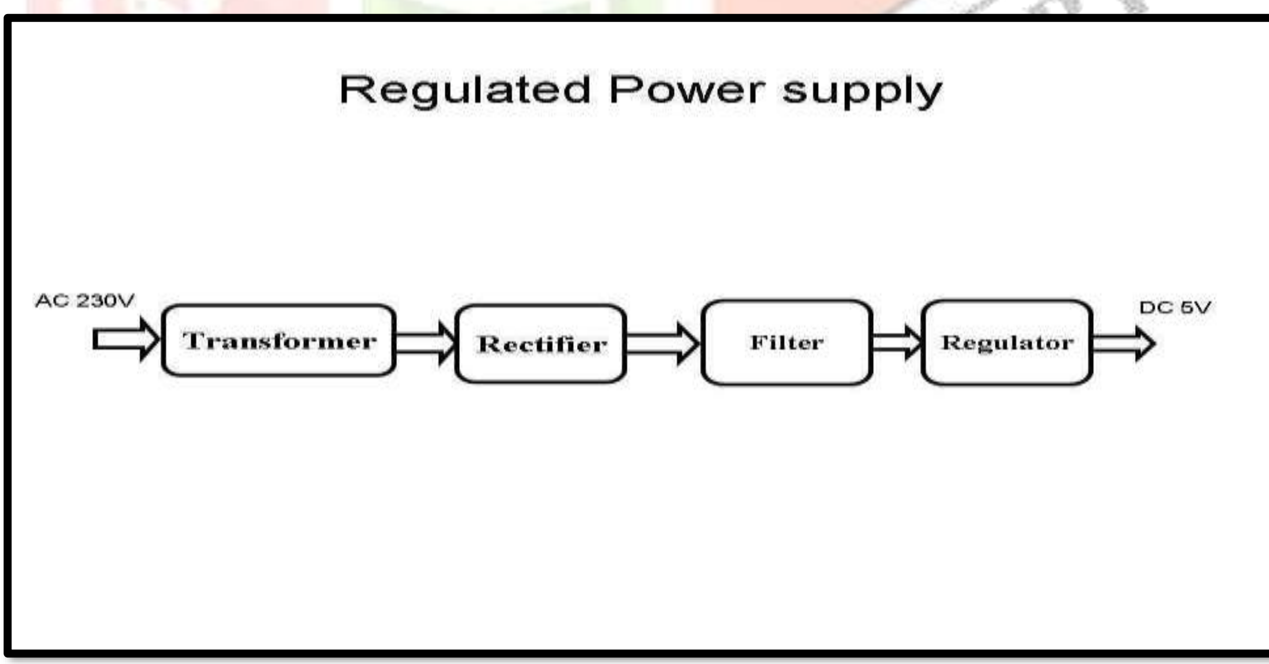

Fig 3: Regulated Power Supply (Block Diagram)

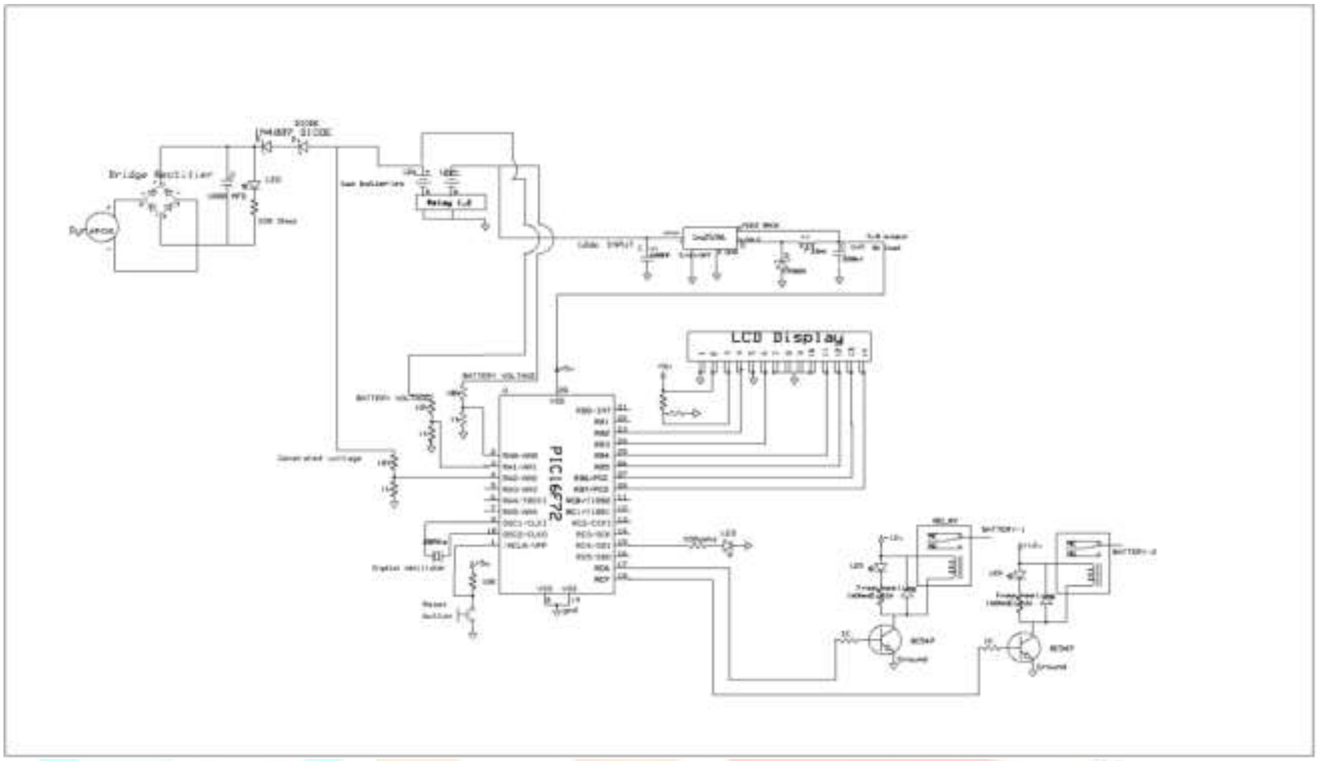

Fig 2. Circuit Diagram

Fig 4. Real-Time Implementation of Circuit

4. The image shows a DIY robotic vehicle platform built on a wooden base with four large wheels.
5. Multiple batteries, electronic components, and connecting wires are mounted on top, indicating an embedded control system.
6. A screwdriver is placed on the board, suggesting ongoing assembly or testing of the project.
7. The setup appears to be a student engineering project, possibly a robotics or automation prototype.

Fig 5.Generated voltage

1. The boost converter successfully increased the input voltage from **6.5 V to 14.0 V**, confirming proper voltage boosting operation.
2. The output voltage (14.0 V) is suitable for charging a higher voltage battery module, validating regenerative charging capability.
3. The increase in output current to **2.0 A** indicates effective energy transfer through the converter.
4. The system demonstrates proper switching action between input and output stages.
5. The initial reading of **0.0 V** confirms that the system correctly detects no- generation conditions.
6. Stable LCD readings indicate proper sensor interfacing and microcontroller data acquisition.
7. The result validates that the proposed system can step up regenerative voltage to usable battery charging levels.

The Smart Battery Switching energy is dynamically stored in battery banks based on the physical proximity of a power source. According to the data in your graph, as the distance increases from 0m to 12.5m, the system captures a rising voltage that peaks at 12.0V. The central microcontroller acts as the system's brain, monitoring this "Generated Voltage" in real-time through sensing circuits. When the voltage reaches pre-programmed logic thresholds, the controller sends a trigger signal to the relay driver stage. These blue electromagnetic relays act as physical gates; when energized, they "click" shut to connect the incoming power to the lead-acid batteries. The use of two separate battery banks allows for sequential charging, meaning the system can fill one bank and then switch to the second to maximize storage efficiency. Buck-boost converters on the board ensure the fluctuating input voltage is regulated to a stable level suitable for the batteries. Meanwhile, the LCD screen provides a live readout of the current voltage and active charging status. The transformers and bridge rectifiers visible on the board likely convert any AC components of the harvested energy into the DC power required by the batteries. Ultimately, the project demonstrates an automated way to bridge the gap between variable energy generation and stable electrical storage.

5.RESULT:-

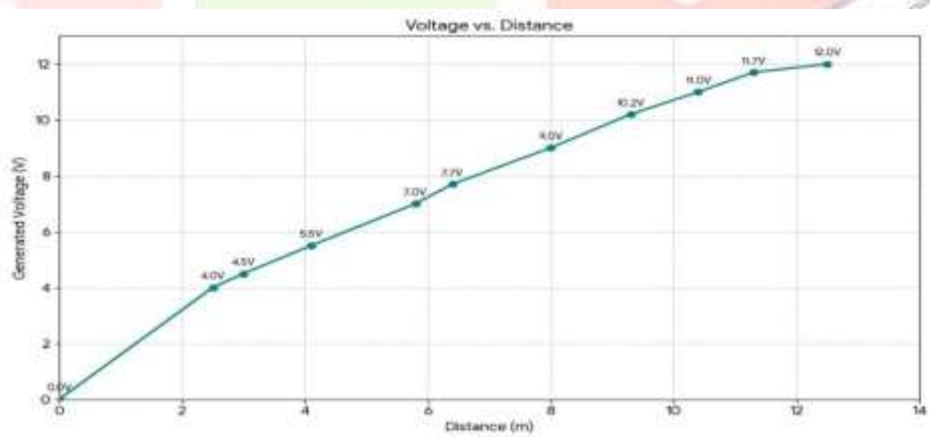

Fig 8: Distance Vs Generated Voltage

The graph shows the relationship between generated voltage and distance. As the distance increases from 0 m to 12.5 m, the voltage rises from 0 V to 12 V. Initially, the voltage increases rapidly between 0 m and around 3 m. After that, the rate of increase becomes more gradual and steadier. This indicates a near-linear relationship with slight non-linearity at the beginning. Each data point is clearly plotted and connected, showing a smooth trend. The system demonstrates consistent voltage generation with increasing distance. Overall, the graph suggests that voltage is directly proportional to distance with minor variations.

5.Conclusion

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented.

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