VEHICLE TO GRID SYSTEM

Department of Electrical and Electronics Engineering

Submitted by

NAME	REGISTER NUMBER
RIFAT ISLAM RANA	410622105008

Guided by

Mr. SEENIVASAN P. B.E.,

TRAINER

Dhaanish Ahmed College of Engineering

TABLE OF CONTENTS:

1. ABSRACT

The Grid-to-Vehicle (G2V) charging system is an advanced technological solution that enables electric

Vehicles (EVs) to draw power directly from the electrical grid for charging. This project focuses on designing and implementing a smart and efficient G2V system that ensures safe, reliable, and optimized charging of EVs while considering grid load conditions and energy efficiency. The system integrates a power electronic converter, control algorithms, and communication interfaces to monitor and manage the charging process. Through this project, We aim to demonstrate how intelligent grid interaction can enhance EV charging infrastructure, reduce peak load stress, and support the growing demand for sustainable transportation. The proposed system also paves the way for future integration with renewable energy sources and vehicle-to-grid (V2G)

2. INTRODUCTION

The rapid adoption of electric vehicles (EVs) as an alternative to internal combustion engine vehicles has led to increased focus on efficient and sustainable charging infrastructure. One of the key components of this infrastructure is the Grid-to-Vehicle (G2V) system, which enables the direct transfer of electrical energy from the power grid to the EV battery. G2V systems are not only crucial for the growth of the EV industry but also play a vital role in supporting the stability and reliability of the electrical grid.

As the demand for EVs rises, unmanaged charging can place significant stress on the power grid, especially during peak hours. To address this challenge, intelligent G2V charging systems are designed to ensure optimal charging based on grid conditions, electricity tariffs, and user preferences. These systems often incorporate power electronics, microcontrollers, sensors, and communication technologies to monitor and control the charging process.

This project aims to develop a prototype of a Grid-to-Vehicle charging system that is safe, efficient, and capable of smart energy management. The proposed system will serve as a model for future developments in EV charging infrastructure and will contribute toward building a more sustainable and energy-resilient future.

3. PROBLEM STATEMENT:

The growing adoption of electric vehicles (EVs) worldwide presents a significant challenge to existing electrical grid infrastructures, particularly during peak demand periods. Traditional charging methods are often uncoordinated and inefficient, resulting in increased grid load, higher energy costs, and potential instability in power supply. Additionally, the absence of intelligent charging systems limits the ability to optimize energy consumption and integrate renewable energy sources effectively.

There is a critical need for a smart, safe, and efficient charging system that can seamlessly manage the transfer of power from the electrical grid to EVs while maintaining grid stability and maximizing energy efficiency. Current solutions lack the capability to dynamically respond to grid conditions, electricity tariffs, and user requirements, making them unsuitable for future large-scale EV adoption.

This project addresses these issues by developing a prototype of an intelligent Grid-to-Vehicle (G2V) charging system that incorporates advanced power electronics, communication interfaces, and control algorithms. The goal is to enhance the EV charging infrastructure and support sustainable, energy resilient transportation.

4. PROPOSED SYSTEM:

The proposed Grid-to-Vehicle (G2V) charging system is designed to provide an intelligent, efficient, and flexible solution for electric vehicle (EV) charging that aligns with modern grid infrastructure and energy management goals. The system enables direct power transfer from the electrical grid to the EV battery while ensuring optimal performance, safety, and grid stability.

This system integrates the following key components:

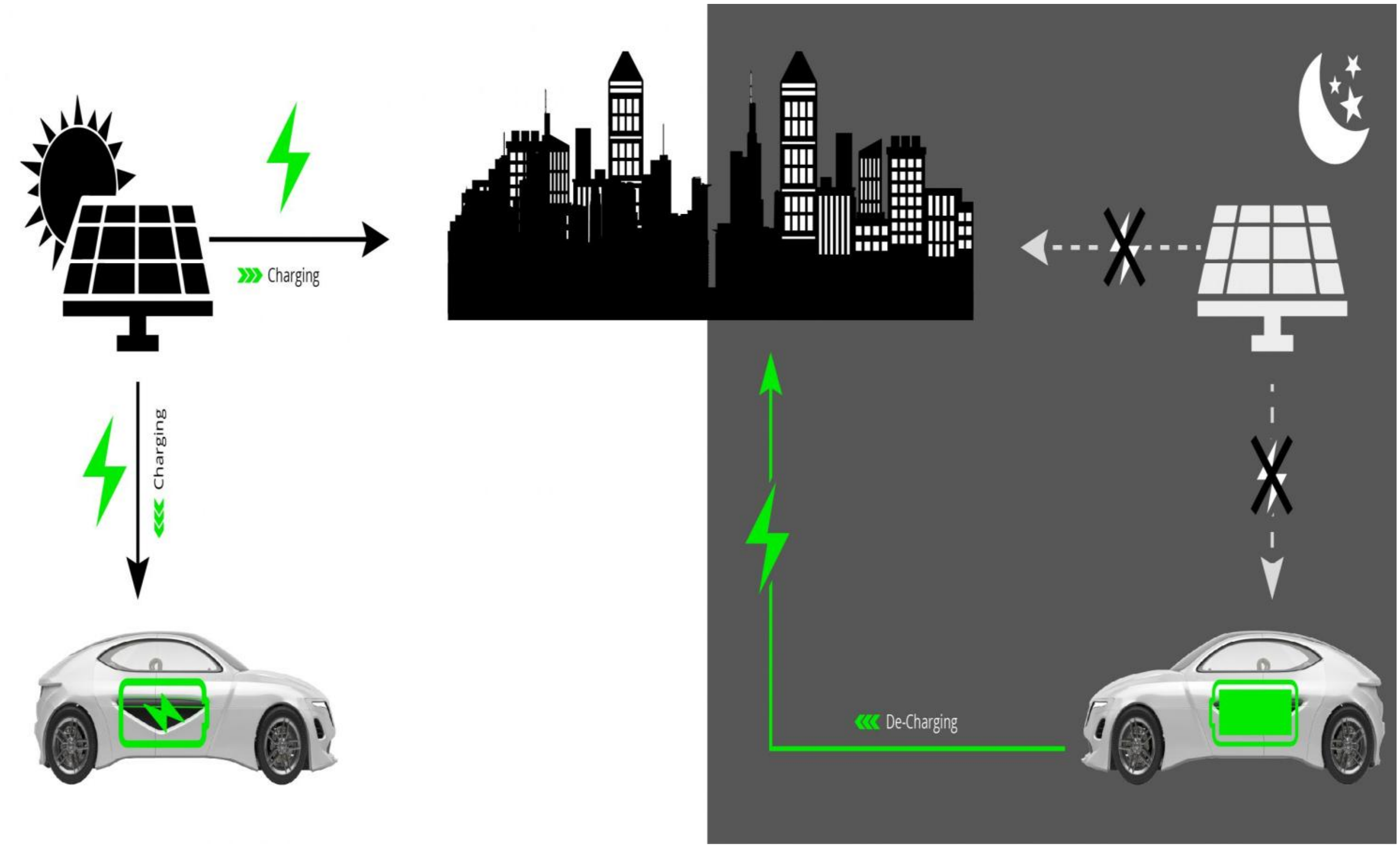
- Power Electronic Converter: Manages the conversion of electrical energy to suitable levels for EV charging while minimizing losses and ensuring voltage and current stability.
- Microcontroller-Based Control Unit: Executes smart algorithms to monitor and control the charging process in real-time based on grid conditions, electricity tariffs, and user-defined preferences.
- Sensors and Communication Interfaces: Enable real-time data acquisition and two-way communication between the EV, grid, and central monitoring system. This ensures effective coordination and dynamic decision-making.
- Smart Energy Management Algorithm: Determines the optimal charging schedule and rate by analyzing grid load, peak hours, and available renewable energy sources.
- The proposed system is capable of adapting charging operations according to fluctuations in grid demand and energy availability. It aims to reduce peak load stress, prevent grid instability, and support environmentally friendly practices by allowing future integration with vehicle-to-grid (V2G) and renewable energy sources.

5. COMPONENTS REQUIRED

The list of hardware components that are required are:

- Bi-Directional Power Convert
- Microcontroller (Arduino / STM32 / Raspberry Pi)
- Voltage Sensor
- Current Sensor
- Battery Management System (BMS)
- Electric Vehicle Battery / Battery Bank
- Grid Simulation Source / AC Mains Supply
- Relay / Contactor
- Cooling System (Heatsink / Fan)
- LCD / LED Display
- Wi-Fi Module / GSM Module (Optional)
- Embedded C / Arduino IDE / Python
- MATLAB / Simulink (Optional)
- Data Logging Tool

6. SOFTWARE COMPONENTS

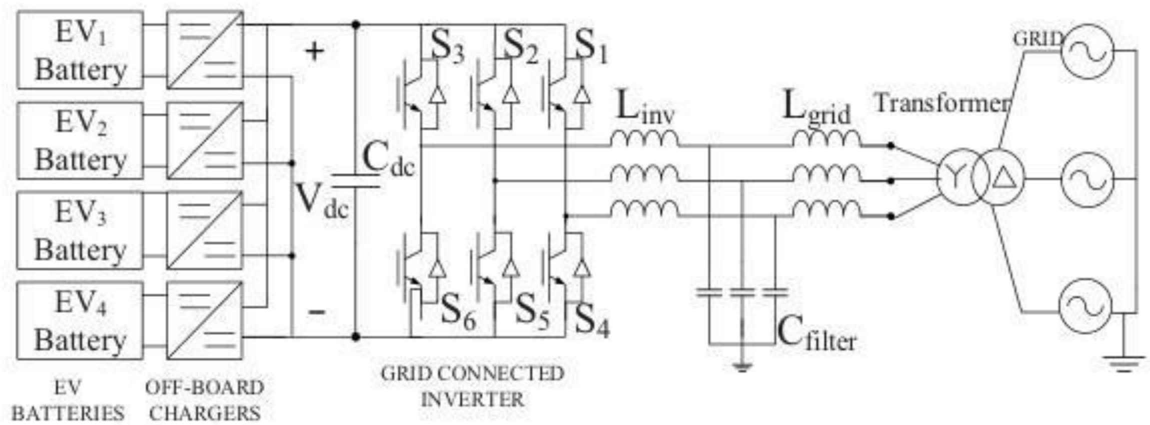


MATLAB plays a crucial role in designing, simulating, and optimizing the autonomous charging robot for electric vehicles. It is used for image processing to detect and track ArUco markers, enabling precise positioning and alignment of the robotic arm. MATLAB's Computer Vision Toolbox supports accurate pose estimation and real-time feedback, improving connection reliability.

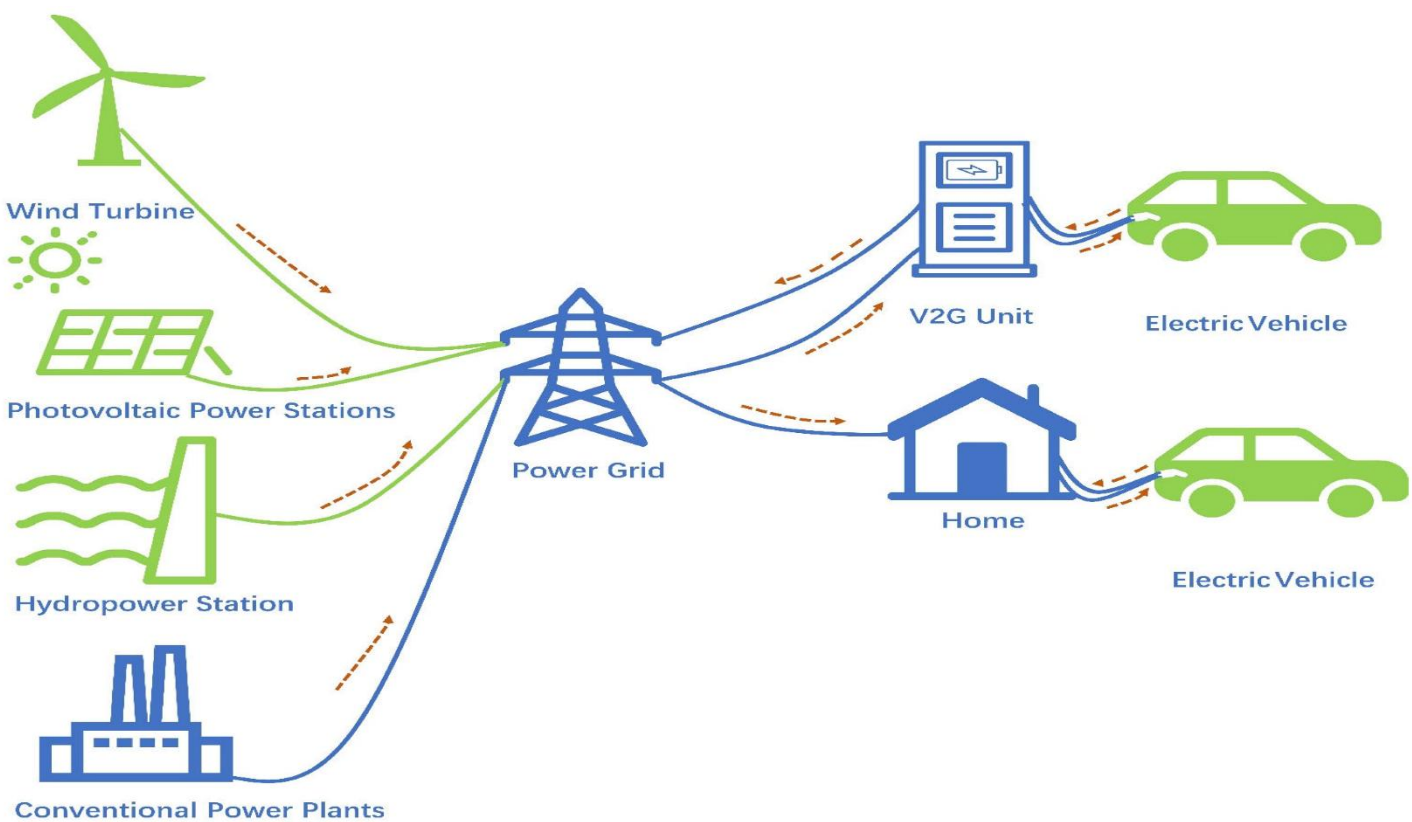
Additionally, the Robotics System Toolbox is used for arm path planning, joint angle optimization, and collision avoidance, ensuring precise arm movement. MATLAB's Simulink environment also facilitates rapid prototyping of control algorithms, including PID tuning and path optimization, reducing development time and enhancing system reliability.

Overall, MATLAB provides a comprehensive platform for integrating vision, control, and simulation, making it a critical tool for efficient project development.

7. BLOCK DIAGRAM



8. PIN DIAGRAM & OUTPUT



9. WORKING

The Vehicle-to-Grid (V2G) system allows two-way power flow between an electric vehicle (EV) and the electrical grid. During off-peak hours, the grid supplies power to charge the EV battery (G2V mode). During peak hours or grid demand, the system discharges stored energy from the EV battery back to the grid (V2G mode).

A bi-directional converter manages the power flow, while sensors monitor voltage and current. The microcontroller runs algorithms to decide when to charge or discharge based on grid load, battery status, and user preferences. Communication modules ensure coordination with the grid, and a battery management system ensures safety during all operations.

V2G Benefits :

- Efficient Energy Use: Optimizes electricity usage by charging during off-peak hours and discharging during peak hours.
- Renewable Integration: Helps balance intermittent renewable sources like solar and wind.
- Cost Savings: EV owners can earn money or reduce bills by supplying energy back to the grid.
- Battery Management: Enhances battery health through smart charging/discharging cycles.
- Environmental Impact: Reduces reliance on fossil fuel-based power plants.
- Emergency Power Supply: EVs can act as backup power during outages.

10. CONCLUSION

The Vehicle-to-Grid (V2G) system is a promising solution for enhancing the efficiency, stability, and sustainability of modern power grids. By enabling two-way power flow between electric vehicles and the grid, this system not only supports energy demand management but also promotes the effective use of renewable energy sources.

The successful implementation of this prototype demonstrates the technical feasibility of V2G technology and its potential to transform EVs into mobile energy assets. With further development and real-world deployment, V2G can play a key role in building a smarter, greener, and more resilient energy future.