IMPLEMENTATION OF IOT BASED SOLAR POWERED SMART ELECTRIC VEHICLE CONTROL

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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NOVEMBER, 2025

DECLARATION

We hereby declare that this project **"Implementation of IoT Based Solar Powered Smart Electric Vehicle control"** represents our own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has been carried out by us and has not been previously submitted to any other university, college or organization for an academic qualification, certificate or diploma/degree.

We hereby warrant that the work that has been presented here does not break any existing copyright. We further pledge to indemnify the institution against any loss or harm originating from breach of the aforesaid duties.

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APPROVAL

The project entitled **"Implementation of IoT Based Solar Powered Smart Electric Vehicle Control"** submitted by **Md. Sakib Al Shahriar (213-33-1419), Md. Lazim Aktar Ruku (213-33-1422), Samrat Hossain (213-33-1428), Mollah Md Rafid Shadad (213-33-1442), Md. Nabiul Hasan Niyan (213-33-1446)** has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in **November, 2025.**

Sutapa Debnath

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DEDICATION

To my beloved parents,
for their unconditional love, constant guidance, and endless support.
&
To the resilient people of Palestine,
who continue to endure the pain of occupation, displacement, and injustice,
yet rise each day with unyielding dignity, courage, and hope.

May this humble work serve as a small tribute a voice from the realm of knowledge and research, echoing solidarity with all who strive for peace, freedom, and justice.

Free Palestine.

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LIST OF ABBREVIATIONS

Abbreviation	Description
IoT	Internet of Things
EV	Electric Vehicle
GPS	Global Positioning System
RFID	Radio Frequency Identification
NFC	Near Field Communication
MCU	Microcontroller Unit
PCB	Printed Circuit Board

ACKNOWLEDGEMENT

First of all, we want to thank God for everything. With his help, we can do our finest work.

We wish to show our deepest admiration for our supervisor, **Sutapa Debnath**, Senior Lecturer in the Department of EEE at Daffodil International University, who has given us the chance to work on an important idea and has taken care of every problem that has come up throughout its development. We would also like to take this chance to thank our supervisor for always being there for us, encouraging us, and helping us with this project. We can't finish this project without his aid and suggestions. Also, please thank him a lot for letting us work on this project.

We would also like to thank all of our classmates for sharing their experience and information and helping us make this endeavor a success. To our dear family, we want to thank them from the bottom of our hearts for being so supportive and for being our inspiration and motivation while we were studying at this school.

ABSTRACT

The IoT Based Solar Powered Smart EV Control System is an innovative project that integrates renewable energy and intelligent technology to create a sustainable and secure electric vehicle solution. It uses solar power to charge electric vehicle batteries, reduces grid power dependency and promotes clean energy use. It is even equipped with IoT (Internet of things) monitor, by which users can check remotely the charging data of charging status, voltage and power levels in real time to ensure the efficiency and avoid over-charging. Furthermore, the card-based engine control operates to provide security that only authorized drivers can operate, and the GPS based accident alert & location tracking brings instant emergency notifications during accidents. With integration of the use of renewable energy, IoT monitoring, smart access control and safety automation, this project provides a sustainable holistic approach for an intelligent and eco-friendly way towards electric mobility in the future.

CHAPTER 1
INTRODUCTION

1.1 Introduction

The need for sustainable transportation systems is becoming an urgent requirement in the modern day, triggered by concerns on increasing levels of climate change impact, declining fossil fuel reserves and elevated environmental pollution. Electric Vehicles (EVs) have presented themselves as a transformative enabler to mitigate these issues in the form of clean, efficient and environmental friendly substitutes for traditional internal combustion engine vehicles. The pervasive deployment of EVs faces new challenges, such as energy source power control, charging station monitoring, safety and user identity authentication. To tackle these challenges, the use of Internet of Things (IoT) platforms, renewable energy generation systems and smart controllers in EVs are emerging as an attractive solution. This project, IoT Based Solar Powered Smart EV System, has developed comprehensive solution where solar power charging is done; monitoring of solar data over IoT (internet of things) system are shown and the accident alert system; location tracking plus engine controlling using smart card control access mechanism shown practically using this technology.

Electric vehicles (EVs) have seen major adoption as an environment-friendly alternative, however if they are charged using the grid, this can put a lot of stress on the already strained power infrastructure and paradoxically not make electricity their ‘clean’ alternative should be in case the power is generated by non-renewable source. Additionally, users typically have problems in checking battery of the vehicle whether be efficient, granting safe access and vehicle alarm management at real time. Conventional EVs don't offer energy independence and state of the art safety. Hence, the requirement for an IoT-based intelligent EV system driven based on clean energy resources, e.g. solar power becomes indispensable.

One of the significant features of this project is to incorporate solar energy which serves as a main powering input for charging the EV battery. Solar power is a clean, renewable resource that is always available and can still be used during grid outages. Since the solar is integrated with its EV infrastructure though, the system itself keeps going even in remote areas where chargers might not be available. Using solar also cuts down on carbon emissions, encourages sustainability and efficiency with EV's.

It also includes IoT for solar power monitoring which gives real time data of the solar voltage, charging current, battery information. This provides maximum solar efficiency use and also prevents against overcharging, thus increasing overall battery life. This information is made available to users remotely via a mobile or web interface, and allows for full transparency and control over the charging process.

Battery performance is a vital characteristic for the operation of an electric vehicle. Improper use or charging of the battery may decrease operational efficiency, increase maintenance cost and cause operational failure. The battery charge monitoring system developed in this project is an IoT-based device that allows users to monitor voltage, state of charge, and the health of the battery. Alarms and warning messages indicate the battery reaches critical status, prompting a user's actions in time.

This constant monitoring is what allows it to stop unexpected failures, maximize charging cycles and prolong the life of your battery. In addition, with historical battery performance data stored in the cloud, users and manufacturers have the potential to identify trends and enhance future EV design and efficiency.

Safety on the road is of great importance in modern transportation systems. Collisions not only result in property damage but are also a major threat to human safety. In most of cases, delay in detecting an accident and emergency response may even exacerbate the situation. To solve this problem, an accident alert system that senses collisions or severe impacts is built into the design. As soon as an accident is detected, the system then transmits to predetermined contacts or emergency services with the automobile GPS coordinates through IoT communication.

This live location tracking not only enhances accident response but also aids in keeping track of the position for security and operations. For example, if the vehicle is stolen, the owner can search and find right where it is through the IoT interface. As a result, the system provides not only safety aspect but also security under which users can be aware of and stay in touch with their vehicle wherever they are.

Unauthorized utilization of vehicles is a problem in private or commercial vehicles. Typical locking mechanisms may not be capable of providing a high degree of security. To solve this problem, the present invention adopts a card-type engine control system which enables only properly authenticated users to initiate and drive an EV. Every card is personalized and validated by system preventing unauthorized persons access to vehicle.

This becomes useful in shared mobility, corporate fleets and personal vehicle protection. Click here to learn more and order The Raffle. It does not only block the burglary but also creates a smart authentication that will build your trustful convenience for checking user.

The real power of this initiative is the intersection of IoT across various components involved in a EV ecosystem. By instructing IoT sensors, microcontrollers and cloud platforms, the system provides end-to-end data collection, analysis and communications. Battery charge, solar charging levels, current vehicle location and accident alerts are available to users from their smartphone or computer no matter where they are.

This intelligent connection makes EV into an intelligent connected vehicle, which is not only environmentally friendly but safer more efficient. Furthermore, IoT integration is scalable lending us the possibility to add features like: predictive maintenance, driving behavior analysis or smart grid integration amongst other in a near future.

The IoT Based Solar Powered Smart EV control Project is a further advance in sustainable, intelligent and secure mobility. The system is an integrated solution to challenges of energy dependence, safety and security, while helping with smart-grid preparations as threats against electric vehicle charging become a concern. The integration of solar charger with IOT enabled monitoring makes EVs, carbon neutral, user friendly and most reliable solution.

In a wider context these systems can feed into smart city developments which rely heavily on sustainable transportation, energy management from renewable sources, and IoT capable infrastructure. The model can be used and refined by national governments, industry, and research organizations to inform the transition toward cleaner and smarter mobility.

The objective of this IoT Based Solar Powered Smart EV control Project combines all the related technologies to make electronics home even smarter than some designers are thinking. Featuring solar powered battery charging, IOT based battery monitoring, accident alert, GPS and RFID based location tracking and card operated engine control the project strengthens sustainability of the system with safety & security. This outset sets the stage for IoT's role in creating the possibility of connecting and deploying green energy to electric vehicle, making our smart vehicles smarter & safer with zero DC leak over i.e. less hazardous where it seems that tendency what these modern generations pursuing? And above all also going wireless i.e., electric plug All the while working hard to meet passengers needs driving advancements and dynamic rides shared on the road to make this new reality viable, cutting-edge IOT development would be not impossible means necessary in order to see better development while sprints taken a pace.

1.2 Problem Statement

The E-mobility represents a quickly-growing market which opens up new opportunities in the field of sustainable mobility (e.g., e-vehicles and connected cars) by, at the same time, involves critical issues on energy dependence, safety monitoring and secure driving. The standard EV... The typical argument against environmentally friendly cars is that you are simply moving the pollution elsewhere (to while we charge form a power point), which is mostly true. Additionally, reduced charging infrastructure accessibility in remote or rural locations limits the mobility and ease of use for EV users.

Then there are the batteries that need managing. Excessive charging, no real-time monitoring and no predictive warning also shorten the life of battery and can cause sudden failure and out-of-service. Right now, users are provided with only partial transparency on how their batteries are performing and this plays a huge role in ensuring the reliability of EVs.

It can be seen that safety is still a big concern of EV drivers. This is particularly important in the case of accidents, where delayed detection and reporting can have catastrophic consequences. Traditional EVs do not have built-in systems for accident detection and real-time location-based emergency notification, making the victim helpless and EMTs unaware.

In addition, car stealing and transmitting is never ceased in personal-purpose or commercial-purpose applications for EV. Standard latch and lock mechanisms or other key systems are simply not able to provide the level of security required. A smatter and secure way is required so that the car can only be driven by authorized users.

These shortfalls demand an integrated approach incorporating renewable membrane energy, instant monitoring through IoT, intelligent safety systems and secure access control.

1.3 Objectives of the Project

- To develop a secure, sustainable, and intelligent solar-powered EV system using IoT technology.
- To integrate live monitoring for battery status, system performance, and EV operation.
- To implement access control using RFID/NFC for authorized vehicle operation.
- To reduce the dependency on grid electricity through renewable solar energy utilization.
- To overcome the limitations of traditional EVs by improving energy efficiency, user convenience, and operational reliability.

Solar Powered Integration into Battery Charging

Use the solar power as a clean and renewable energy to charge EV battery, make you no longer rely on the grid power, and help save your living cost!
Since the system must be able to work even in less charging infrastructure areas.

IoT-Based Battery Charge Monitoring

Developing an IoT-based monitoring system for real-time battery voltage, current, state of charge and health. For alerting or notifying the user in a timely manner when there is low battery, over-charge, or fault so that the life of a battery can be prolonged.

Accident Alert and Location Monitoring

To construct an accident/impact sensor that can detect collisions or any sudden impacts.
For the automatic sending of emergency alerts and GPS-based location information to predetermined contacts or emergency services for a quicker response time and greater security.

Secure card-based engine control and access

To implement an intelligent card-based authentication mechanism, so that no unauthorized users would be able to start or drive the EV.
For improved vehicular security, unauthorized entry and more secure private and commercial use.

IoT Real-Time Connection and User Interface

To facilitate easy connections of the EV with users using IoT technology for remote monitoring and controlling. To provide the user with access to important data such as solar charging information, battery performance metrics, accident alerts and car location from smartphones or web-based dashboards.

Sustainable and Smart Mobility Advancement

Development of an innovative modular multifaceted platform that integrates RE, IoT technologies, safety and security aspects in a PV based EV charging system. To invest in the future of intelligent transportation systems and smart cities, fostering innovation in travel smart.

1.4 Brief Methodology

The IoT Based Solar Powered Smart EV control Project method comprises a framework that includes renewable energy integration, IOT based monitoring, safety feature and secured engine control. The system is organized such that sustainability, monitoring in-reality, safety and security of the user as well as access to vehicle is guaranteed. The architecture of the IoT Based Solar Powered Smart EV control Project integrates the various component like renewable energy, IoT monitoring, safety and secure authentications to lead them seamlessly as a single one fully integrated system. Project addresses sustainability, safety, security and efficiency embedded hardware designs, IoT software development doing real time monitoring as well as end-to-end test aspects of modern e- vehicles.

The procedure is then split into main steps:

- System Design and Architecture
- Hardware Implementation
- Software Development and IoT Integration
- Workflow Choice Accident Alert And Position Monitoring Workflow
- Card-Based Engine Control Workflow
- Testing and Validation
- Performance Evaluation

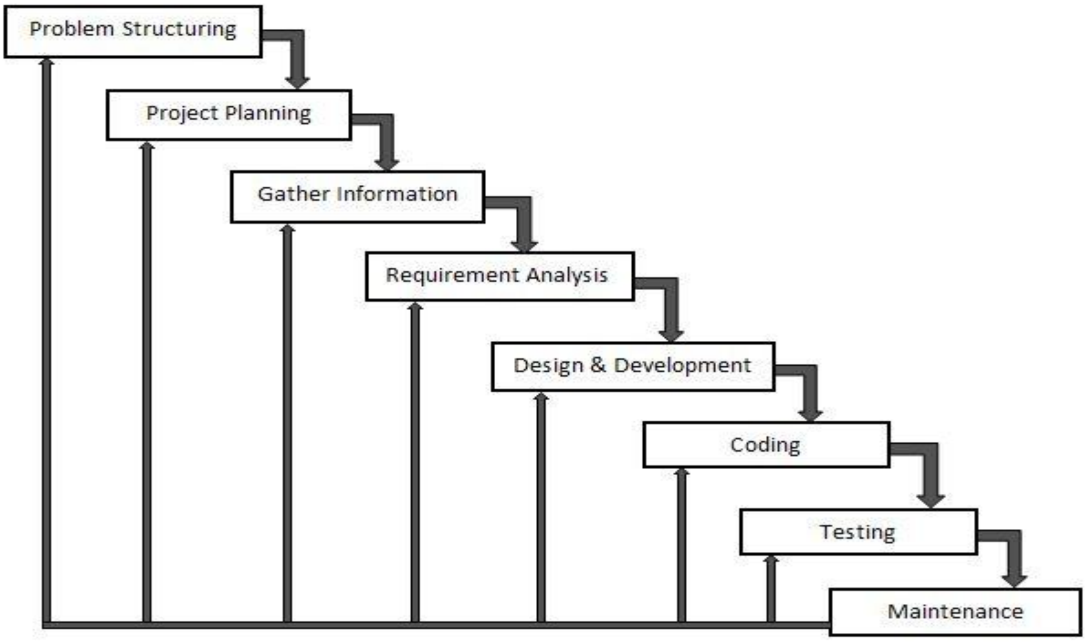


Figure 1.1: System Flow Chart

1.5 IoT System

The network of physical objects, automobiles, household appliances, and other objects that are embedded with electronics, software, sensors, actuators, and connection that allows them to communicate and share data is known as the Internet of Things (IoT).

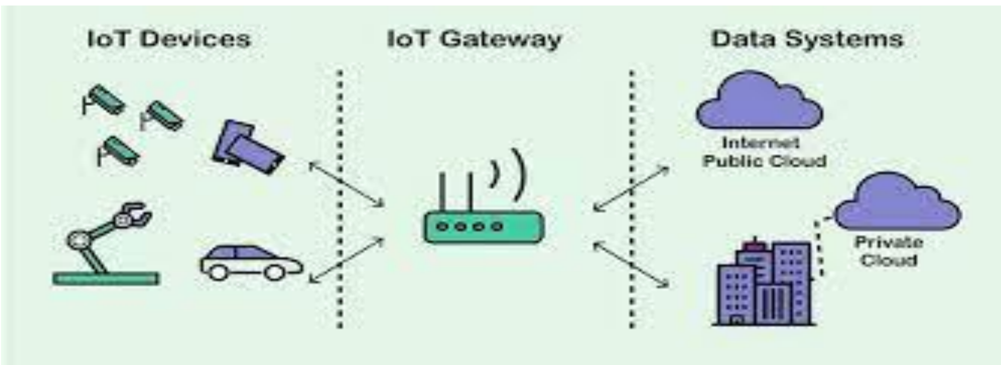


Figure 1.2: IoT System

The concept of the "Internet of Things" has changed as a result of the confluence of several technologies, including embedded systems, real-time analytics, machine learning, and commodity sensors.

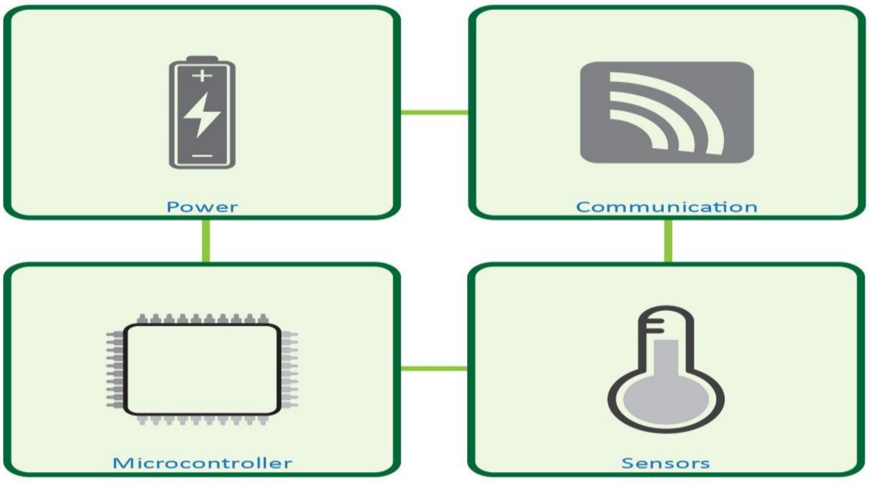


Figure 1.3: Block Diagram of IoT

Numerous technological fields, such as embedded systems, wireless sensor networks, control systems, automation (including in homes and buildings), and others, are connected to the Internet of Things. Consumer goods linked to the "IoT Based Solar Powered Smart EV" idea make up the majority of the IoT application equipment. These products include appliances and gadgets (lights, thermostats, cameras, home security systems, and other smart home devices) that are compatible with one or more common ecosystems and that can be operated by gadgets that are part of that ecosystem, like smartphones or smart speakers. As a result, there are now many valid worries regarding the risks that the Internet of Things (IoT) poses, including security and privacy issues.

1.6 Structure of the Report

Chapter 1: Introduces the project's background, objectives, and methodology for developing a solar-powered IoT-based smart EV system.

Chapter 2: Reviews related research and compares existing systems to justify the proposed model's innovation.

Chapter 3: Describes the system design, hardware components, and circuit integration of the smart EV prototype.

Chapter 4: Presents testing results, performance analysis, and discussions on system functionality and reliability also the mode of normal situation and accident situation.

Chapter 5: Outlines project schedule, milestones, resource allocation, and cost management strategies.

Chapter 6: Evaluates the project's economic, environmental, societal, and ethical impacts.

Chapter 7: Concludes findings, highlights skills learned, and suggests future improvements for the system.

1.7 Motivation for Project

The explosive development of urbanization, population growth and industrial production has sharply increased the demand for transportation as well as environmental problems such as air pollution, greenhouse gases (GHGs) emission and gradually exhausted fossil fuels. Conventional cars and trucks that run on gasoline and diesel also produce harmful emissions, and depend on a finite supply of nonrenewable energy. In this scenario, electric vehicles (EVs) are being recognized as a clean and efficient option. But, EVs are still confronted with serious problems such as energy sustainability, safety, real-time monitoring and security so that the demand in efficient solutions continues to grow.

That most EVs are dependent on grid-based electricity puts strains on current power infrastructure, and in many areas at least, that charge is coming from non-renewable resources such as coal. This negates the environmental credit of EVs. Using solar energy as the charging solution, supports an energy independent and low carbon lifestyle, even in regions with unreliable grid access or without electricity. The aim is to develop a genuinely green and sustainable mobility option.

EV users (who cares about being eagle eyed). The problem is though that such vehicles have short range, tend to break down suddenly due to unhealthy battery pack and you don’t have real time data of charging. The purpose of integrating IoT-based battery charge monitoring is to empower users with the full control and status update of their battery as to its reliability, longer life cycles, and minimal operation risk.

Traffic accidents continue to be among the leading causes of injuries and deaths throughout the world. Most EVs and traditional cars do not have intelligent systems for collision sensing and emergency notification. Further complicating matters, slow attendance to accidents will usually amplify their effect. With the addition of IoT based accident detection and GPS-based location tracking, this project is aimed at improving road safety, reducing response time and hopefully saving lives.

Hot wiring and theft is still a matter to be dealt with. Other known key actuated systems are susceptible to being duplicated and played with. If the card-based engine control method is emplacement, it is judged nocturnally security of EV that can for only by a true user who lets a start operation be performed and drives. This additionally builds confidence in the system for private and shared tissue ownership.

By bringing IoT to cars, car can become smarter, connected things. The goal is to gain access the IoT for real-time monitoring, remote access and user interaction. The first system integrates renewable energy efficiency, coupled with battery state of health checking and crash safety & security within the IoT based platform, and as such is one of the premier benchmark models for future smart transportation.

Across the world and here at home governments and industry are moving toward smart cities and meeting the Sustainable Development Goals (SDG). Clean energy generation, smart mobility and digital connectivity are central in these imaginations. The objective of this project is to help these goals by developing and demonstrating a sustainable, smarter, safer, electric vehicle technology that promotes the use of renewable energy while considering modern transportation usage needs.

The inspiration of IoT Based Solar Powered Smart EV Project comes from the important and necessity we are facing nowadays is that Energy sustainability, Battery integrity, Accident safety and Vehicle security in electric mobility. Integrating solar power, IoT technology, accident alert system, GPS-based monitoring and card-based access control, the project's key objective is to develop an EV model for future that is sustainable, safe and smart experience for users.

1.8 Project Management

Project management is important for success of the IoT Based Solar Powered Smart EV Project. With the combination of several technologies to be used in the project (such as renewable energy, IoT connection, accident alert system, battery monitoring or secure engine control), a well-organized implementation plan needs to be defined/implemented to guarantee performance and cost-effectiveness. The approach to project management includes planning, allocation of resources, execution, monitoring and evaluation. Project management on IOT Based Solar Powered Smart EV Project focuses planning, resource rationalization, risk analysist quality assurance and reviewing. When the work is divided into defined stages and followings, through systematic monitoring, it will enable the completion on time using cost-effective methods with desired accuracy of work. Ultimately, the approach will ensure a sustainable, smart, and secure EV system to meet the transportation needs of today.

- Project Planning
- Resource Management
- Work Breakdown Structure (WBS)
- Risk Management
- Quality Assurance
- Monitoring and Evaluation
- Example Project Schedule (6 Months)

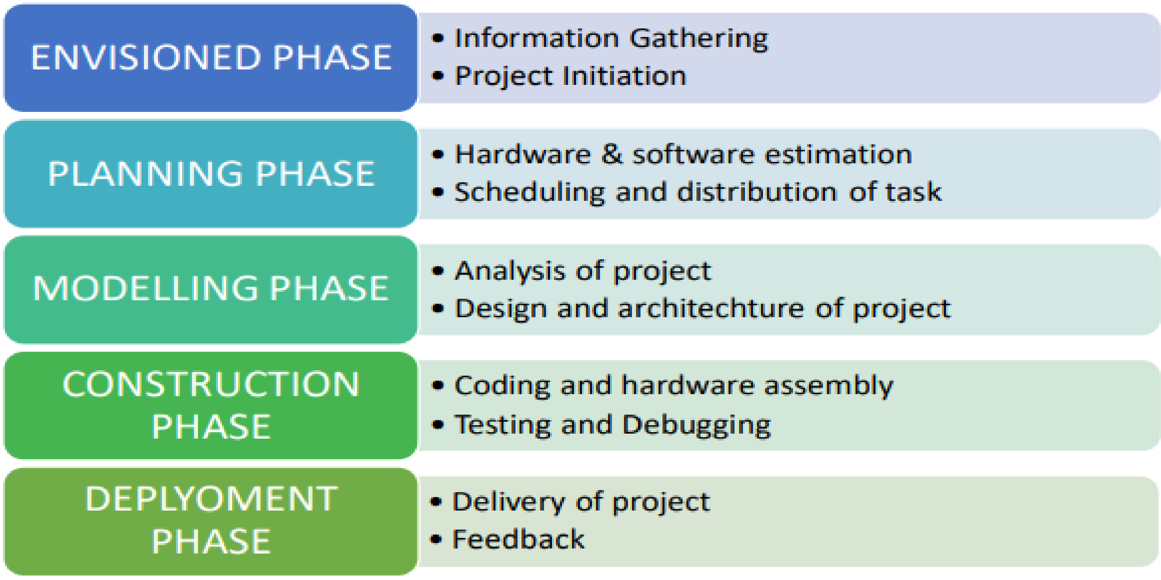


Figure 1.4: Project Management

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The urban transportation system is in the midst of a revolution as global communities adopt smarter and greener mobility options. The focus on damaging environment, increasing fuel cost and diminishing fossil fuels resources also provided motivation for alternatives that were safe, efficient, reliable and environmentally friendly. Among these alternatives, Electric Vehicles (EVs) have received a considerable attention for their ability to cut carbon emissions, decrease dependence on finite resources and aid sustainable energy programs. Yet, the movement toward EVs is not easy. Traditional EVs have short comings like heavy dependence on grid based charging, inadequate battery management systems, lo of advanced safety function and improper securities precautions. [1]

One of the key motivation of this project is that we are trying to make use of solar power for charging of EV battery. Solar power as an infinite and renewable energy source, offers a sustainable solution to our dependence on the grid. According to the invention, by mounting solar panels and joint controllers for them on the system endeavors to be able to charge EV battery in a green method. This is not only a way to cut emissions but also lets you charge in rural or off-grid locations that don't have charging stations. [2]

Battery characteristic is one of the most important parameters in EV running. Traditional systems do not provide a real-time status for satellite battery charging, health or energy monitoring. The system features the integration of IoT based battery charge monitoring, the user connects through mobile or web platform and monitors the battery related parameters like voltage, current state of charge and health. The transmission of data in real time and real-time alerts can prevent overcharging, improve efficiency, and prolong the life of the battery while traveling.[3]

Traffic incidents remain a worldwide safety problem, and the consequences can be serious due to an emergency response delay. This work presents an accident detection system that detects collision or impact via sensors. When some mishap has occurred, the device sends an SOS via IoT connectivity to predefined contact numbers and emergency services with GPS coordinates. Good for safety and Security Real Time location tracking features provides not only safety of the person/vehicle but also prevents it from theft/misuse.[4]

Security is another major issue in contemporary cars. Copies can easily and inexpensively be made of the prior art key system. The project is also featured a card-based engine immobilizer with an RFID or NFC. It can only be ignited by the authorized users whose cards are enabled, so as to prevent theft efficiently. This functionality can be especially valuable in car sharing platforms and fleet management applications where controlled access is important.[5]

What makes this project unique is the way IoT tech has been brought in to combine solar charging of battery, monitoring of battery status, accident alert (through an inbuilt impact sensor) with help support, GPS tracking and real-time access control. Via IoT platforms, the EV interacts with users in real time with data visualizations and alerts, plus remote access via smartphones or web-based interfaces. This makes the EV a connected intelligent car that is easy, safe and fast for users.[6]

The IoT-Based Solar Powered Smart EV System represents a major advancement in future transportation by integrating intelligent IoT operations, advanced safety mechanisms, security features, and renewable solar energy to overcome the limitations of traditional electric vehicles. This innovative model not only reduces carbon emissions but also enhances road safety, improves system reliability, and supports smart city infrastructure. By combining solar-based charging, IoT-enabled battery monitoring, accident detection, GPS location tracking, and secure RFID/NFC engine control, the project provides a comprehensive and sustainable mobility solution. This breakthrough technology is designed to make electric vehicles greener, smarter, safer, and more efficient, offering a fully future-ready approach to modern transportation needs.

2.2 Related Research

The sugar simply put, a system must grow with the environment and market. Evolution scenario has been discussed right in the context of 5G technology enabling telecommunication. Various solutions and approach have been presented in the literature for the vehicle tracking and traffic management system. These systems differ in methodology as well as in strengths and weaknesses.

1. **An IoT Vehicle Monitoring System in Real-Time:** Alquhali et al. (2020), they developed an IoT-enabled vehicle tracking system using GPS and GSM for communication with a real-time approach. This type continuously monitors and can be utilized to predict actual arrival times of vehicles. However, as other GPS-based systems it suffers limitations in urban area since satellite signals are blocked by buildings and other obstacles [7].
2. **GSM/GPRS-Based Smart Tracking System**: Mustafa et al. (2019) presented a smart tracking system based on GSM/GPRS for vehicle tracking and communication between the servers with the vehicles. Such system to enable real-time data acquisition and the vehicle monitoring may have become established. However, it relies on cellular coverage, which can be spotty in rural communities [8].
3. **Vehicle Detection and Speed Monitoring using GMR Magnetic Sensors**: Pelegri et al. (2002) investigated the application of Giant Magneto Resistive (GMR) magnetic sensors monitoring for a vehicle speed. However, these sensors only provide speed estimation in inclement weather but with the investment made at discrete points and not concerning any life traffic operations on larger AOI (Area of Interest) [9].
4. **Wireless Sensor Network Based Monitoring on Vehicle Speed of About:** Kannan, S et al. (2010) presented a method based on wireless sensor networks and could be used for vehicle speed monitoring and traffic guidance. Although it performs well in monitoring selective road segment, this approach still involves many sensors and infrastructures for complete coverage [10].
5. **Speed Monitoring System using RFID:** Al-Gindy et al. (2013) introduced the application of RFID to monitor speed. RFID has the advantages that it does not require line of sight and is not sensed at check points, but is confined to position tags in predefined locations and cannot provide continuous speed or location information [11].
6. **Over-Speeding Detection System:** Kodali & Sairam (2016) developed a system to detect the speed of the vehicle and alert, if it exceeds the limit. Though yielding accurate

speed value, it does not take location tracking or arrival time prediction into account [12].

7. **Wi-Fi Enabled Smart Bus Tracing**: Kiran et al. (2017) created an intelligent bus tracking system based on Wi-Fi. Although this decreases data costs, it is restricted to Wi-Fi covered-available areas and up-to-date intermittently, causing holes in live tracking [13].
8. **IoT-Enabled Smart Bus Management System:** Sridevi (2017) designed an IOT based bus system by integrating GPS and cloud services to monitor the buses in real time. This approach assists in estimating arrival times, however it requires special attention to the latency of data and scalability when dealing with high density traffic environment [14].

2.3 Compare and Contrast

It is important to compare the present vehicle systems with the proposed IoT-based Solar Powered Smart EV System in order to pave the way for improvements and missing features:

1. **Grid Dependency vs. Solar Power:**
   Conventional Electric Vehicle (EV) systems mainly depend an grid for charging. The present system on the other hand decrease this dependency, since solar panels are implemented and EV can be charged from off-grid position. This helps to make it sustainable by utilizing renewable power.
2. **Battery Monitoring and Safety:**
   Current EV systems do not include extensive battery monitoring capabilities which results in inefficient charging and reduced battery life. The IoT-powered app, in contrast, features a battery-monitoring game to track battery vitality, including an overview of the voltage and current of the battery. This results in the more effective control of energy resources, and longer battery life.
3. **Vehicle Security:**
   Majority of EVs at this instance still employ old-fashioned key-based security as tickets for unauthorized way in. The invention improves the safety of a vehicle by providing an access control system based on cards (e.g. radio frequency identification, hereinafter RFID) or near field communication (hereinafter NFC), which substantially decreases risks of the vehicular robbery and unauthorized usage and significantly increases authenticity of authorized users.

4. **Accident Detection and Response:**
   Although many cars come equipped with crash detection capabilities, they are generally not in direct contact with first responders. The internet of things (IoT)-enabled application promotes security by recognizing accidents and reporting them to emergency contacts along with GPS coordinates, thereby reducing the response time for an emergency and reducing its severity due to robust delay.

2.4 Summary

In this chapter, we focus on the IoT-Based Solar Powered Smart EV System and explain about its ability to integrate renewable energy as well as IoT technology to solve existing problem which were lacked by normal electric vehicles (EVs). Highlights are solar-enabled charging, 24/7 battery monitoring, accident detection and alert system, GPS tracking and advanced security via card-based access control. The system is designed to enhance efficiency, safety and sustainability in EVs.

Review of related works: The literature review shows the existing GPS, GSM and RFID based vehicle tracking and safety system that influences the design in this project. Comparison with conventional systems reveals the benefits of proposed solution in terms of energy utilization, security and accident detection.

Finally, we conclude the chapter with an outlook on how such a smart EV ecosystem could transform our notion of transportation by supplanting today's vehicles by environmentally safer, smarter, and better secured electric cars.

CHAPTER 3
PROJECT DESIGN

3.1 Introduction

In recent years, there has been a considerable evolution in sustainability and intelligent mobility solutions based on the increasing problems of environmental pollution, climate change and depletion of fossil fuel sources. Conventional petrol and diesel cars are significant sources of air pollution and planetary carbon emissions. As a reaction, Electric Vehicles (EVs) have risen as a clean, efficient and environmentally-friendly solution. Electric vehicles (EVs) which are helping in decreasing reliance on fossil fuel as well as reducing operational costs and hence tend to support the world-wide movement for “green energy”. However, while conventional EVs offer benefits they still suffer from drawbacks: biasing towards the grid charging, poor status and security features.

To overcome these limitations, this project proposes an IoT Based Solar Powered Smart EV System that integrates renewable energy, real-time IoT monitoring, accident alert mechanisms, GPS-based location tracking, and secure card-based engine control. The aim is to develop a sustainable, intelligent, and secure EV system that enhances safety, reliability, and user convenience.

3.2 The list of Devices used in the Project is Given Below

- ESP-32
- Node MCU.
- Buck Module.
- Battery.
- GPS Module.
- Triple Axis Accelerometer MPU-6050.
- Arduino NANO
- RFID Module
- Voltage Sensor
- LCD Display
- Solar Cell

3.3 System Design

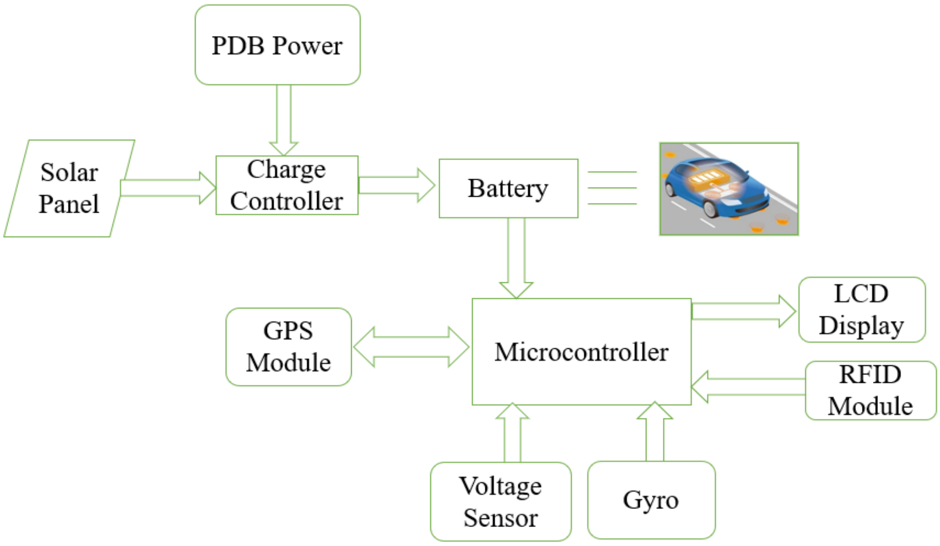


Figure: 3.1 Basic system design

The block diagram depicts a Solar-Based Adaptive Vehicle Monitoring and Control which automates operations with Renewable energy using sensors. The Power Distribution Board (PDB) is a crucial component in the system that manages and distributes electrical power from the main power source in this case, the battery to various modules such as the microcontroller, sensors, GPS, LCD display, and RFID module. The solar panel is the secondary source of electricity, generating power from sunlight. This electricity is regulated by a charge controller that ensures the battery is filled up properly and not over- or undercharged. The energy is stored in the battery so it can keep working when there isn’t a lot of sunlight. The microcontroller is the brain of system that processes inputs from various sensors. The gyro sensor provides balance, the voltage sensor calculates power levels, the RFID module allows for safe access and GPS provides location tracking. Voltage, location and system status are displayed on an LCD. These elements interplay together to design a green, smart and cost effective system which will eventually contribute not only to the reduction of reliance on fossil fuels but also in transporting people more sustainably.

By using solar power together with smart sensors and microcontroller control, the system works efficiently, intelligently, and sustainably. It uses less of non-renewable energy and makes vehicle operations more automatic. Overall, this system shows how combining solar energy with advanced technology can create smart and eco-friendly transportation solutions.

Work Flow chart

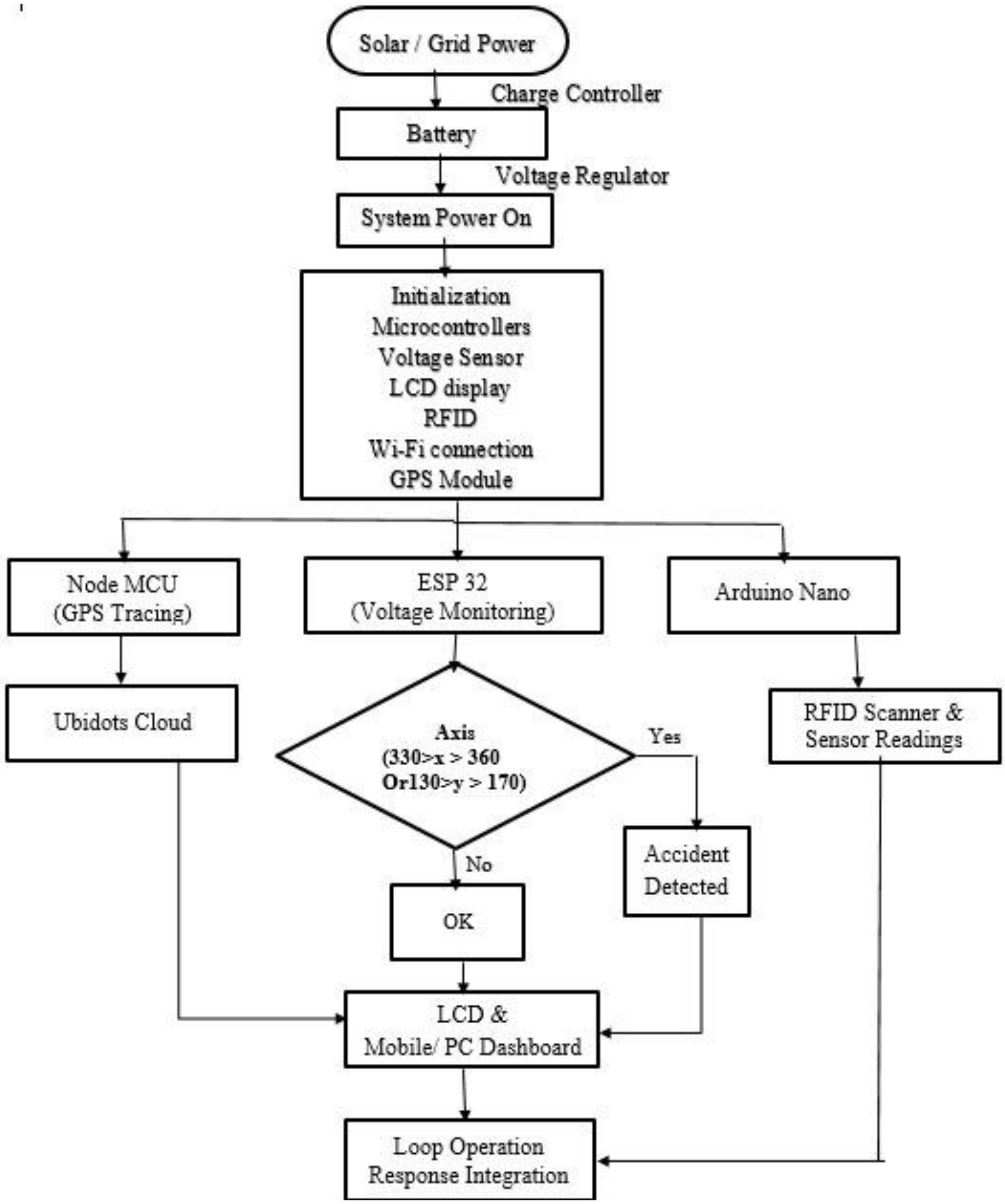
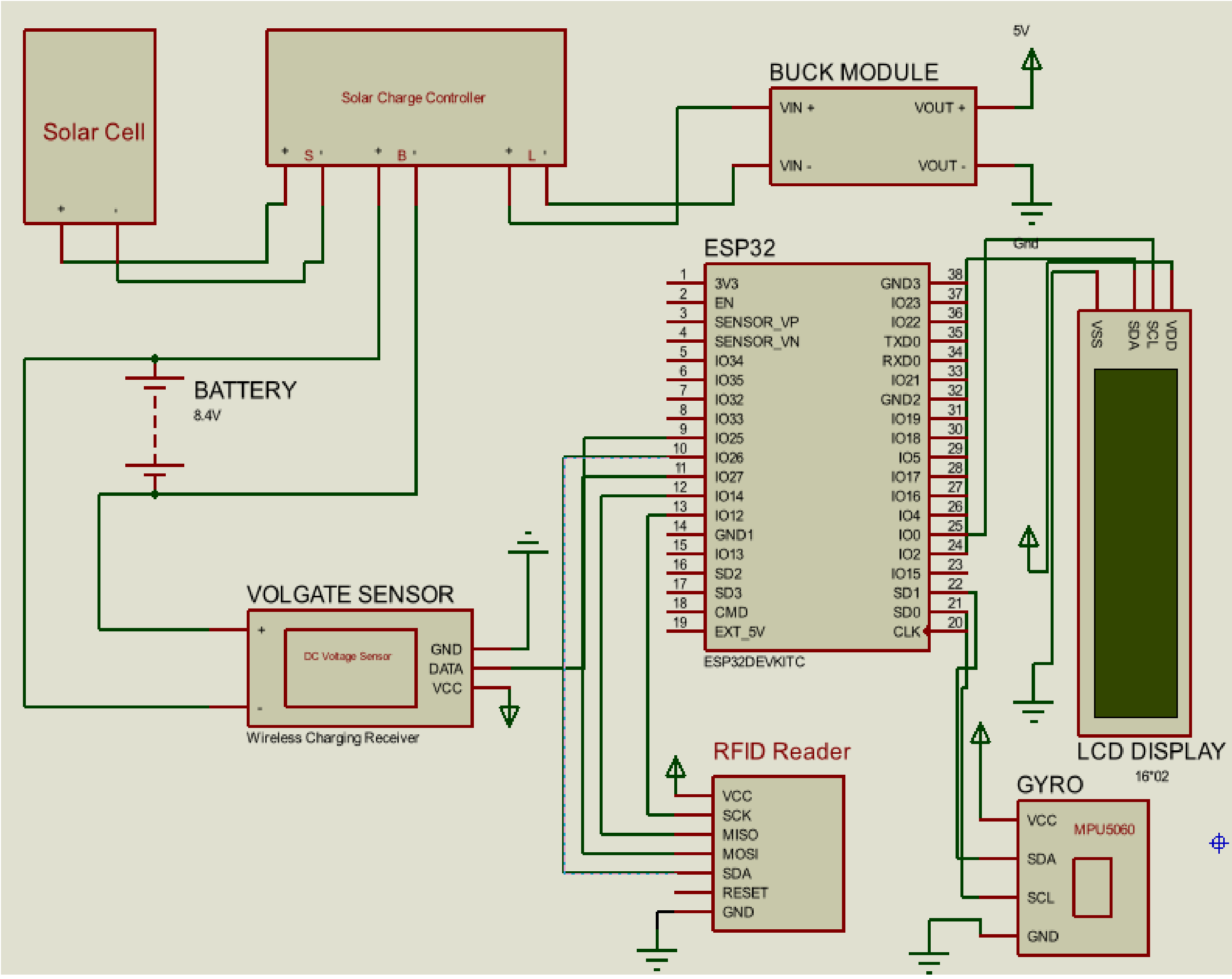


Figure 3.2: Workflow Diagram

3.4 System Circuit Design



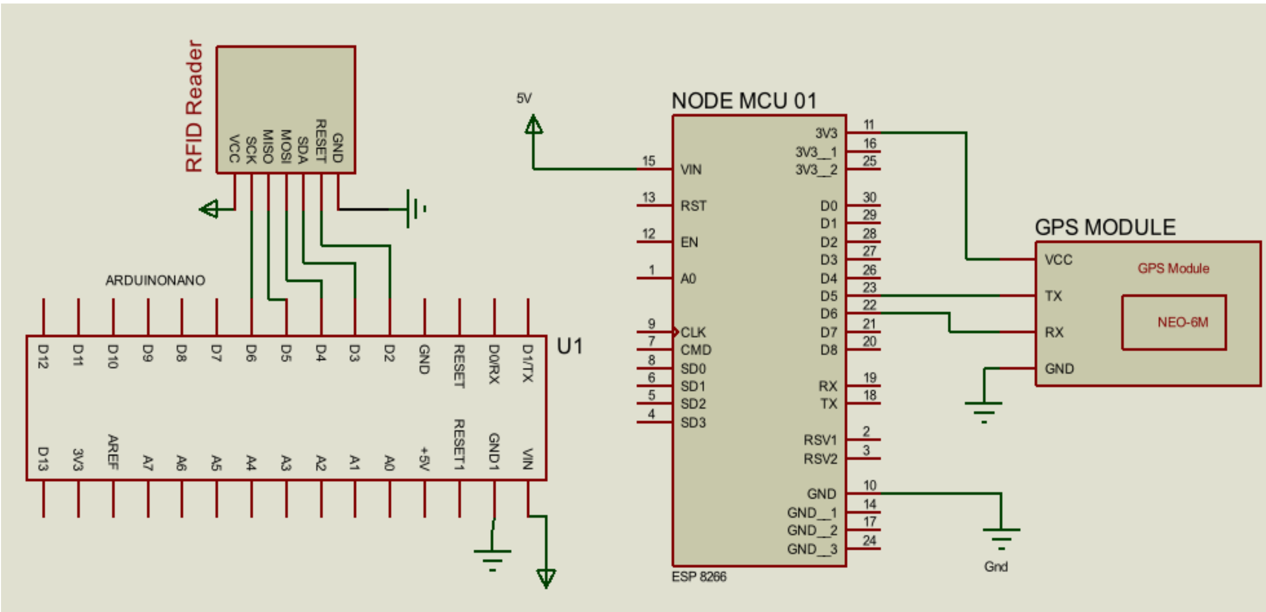


Figure 3.3: Circuit Design

3.5 Project Setup

Arduino NANO

Arduino Nano is an embedded version of Arduino that works with surface mount breadboards and has built-in USB. It is the smallest Arduino module that is fully functional and works with breadboards. It includes all the electrical features of the Decimal/Duemilanove, plus more analog input pins and a +5V AREF jumper on board. It doesn't have a power jack on it. The Nano automatically detects and switches to the higher potential power supply, so you don't need the power choose jumper.

There are many ways to connect the Nano 3.0 to a computer, another Arduino, or other microcontrollers. The ATmega328 has UART TTL (5V) serial communication, which can be used on digital pins 0 (RX) and 1 (TX).

The board has a CH340G chip (which replaces the FTDI FT232RL) that sends serial data over USB. The CH40G drivers that come with the Arduino software make a virtual com port for software on the computer. There is a serial monitor in the Arduino software that lets you send and receive simple text data to and from the Arduino board. When data is sent from the CH340G chip and USB connection to the computer, the RX and TX LEDs on the board will flash. This does not happen when serial communication is happening on pins 0 and 1.

Arduino Nano Technical Specifications:

- Microcontroller: Atmel ATmega328
- Operating Voltage (logic level): 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O: Pin 40mA
- Flash Memory: 32KB (of which 2KB used by bootloader)
- SRAM: 2KB
- EEPROM: 1KB
- Clock Speed: 16MHz

Figure: 3.4: Arduino NANO

ESP-32

Espressif Systems created the ESP32, an amazing microcontroller and system-on-chip (SoC). It's commonly used in various IoT (Internet of Things) applications since it is versatile, inexpensive and has many capabilities. The ESP32 has these features:

Microcontroller: There's a dual-core Xtensa LX6 CPU that can be clocked at up to 240 MHz. Dual-core is designed to let you do more things at once with well-rested performance.
Wireless connection: One of the things I really like about the ESP32 is that it actually has Wi-Fi and Bluetooth built into it. It supports Wi-Fi 802.11, b/g/n/e/i, Bluetooth v4. 2 BR/EDR, and BLE (Bluetooth low Energy) for IoT application which requires both power performance and long-range wireless experience.
Memory: The ESP32 contains several types of Flash memory and SRAM for code execution and data storage.
Peripheral Interface: The ESP32 provides a rich interface like SPI, I2C, UART, CAN, I2S and more. These interfaces enable the ESP32 to communicate with sensors, actuators, displays and other devices.
Security: Security is one of the main concerns in IoT applications, and the ESP32 has a lot of security features including hardware accelerated encryption (AES, SHA2, RSA), safe boot, and flash encryption to secure data while also protecting its firmware.
Low Power: ESP32 is a low power solution which is pretty cheap and can connect to WiFi, allowing your coin t be online! It has a variety of power-saving modes and features due to its deep sleep mode that enables the device to save up on energy consumption when idle.
Development Tools: Relating to tools for programming the ESP32, Espressif provides a variety of beneficial resources and tools which are available in a form of an 'ESP-IDF' (Espressif IoT Development Framework) based on tools such as command line compilation

tool with built-in utility functions for flashing and test performed, The platform IO IDE or Arduino IDE with Board Support Package.

Community Support: The ESP32 benefitted from the support of an active and enthusiastic community that shared libraries, examples and specific tutorials that help beginners to start working with it and professionals who can find solutions for all the problems they may have.

In summary, the ESP32 makes for a flexible and powerful microcontroller platform which factors why it has been so popular among IoT enthusiasts — combing features with performance and price.

ESP-32 Technical Specification

- Microcontroller: Tensilica 32-bit Single-/Dual-core CPU Xtensa LX6
- Operating Voltage: 3.3V
- Input Voltage: 7V to 12V DC
- Digital I/O Pins (DIO): 25
- Analog Input Pins (ADC): 6
- Analog Outputs Pins (DAC): 2
- UARTs: 3
- SPIs: 2
- I2Cs: 3
- Flash Memory: 4 MB
- SRAM: 520 KB
- Clock Speed: 240 Mhz
- Wi-Fi: IEEE 802.11 b/g/n/e/i

Figure: 3.5: ESP-32

Node MCU

Node MCU is an open-source IoT platform, you can use for FREE. It has hardware and firmware based on the ESP-12 module developed by Espressif Systems. Note: The term "Node MCU" usually refers to the firmware instead of kits. The firmware uses Lua as a scripting language. This is based on the eLua project, and built on Espressif Non-OS SDK for ESP8266. It relies on a number of open-source projects, like lua-cjson and SPIFFS.

Node MCU followed soon after the ESP8266. Espressif Systems began developing the ESP8266 in September 2013 (it was pushed as open-source on January 24, 2014). The ESP8266 is a Wi-Fi SoC which has the Tensilica Xtensa LX106 core integrated. You can find it in action in lots of IoT projects (check the related projects). First node mcu-firmware file was published at GitHub by Hong on October 13, 2014—this is where Node MCU started. As two months passed, this project expends into an open-hardware framework when Huang R, expansion the use of an gerber file for a ESP8266 board which called devkit v0. 9.

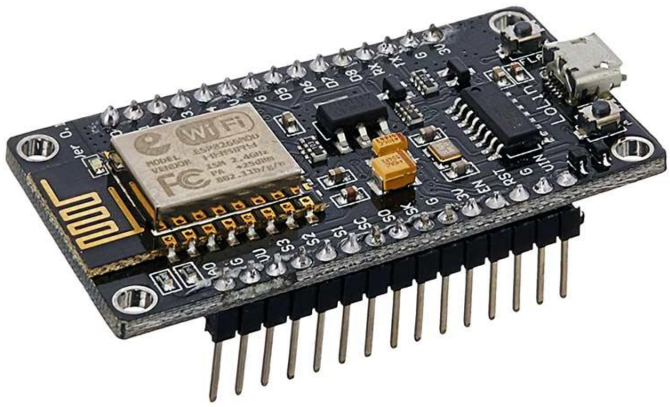


Fig- 3.6: Node MCU

Node MCU Technical Specifications

- Power input: 4.5V ~ 9V (10VMAX), USB-powered
- Transfer rate: 110-460800bps
- Support UART / GPIO data communication interface
- Support Smart Link Smart Networking
- Working temperature: -40°C ~ + 125°C
- Drive Type: Dual high-power H-bridge
- Don’t need to download resetting
- A great set of tools to develop ESP8266
- Flash size: 4MByte
- Lowest cost WI-FI

Buck Module

The LM2596 series of regulators are monolithic integrated circuits that accomplish all the work of a step-down (buck) switching regulator and can power a 3-A load with great line and load regulation. You can get these devices with fixed output voltages of 3.3 V, 5 V, 12 V, or an adjustable output version.

Figure 3.7: LM2596 Voltage Converter

These regulators are easy to operate because they don't need many external parts. They also have inbuilt frequency compensation and a set frequency oscillator. The LM2596 series switches at 150 kHz, which means that the filter parts can be smaller than they would be with switching regulators that switch at lower frequencies. It comes in a regular 7-pin TO-220 box with a few different ways to bend the leads, as well as a 7-pin TO-263 surface mount package.

Battery

The best lithium battery to build in 2013 was the 18650-battery cell type, which Panasonic first produced in 1994. The battery was primarily a larger, longer and heavier than the standard AA batteries as they indicate the size of the cell model. It measured 18mm x 65mm for the18650. These batteries typically range from 2,300 to 3,600 MAh in size and between 3.6-3.7 volts in voltage.

Figure 3.8: Li-po Battery

The cells peaked in 2011, but there was a resurgence in demand for them when electric cars like the Tesla were introduced. These batteries were also in demand for drones, medical devices, and military-aero gear. There were approximately 2.55 billion [24] 18650s produced in 2013. The batteries were consistent, and inexpensive to manufacture on a per watt hour level.

When you look around at the market now, a heap of devices had big changes forced onto their designs. Tablets and smartphones, for example, were growing thinner and flatter as they demanded more power. Demand for these types of cells fell in these markets, but manufacturers overproduced them because they were concerned about a shortage of batteries for electric vehicle, mil-aero and medical applications. But as electronics consume more and more power, batteries with even greater capacity will soon be needed. That's where cell types such as the 21700 may be able to help.

GPS Module

The project is made by the use of u-blox NEO-6M global positioning system module. It is a very popular, inexpensive, and high-performance GPS module with a ceramic patch antenna, an onboard memory chip, and a backup battery that can be easily be connected to a wide range of microcontrollers. Right now, the GY-GPS6MV2 and GY-GPSV3-NEO are the two NEO-6M GPS modules that are very popular.

The NEO-6M GPS engine in these modules is really good, and it works well indoors because it is very sensitive. There is a rechargeable battery which works with the MS621FE, and an EEPROM for saving configuration settings. The module works well with a DC input between 3.3 and 5v because it has a built-in voltage regulator. As indicated, the GPS modules are based on the u-blox NEO-6M GPS engine. The type number of the NEO-6M is NEO-6M-0-001, and its ROM/FLASH version is ROM 7.0.3 (PCN reference UBX-TN-11047-1). The NEO-6M module includes one configurable UART

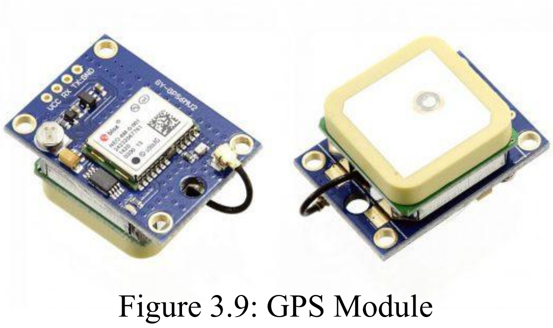


Figure 3.9: GPS Module

There is one interface for serial transmission, although the default UART Baud rate is 9,600. Because the GPS signal is right-hand circular-polarized, the GPS antenna differs from a whip antenna, which is commonly used for linear-polarized transmissions. The patch antenna is regarded to be the most prevalent type of patch antenna. Patch antennas are generally flat, with a main body that is composed of ceramic and metal. They are typically connected to a metal base plate. These are invariably set inside a housing. To discover more information about their supplier's reference designs, please visit the u-blox website. For the GPS receiver to operate properly, the mounting location of the antenna is extremely critical. The patch antenna should be installed parallel to the geographic horizon when you use it. The antenna should be visible to the entire sky so that it can have as much LOS to as many satellites as feasible.

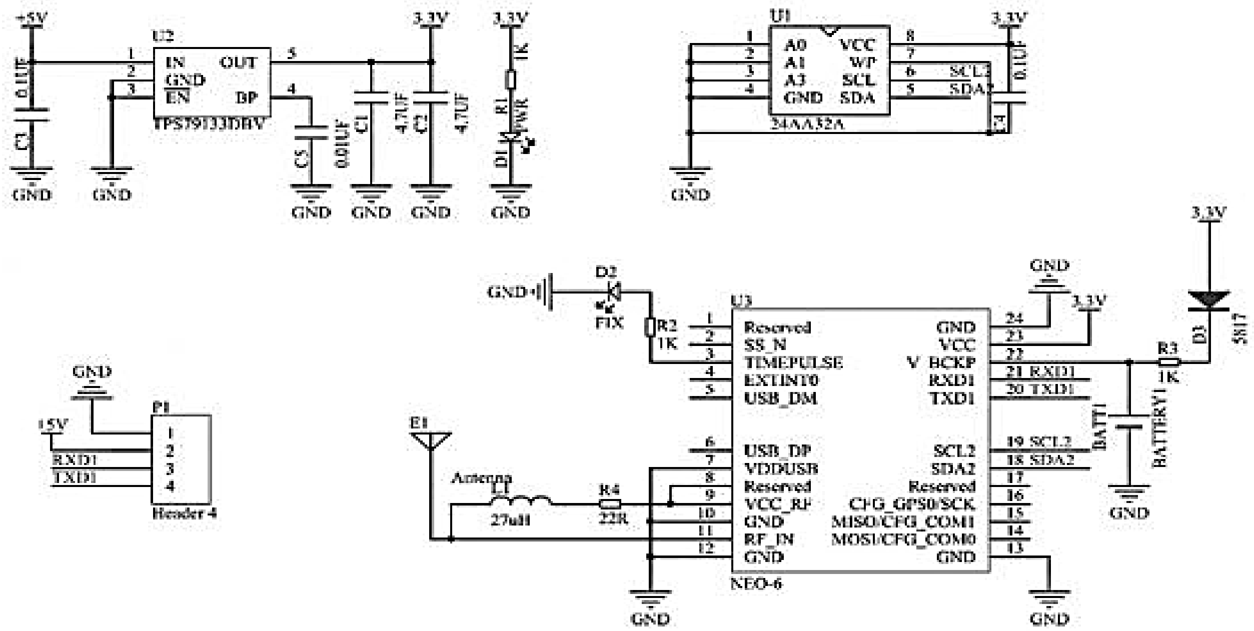


Figure 3.10: Circuit Diagram of GPS Module (Research Gate)

Triple Axis Accelerometer MPU-6050:

The breakout board for the MPU-6050 MEMS embodies the GY-521 module. The digital motion processor incorporated SMA6861 into the 6050-sensor board. DMP fundamentally means that onboard a 6050-sensor board, you can run complicated algorithms right on the board. Generally, the DMP runs algorithms that change the raw sensor signals into stable position data but also enables more complicated features. That's it. This lesson merely contains a brief overview of the GY-521/MPU-6050. This demonstration just illustrates how to acquire the raw values from the sensor. To fetch the sensor's values, I2C serial data bus was s used. This bus only needs two lines" SCL and SDA.

Triple Axis Accelerometer MPU-6050 Technical Specifications

- MPU-6050 module (three-axis gyroscope + triaxial accelerometer)
- Chip: MPU-6050

- Power supply:3-5V (internal low dropout regulator)
- Communication: IIC communication protocol standard
- 16bit AD converter-chip, 16-bit data output
- Gyro Range: ± 250 500 1000 2000 o / s
- Acceleration range: ± 2 ± 4 ± 8 ± 16g
- Using Immersion Gold PCB, welding machines to ensure quality
- 2.54mm pin spacing
- Size: 2x1.6x0.1mm

Figure: 3.11: Triple Axis Accelerometer MPU-6050

RFID Module

Radio frequency identification (RFID) is a way to automatically identify things by storing and retrieving data from a distance using devices called RFID tags or transponders. An RFID system is a tiny radio transponder that can send and receive radio signals. When a reader device sends an electromagnetic read pulse to the tag, the tag sends digital data, like an identifying inventory number, back to the reader. We used this number on items that are in stock.

The RFID reader sends out radio waves that passively energize the tags. Active tags have batteries that power them, and the RFID reader can read them from a longer distance (for example, they can be read hundreds of meters away).

Figure 3.12: RFID Module

The tag doesn't have to be in the reader's line of sight like a barcode does, thus it can be within the object being tracked. RFID is one way to automatically identify people and collect data (AIDC).

RFID Technical Specifications:

- Operating Current :13-26mA/DC 3.3V
- Idle Current :10-13mA/DC 3.3V
- Sleep Current: <80uA
- Peak Current: <30mA
- Operating Frequency: 13.56MHz
- Supported card types: mifare1 S50, mifare1 S70, mifare UltraLight, mifare Pro, mifare Desfire and mifare Classic
- Environmental Operating Temperature: -20-80 degrees Celsius
- Environmental Storage Temperature: -40-85 degrees Celsius
- Relative humidity: relative humidity 5% -95%
- Data transfer rate: maximum 10Mbit/s
- Size: RFID-RC522 Module:3.9 x 6 cm The Standard S50 Blank Card :8.5 x 5.4 cm
- Diameter of S50 special-shaped card: 3.1(max)

Voltage Sensor

The Voltage sensor can tell the difference between 0.0245V and 25V of supplied voltage. The resistor divider theory is what this module is based on. This module lets the input voltage drop by five times. The input voltage for this module can't be more than 25V because the Arduino or microcontroller analog input voltage can only be 5V. If you connect 25V DC to Vin, the 'Sig' pin will give you 5V.

Figure: 3.13 DC Voltage Sensor

Voltage Sensor Technical Specifications:

- Voltage input range: DC 0-25V
- Voltage detection range: DC 0.02445V-25V
- Voltage Analog Resolution: 0.00489V
- DC input connector: Terminal cathode connected to VCC, GND negative pole Output interface: "+" connect 5/3.3V, "-" connect GND, "s" connect the Arduino AD pins.

LCD Display

A flat screen that exploits the light-modulating properties of liquid display is called an LCD. They are widespread in things like video players, game systems, clocks, phones, computers, calculators, and more.

There are 16 columns and 2 rows on a (16×2) LCD panel. It can display 16 characters in two lines.

Pin	**Function**
VSS	attached to the ground
VDD	connected to power at +5V
VO	to change the contrast
D0–D7	to write and read data
R/W	A Read/Write pin allows the user to select reading or writing.

Pin	Function
RS	A register select pin that indicates to the LCD whether an instruction or data command is being sent. You can choose between the instruction register, which the LCD's controller looks at to determine what has to be done next, and the data register, which stores what appears on the screen.
E	A pin you can use to read the data when it receives a High logic (1) signal. Then when the signal transitions from a High level to a Low level, you execute your instructions.
A	Buttons that power the LCD backlight on and off. Connect A to 3.3V.
K	Pins which enable and disable the LCD backlight. Link K to GND.

Table 01: LCD Display Outline

Similar products:

1. LCD Display 16X2 with Header soldered
2. LCD display module 16X2
3. LCD display module advanced 16X2
4. 3 wire LCD module 16X2
5. I2C LCD Display 16X2
6. Arduino LCD keypad shield
7. LCD Display (16X2)

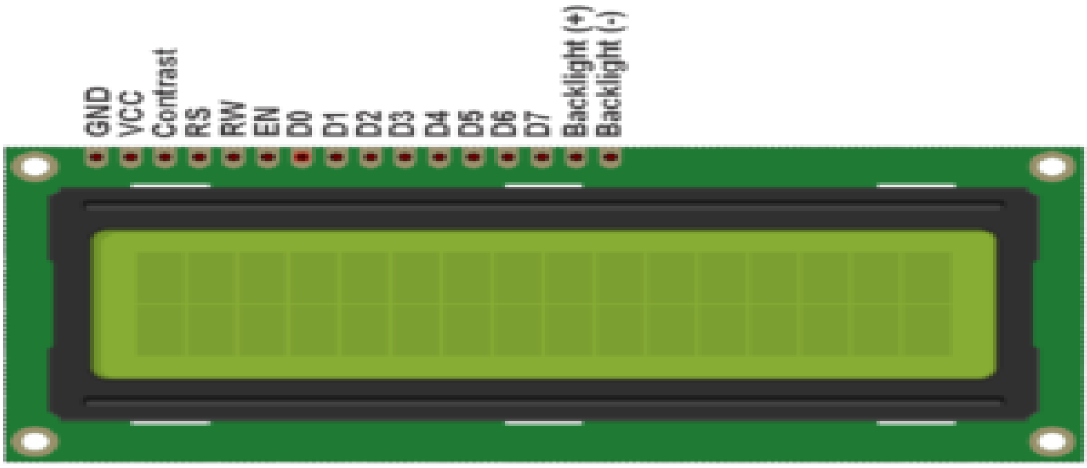


Figure: 3.14 LCD Display

Solar Cell

By means of the photovoltaic effect, a solar cell (also called a "PV" cell) is able to convert light directly into electricity. Solar panels are made of solar cells. They are integral to many renewable energy systems, for homes, electric cars and businesses. The solar cell is an essential technology of renewable energy to efficiently convert the sunlight into electric power. In initiatives such as a smart EV that is solar powered, solar cells have a vital function in the sustainable charging of batteries, decrease reliance on grid and drives green mobility.

Figure: 3.15 Solar Cell

Solar cell Technical Specifications:

- **Voltage (Vmp):** 1.2 V
- **Current (Imp):** 100 mA – 500 mA (depends on size & quality)
- **Open Circuit Voltage (Voc):** ~1.5 V
- **Short Circuit Current (Isc):** ~120 mA – 550 mA
- **Power Output (Pmax):** 0.12 W – 0.6 W
- **Material:** Monocrystalline or Polycrystalline Silicon
- **Dimensions:** ~60 mm × 60 mm (varies by model)
- **Operating Temperature:** –20 °C to +60 °C
- **Application:** Small IoT devices, sensors, battery charging (1.2 V NiMH), mini-Arduino projects

Developed Project:

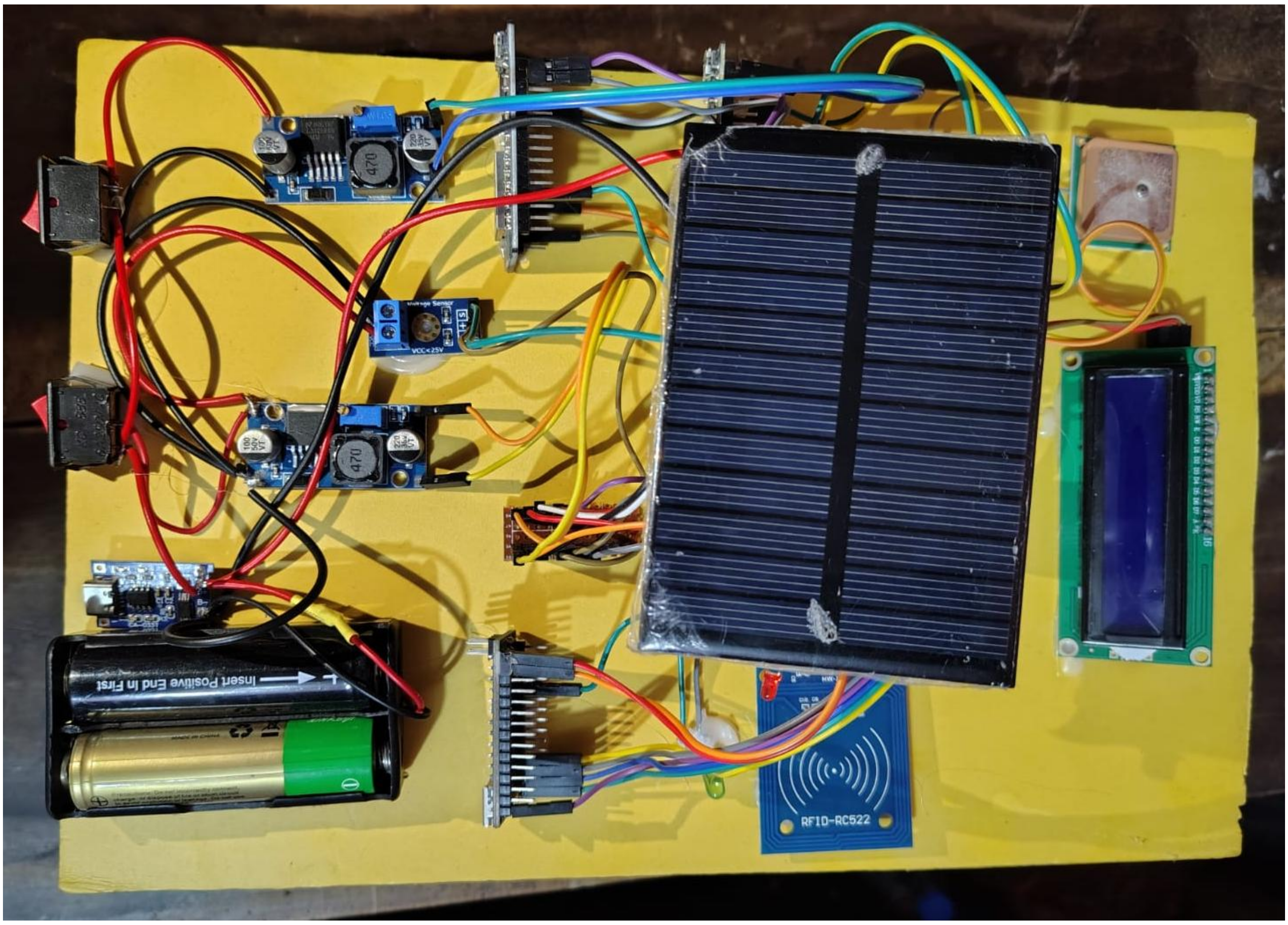


Figure: 3.16 Developed Project

3.6 Summary

The entire chapter 3 gives description of the materials, hardware, and software used in the development implementation of the Iot-Based Solar Powered Smart EV (Vehicle) System. The chapter highlights the combination of renewable solar energy and intelligent IoT techniques to realize a sustainable, efficient, and secure EV system. To solve the problems of traditional EV, including grid-connected charging reliance, poor intelligence and security protection etc., this system utilizes the facilities for self-power generation as well as its own control which could keep eyes on real-time information.

At the hardware level, we are using an ESP-32 and Node MCU microcontroller acting as a processor and communication core for the overall system. These are for data processing, control of the board and wireless communication: Wi-Fi and Bluetooth. The GPS module allows for real time vehicle tracking, and the MPU-6050 accelerometer provides motion detection and accident notifications. RFID module to improve vehicle safety using the card to take power, you want to implement for the engine start (card security). Power. The Voltage sensor keeps an eye on your machine’s power 24/7, and the LCD screen displays all the info in real time! The solar cell is main power supply source that generated electrical energy from sunlight and stored in lithium-ion batteries by a buck converter and charge controller.

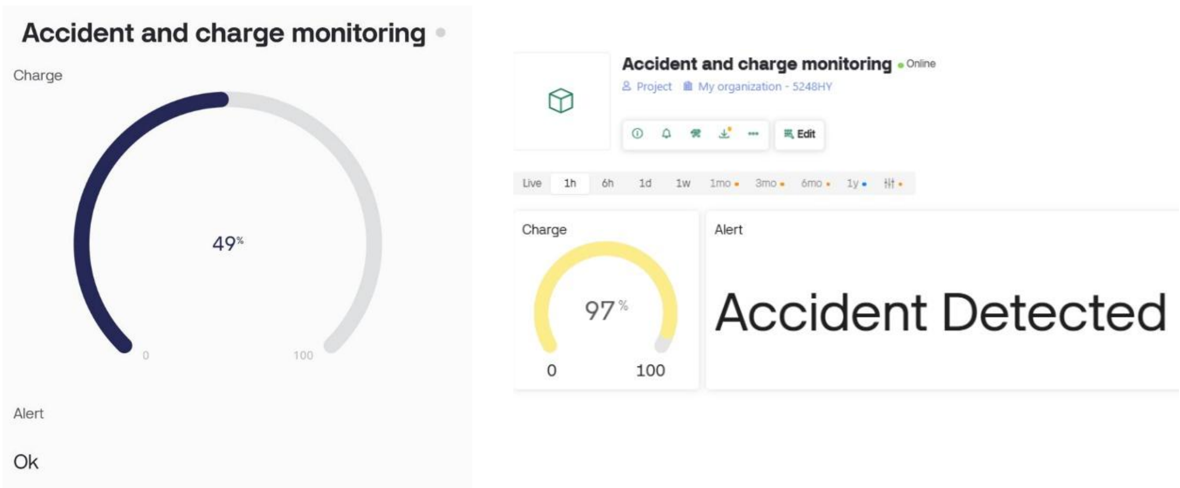
The system structure, circuit implementation, and experimental configuration are reasonably organized for the efficient energy supply, high reliability and strong robustness. The logical flow of power generation, data acquisition and processing, display and cloud-based monitoring is mapped out in the flowchart presented in this chapter which acts as the backbone of the proposed smart EV architecture.

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Result

The IoT Based Solar Powered Smart EV Project combines solar power charging, IoT based battery monitoring, accident alert system, GPS location tracking and card based engine control to form an effective and intelligent as well as secure electric vehicle system making it a sustainable approach. The following findings were made as part of the pilot and implementation process.

The photovoltaic panels worked conveniently well in charging the EV battery under different luminance. The charge controller kept the voltages and current at an optimum level, which would not only allow to readily charged up the battery but also always protect the battery. Electricity via solar reduced the dependence on grid power significantly during working hours. The system proved to have reliable solar integration, providing a consistent charge even on partly cloudy days.

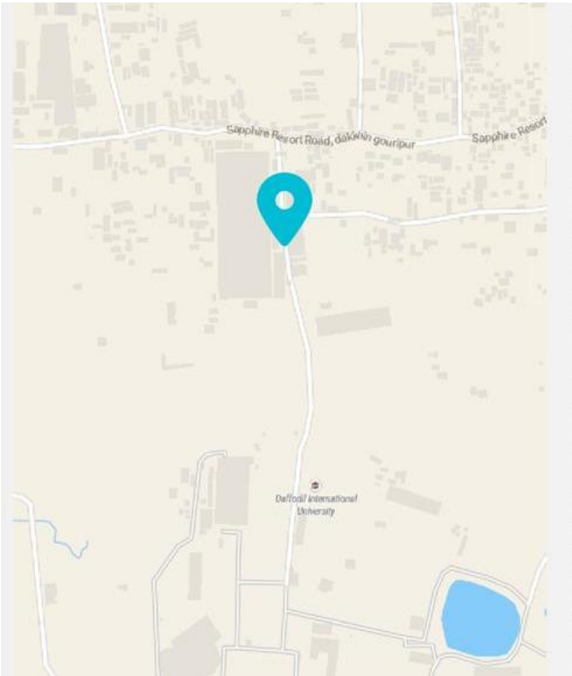


(a) (b)

Figure 4.1: IoT Accident Alert System (a: Normal Mode, b: Accident Mode)

Wireless monitoring of the battery voltage, current, and state-of-health in a real-time operation was also demonstrated by these systems using IoT platforms (Blynk [23], Thingspeak, or Firebase). Users get immediate notifications for low battery, over-charging, and abnormal status via mobile / web applications. The machine even had a system to allow the battery health to be seen by the user, remotely so that businesses could do preventive maintenance on the machines and have a longer lasting battery. Analysis of data logs revealed correct battery performance measurement, thus verifying the operations of the IoT monitoring system.

Collisions or any sudden impact were reliably detected by the accelerometer-based accident detection system. In the event of a crash, real-time notifications were transmitted with the EV's GPS location to designated contacts or authorities. The notification delay was less than 5 s, which can provide timely notification and achieve rapid emergency response. The tests controlled and found that the system is highly effective in mitigating road safety.



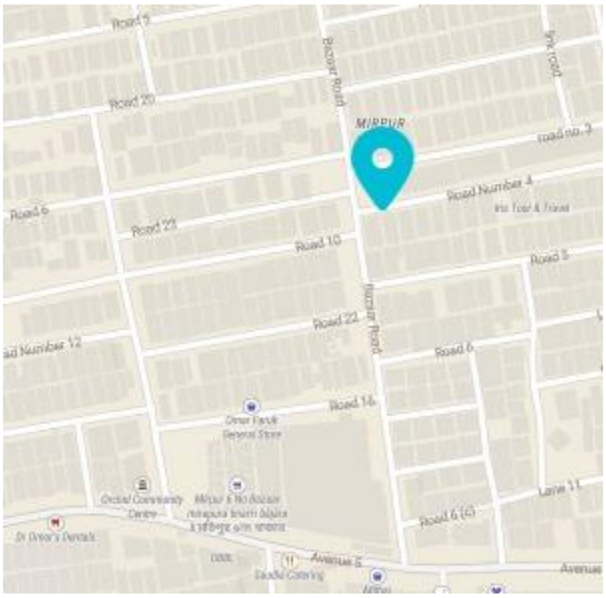


Figure 4.2: IoT Location Monitoring System

The real time feature of this GPS module is used to track the location of vehicle. The EV location could be accessed by users remotely on the IoT platform to facilitate location tracking of the vehicle and adding security or recovery services in case of theft for example. The new information was transmitted every 1–5 s using GPS position updating, so that continuous global tracking of images both in metropolitan and rural settings was achieved.

The RFID/NFC card based engine control system achieved the desired implementation of limiting unauthenticated access. Only authorized cards could initiate the EV but invalidated cards were refused access to guarantee increased vehicle safety. The device automatically replied instantly to indicate whether a card was authenticated through the indicator LED or displayed on the IOT dashboard. Test testing verified that the card-controlled engine immobilizer was successful in deterring misappropriation or theft of the vehicle.

The integration of all subsystems (solar charging, battery monitoring, accident alert, GPS tracking and secure engine control) in one IoT platform was successfully made. The system included an easy-to-use user interface to allow remote monitoring, control and alerting. Power control and protection, safety and security work all worked fine under various operational conditions. The project achieved the real feasibility on a sustainable, intelligent and security EV system that will lead to future enhancements and commercialization.

The findings of the IoT Based Solar Powered Smart EV Project present that the incorporation of solar power element with IoT monitoring, accident alert system, GPS tracking and card based secured access is a strong, intelligent and environment friendly electric vehicle solution. The project resolved the urgent problems of traditional electric vehicles (EVs), such as energy supportability, safety protection, battery management and vehicle prevention and confirming the feasibility or validity of the developed system.

Figure 4.3: LCD Monitoring System

4.2 Discussions

The IoT-Based Solar Powered Smart EV Project effectively accomplishes its fundamentals to offer a sustainable, intelligent and secure electric vehicle system that combines solar charging, IoT monitoring system, accident detecting system, GPS tracking system and smart access control module. The solar subjects have shown steady performance in a wide range of sunlight conditions, even under partly cloudy conditions, and cut grid power usage rates by significantly, excluding the night time demand. This is aligned with the pursuit of environmental sustainability, and can further facilitate EV operation in regions where there are no charging facilities. The charge controller regulated voltage and current to improve conversion efficiency, prevent overcharging, and ensure battery safety. This is evidence of the system being in excellent practical agreement with the theoretical assumptions about solar energy utilization and charge regulation. Furthermore, the IoT-based battery monitor achieved real-time monitoring of important parameters such as voltage, current and state-of-charge, and it delivered alarms for abnormal battery states. These characteristics obviously increased user knowing and also supported preventive maintenance, making the battery have longer useful life while also being higher in operational reliability when use by EVs.

The project had clear success in safety and security. The accelerometer-driven accident detection system detected crashes accurately and sent out alerts with GPS location to preset emergency contacts in less than 1 min thus, serving the purpose of quick help services and ensuring maximum safety. Live GPS tracking also guaranteed that users had the ability to track their vehicle in real time, increasing theft prevention and location-sharing.

CHAPTER 5
PROJECT MANAGEMENT AND FINANCE

5.1 Task, Schedule and Milestones

Start and stop of a job this section describes the beginning and ending of a project, and denote completion of some major task. Clarification on how the schedule/milestone is distinct from that described in Introduction chapter shall be made. The IoT Based Solar Powered Smart EV Project was implemented in a well-organized timeline that addressed all the main stages starting from initial plan to final evaluation. The overall project length was approximately sixteen (16) weeks, which were segmented into milestones in order to keep up with deadlines and make steady progress.

The first 2 weeks were used to establish the project goals, gather references and research on related art. For the next three-week period circuit design and system architecture development was conducted, followed by four weeks of hardware assembly, sensor calibration and solar integration. Development of software and integration of IoT took place within next three weeks i.e programming Node MCU, GPS, RFID modules. Testing and debugging process lasted for roughly two weeks, verifying that all subsystem can work really well and stably. The last 2 weeks were used to document, analyze results, and prepare project presentations.

Each of these was a major milestone in the development path—from concept and system design to realization of the IoT-based smart EV prototype. This staged structure provided a means for resource to be used effectively and gave each part of the design team an chance to sign off before work moved forward resulting in completion of the project on time, within budget with no rework.

5.2 Resources and Cost Management

Efficient use of resources and keeping the budget in check were conducted strategically to make this project a success. As pm's we wanted to maximize our use of the hardware we got, at the same time be cost-effective and continue to not compromise quality. The selected set of hardware ESP32, Node MCU, GPS module, RFID reader, voltage sensor and the solar panel as well as display unit is the most appropriate in terms of performance as well as cost. Local components were used, wherever possible to minimize the procurement lead time and cost.

A complete budget was developed at the outset of this study to assign costs for each section, testing instruments, and supplies. Expenses were monitored carefully while the project was being implemented to ensure compliance with the budget. Repeatable materials from laboratory stocks were also efficiently used to minimize spending. Arduino IDE, Proteus and Blynk were utilized also to eschew licensing fees (Software: Open-source software such as Udibots, proteous and blynk was employed ultimately in order to avoid licensing cost).

Efficient resource usage and cost optimization was another factor for the success of this project. Our focus, as project managers, was "doing more with less", which meant utilizing limited hardware and financial resources without diminishing quality. The components; ESP32, Node MCU, GPS module, RFID reader and voltage sensor were chosen due to their performance, compatibility and price efficiency while the solar panel and display unit we chosen solely based on cost. The local availability of components was preferred to minimize the purchasing time and cost.

An explicit budget plan was established at the outset of the project to earmark costs for each component, test equipment as well as support materials. Costs were carefully controlled during execution to avoid budget overrun. Reusable supplies from the laboratory inventory were used to minimize cost. Moreover, open-source tools such as Arduino IDE, Proteus and Blynk were employed to save on commercial license fees.

Sl No.	Components Name	Quantity	Price
1	Arduino Nano (R3)	1	580/-
2	Node MCU(ESP-8266)	1	350/-
3	Solar Panel	1	350/-
4	LCD Display (16*2)	1	250/-
5	Battery (18650-Lithium)	2	340/-
6	RFID Module	1	220/-
7	GPS Module (NEO-6M)	1	990/-
8	WiFi& Bluetooth (ESP-32)	1	520/-
9	Gyro Sensor (MPU-6050)	1	230/-
10	Buck Module	1	200/-
11	Voltage Sensor	1	90/-
12	Connecting Wires	As per req.	100/-
13	LED	2	10/-

14	RFID Card	2	50/-
15	Battery Holder	1	50/-
16	Battery Charger	1	340/-
17	Connector	As per req.	100/-
18	Glue Stick	As per req.	50/-
	Total Cost		4870/-

Table 5.1: Components and Costing

Through efficient resource allocation, the project was completed within the estimated budget while ensuring high reliability, sustainability, and functionality of the overall system.

5.3 Lesson Learned

This technical work allowed lessons to be learnt for the practical utilization of IoT and a RE system, combined with embedded hardware technology. The biggest lessons were learned in how to integrate all these technologies like solar charging, real time monitoring and smart authentication into a working system. It took our technical abilities to another level in circuit design, programming for microcontrollers and debugging complex electronics.

It was also absolutely vital to do teamwork and communicate well in order to keep advancing in a fixed schedule. It reinforced the importance of testing, data validation and documentation to maintain system reliability. And, increased our commitment in sustainable engineering practices and how IoT-based renewable systems will be serving the Smart Eco-friendly transportation.

Altogether, this project kept our understanding orbited between academic knowledge and professional application in future for challenging career of Electrical and Electronic Engineering.

CHAPTER 6
IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

The IoT Based Solar Powered Smart EV Project As Direct Input To Sustainable Economic And Social Development.

Economic Impact: The model saves operation cost by tapping into abundantly available sunlight rather than grid electricity or fossil fuels. This would create more accessible and less grid-reliant electric mobility, lower costs for energy imports. Domestic production and servicing of solar–IoT products can also be a source for employment as well as technical entrepreneurship in Bangladesh.

Impact on society: The model increases public awareness about clean energy use and creates the infrastructure for intelligent transport networks. Additionally, both an accident-notification and GPS-tracking functionalities provide added passenger safety, and card-based authentication to minimize misuse or crime.

Global Impact: This project is directly related to UNSDGs. It works to promote the reduction of greenhouse-gas emissions and increase the shift to low-carbon transport systems, through development of renewable energy and smart technologies across a global scale.

6.2 Environmental and Ethical Issues

Environmental: This project shows a marked decrease of carbon emissions instead of grid as well fuel charging with solar. IoT based battery monitoring system helps in optimal utilization of energy, long life of the battery and decreased e-waste. The use of sustainable solar panels and low energy electronic modules achieves lower ecological impact.

Ethically: IoT connections, bring about data privacy concerns. The application is responsible for recording and sending information about the location, battery status, access history of the user. Thus, ethical deployment would entail strong encryption, user consent and data protection mechanisms that are in accordance with best practices for IoT security. Furthermore, safety and reliability have to be considered in order not to create damages based on false or bad notifications**.**

6.3 Utilization of Existing Standards or Codes

The design and implementation are consistent with international and institutional guidelines:

- **Electrical Safety:** IEEE Standard 80 and IEC 60364 for low-voltage DC systems.
- **IoT Protocols:** MQTT and HTTP standards for secure cloud communication.
- **Renewable Energy:** IEC 61724 for photovoltaic system performance monitoring.
- **Embedded System Design:** IEEE Embedded Systems Standards and Arduino/ESP SDK guidelines.
- **Environmental Compliance:** Restriction of Hazardous Substances (RoHS) for electronic components.

Adherence to these guidelines will provide a prototype that can be electrically reliable, network safe, and environmentally responsible developed.

6.4 Other Concerns

There are, however, some obstacles to implementation left (dependence on constant internet access required for ongoing IoT monitoring or relatively high price of solar panels). Future iterations must focus on comprehensive cloud-security architecture, enhanced weather-proofing of hardware and saving the cost by sourcing local components. Long term on-field evaluation and lifecycle analysis are desirable before mass utilization.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The IoT Based Solar Powered Smart Snow Mobile implementation is a practical demonstration of research which integrates renewable energy and internet of things, security control system and lock down access in to smart snow mobile. Through integrating solar battery charging, IoT based battery monitoring system, accident alert and GPS location data recording system and card-based motor control, the project successfully deals with challenges of a modern electric vehicle with respect to energy sustainability & road safety, user tracking/reporting and real time monitoring.

The project demonstrates, therefore, the possibility and successfulness of the integration between renewable energy and IoT intelligence inside EVs. It not only improves operational efficiency and safety but also significantly contributing to sustainable transportation solutions in the context of smart city and green energy programs.

Despite certain shortcomings (namely, the reliance on sunlight for solar charging processes and the risk of disruptions in GPS signals), this will act as a solid base for future development, including predictive maintenance using AI (artificial intelligence), vehicle-to-grid integration, and improved IoT security.

The project is a major step towards smart, environmentally friendly and safe electric vehicles, showing how advanced technology can be put to work for safer and more responsible easier.

7.2 New Skills and Experiences Learned

Sustainable Energy Utilization

- Solar-Powered Charging reduces dependency on the conventional electricity grid.
- Environmentally friendly, producing zero carbon emissions during operation.
- Helps in lowering operational costs by harnessing free solar energy.
- Supports off-grid and remote operation where conventional charging stations are unavailable.

Enhanced Battery Management

- IoT-based battery monitoring provides real-time updates on voltage, current, and state-of-charge.

- Alerts for low battery, overcharging, or abnormal conditions enhance battery reliability and lifespan.
- Remote monitoring allows users to optimize charging schedules and manage energy efficiently.

Improved Road Safety

- Accident detection system identifies collisions or sudden impacts instantly.
- Sends emergency alerts with GPS location to predefined contacts or services, reducing emergency response time.
- Can potentially save lives by enabling quicker medical or rescue intervention.

Real-Time Location Tracking

- GPS tracking lets anyone see where the car is at all times.
- Increases the security of the car, making it possible to get it back if it is stolen or used without permission.
- Supports applications like fleet management, route optimization, and geo-fencing.

Secure Access Control

- Card-based engine control (RFID/NFC) prevents unauthorized access or theft.
- Ensures that only authorized users can operate the vehicle.
- Particularly useful for shared vehicles, corporate fleets, or rental EV systems.

IoT-Based Remote Control and Monitoring

- A centralized IoT platform lets users watch and control many functions at the same time.
- Notifications, alerts, and data visualization enhance user convenience and system reliability.
- Enables future integration with cloud analytics, predictive maintenance, and smart city infrastructure.

7.3 Future Recommendations

- We can eventually put the whole circuit into a tiny module.
- A safety system that uses less power.
- Camera can be added to capture image of the Vehicle.
- In future a penalty system can be added with this IoT device.

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APPENDIX A

TURNITIN REPORT

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ORIGINALITY REPORT

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APPENDIX B

COMPLEX ENGINEERING PROBLEM SOLVING AND ENGINEERING ACTIVITIES

Complex Engineering Problems (P) Solving		
	Attributes	Statement from students
P1	Depth of knowledge required	Requires advanced knowledge in IoT integration, renewable energy systems, embedded programming, and hardware- software system architecture.
P2	Range of conflicting requirements	The system balances the conflicting needs of energy independence (solar charging) and operational reliability (real-time battery monitoring).
P3	Depth of analysis required	Hardware components were selected based on performance, compatibility, and affordability, with preference given to locally available components to minimize cost.
P4	Familiarity of issues	
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and conflicting requirements	Stakeholders (users, emergency services, manufacturers) face the consequence of delayed emergency response which is mitigated by real-time alerts and GPS data.
P7	Interdependence	The accident detection system is fully dependent on the GPS module/Node MCU to transmit location data for emergency response.

Complex Engineering Activities (A)		
	Attributes	Statement from students
A1	Range of resources	The project utilizes core knowledge in Electrical and Electronic Engineering, supplemented by specialized knowledge in IoT integration, embedded programming, and renewable energy systems.
A2	Level of interaction	
A3	Innovation	The design involved creating a unified system architecture to integrate multiple complex subsystems (solar charging, loT monitoring, secure access) into a single, sustainable, intelligent, and secure EV model.
A4	Consequences of society and environment	IoT-based smart vehicles with solar power improve efficiency, reduce emissions, and enhance

		sustainability, but may increase inequality due to limited access in some areas. They offer significant environmental benefits, though infrastructure challenges remain.
A5	Familiarity	

K-P-A Addressing (Fill up by Supervisor)																			
Knowledge Profile (K)								**Complex Engineering Problem (P)**							**Complex Engineering Activities (A)**				
K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	

APPENDIX C
PROGRAM CODE

Program for Accident & Charge Monitoring (ESP-32):

```
#define BLYNK_PRINT Serial

/* Fill-in your Template ID (only if using Blynk.Cloud) */
#define BLYNK_TEMPLATE_ID "TMPL6yvTkYDLB"
#define BLYNK_TEMPLATE_NAME "Accident and charge monitoring"
#define BLYNK_AUTH_TOKEN "dr4EhCiKn1OocKuP_XhB2FqA_rVDrUyS"

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <Wire.h>
#include "I2Cdev.h"
#include <MPU6050.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

// for gyro
MPU6050 mpu;
int16_t ax, ay, az;
int16_t gx, gy, gz;
int x, y;

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "student";
char pass[] = "iotstudent";
const int voltageSensor = 34;
float vOUT = 0.0;
float vIN = 0.0;
```

```
float R1 = 30000.0;
float R2 = 6550.0;
int vvalue = 0;
float charge = 0.00;

//current sample count
long lastsample = 0;
long samplesum = 0;
long samplesum1 = 0;
long samplesum2 = 0;
int sampleCount = 0;
float mainvolt;
float mainvolt1;

void setup() {
  Serial.begin(9600);
  Wire.begin();
  mpu.initialize();
  lcd.init();
  lcd.backlight();
  analogSetWidth(10);
  Blynk.begin(auth, ssid, pass);
}

void loop() {
  Blynk.run();

  for (sampleCount = 0; sampleCount <= 100; sampleCount++) {
    samplesum += analogReadMilliVolts(voltageSensor);
    // samplesum1 += sq(analogRead(acs7121) - 506);
    //    sampleCount++;
    delay(1);
 }
```

```
mainvolt = samplesum / 100.0;
vOUT = mainvolt / 1000.00;
vIN = vOUT / (R2 / (R1 + R2));

// vIN = vOUT * 5.00;
Serial.println(vIN);
charge = mapfloat(vIN, 7.0, 8.2, 0.00, 100.00);

if (charge <= 0.00) {
  charge = 0.00;
}
if (charge >= 100.00) {
  charge = 100.00;
}

samplesum = 0;
mpu.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
x = map(ax, -17000, 17000, 300, 400);  //Send X axis data
y = map(ay, -17000, 17000, 100, 200);  //Send Y axis data

Serial.print(x);
Serial.print("|");
Serial.println(y);
Blynk.virtualWrite(V0, charge);

delay(1000);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Bat Ch:");
lcd.print(charge);
lcd.print("%");

if (x > 360 || x < 330 || y > 170 || y < 130) {
  Serial.println("Accident Detected");
```

```
    Blynk.virtualWrite(V1, "Accident Detected");
    Blynk.virtualWrite(V2, 1);
    lcd.setCursor(0, 1);
    lcd.print("Accident");
  }

  if (x < 360 && x > 330 && y < 170 && y > 130) {
    Serial.println("Everything Ok");
    Blynk.virtualWrite(V1, "Ok");
    Blynk.virtualWrite(V2, 0);
  }
  delay(1000);
}

float mapfloat(float x, float in_min, float in_max, float out_min, float out_max) {
  return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min;
}
```

Program for Location Monitoring (Node MCU):

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include "Ubidots.h"
/*
   This sample sketch demonstrates the normal use of a TinyGPS++ (TinyGPSPlus) object.
   It requires the use of SoftwareSerial, and assumes that you have a
   4800-baud serial GPS device hooked up on pins 4(rx) and 3(tx).
*/
const char* UBIDOTS_TOKEN = "BBUS-e53onsg984gPuCufz9R8ZrL3P86nxB";  // Put
here your Ubidots TOKEN

// Put here your Wi-Fi SSID
const char* WIFI_SSID = "student";
const char* WIFI_PASS = "iotstudent"
```

```
Ubidots ubidots(UBIDOTS_TOKEN, UBI_HTTP);
static const int RXPin = D5, TXPin = D6;
static const uint32_t GPSBaud = 9600;
float lat = 00.000000;
float lng = 00.000000;
char latar[20] = {' '};
char lngar[20] = {' '};
int lat_int;
int lng_int;
float lat_float;
float lng_float;
int lat_fra;
int lng_fra;

// The TinyGPS++ object
TinyGPSPlus gps;

// The serial connection to the GPS device
SoftwareSerial ss(RXPin, TXPin);

void setup() {
  Serial.begin(9600);
  ss.begin(GPSBaud);
  ubidots.wifiConnect(WIFI_SSID, WIFI_PASS);
}

void loop() {
  // This sketch displays information every time a new sentence is correctly encoded.
  if (ss.available() > 0) {
    gps.encode(ss.read());
    Serial.print(F("Location: "));

    if (gps.location.isValid()) {
      // Serial.print(gps.location.lat(), 6);
```

```
  lat = gps.location.lat();
  // Serial.print(F(","));
  // Serial.println(gps.location.lng(), 6);
  lng = gps.location.lng();
}
Serial.print(lat);
Serial.print(",");
Serial.println(lng);

lat_int = (int)lat;  // compute the integer part of the float
lng_int = (int)lng;  // compute the integer part of the float

lat_float = (abs(lat) - abs(lat_int)) * 1000000;
lng_float = (abs(lng) - abs(lng_int)) * 1000000;

lat_fra = (int)lat_float;
lng_fra = (int)lng_float;

sprintf(latar, "%d.%d", lat_int, lat_fra);  //
sprintf(lngar, "%d.%d", lng_int, lng_fra);  //
Serial.print(latar);
Serial.print(",");
Serial.println(lngar);

ubidots.addContext("lat", latar);
ubidots.addContext("lng", lngar);

char* context = (char*)malloc(sizeof(char) * 60);
ubidots.getContext(context);
int Value = 1;
ubidots.add("position", Value, context);  // Change for your variable name
// ubidots.send();
bool bufferSent = false;
```

```
    bufferSent = ubidots.send("gps");  // Will send data to a device label that matches the device Id

    if (bufferSent) {
      // Do something if values were sent properly
      Serial.println("Values sent by the device");
    }

    smartDelay(60000);
  }

  if (millis() > 5000 && gps.charsProcessed() < 10) {
    Serial.println(F("No GPS detected: check wiring."));
    while (true)
      ;
  }
}

static void smartDelay(unsigned long ms) {
  unsigned long start = millis();
  do {
    while (ss.available())
      gps.encode(ss.read());
  } while (millis() - start < ms);
}
```

Program for Card Based Engine Control (Arduino Nano):

```
#include <SPI.h>
#include <MFRC522.h>

#define SS_PIN 10
#define RST_PIN 9
```

```
int engine = 2;

MFRC522 mfrc522(SS_PIN, RST_PIN);  // Create MFRC522 instance.

int flag = 0;

void setup() {
  Serial.begin(9600);  // Initiate a serial communication
  pinMode(engine, OUTPUT);

  SPI.begin();         // Initiate  SPI bus
  mfrc522.PCD_Init();  // Initiate MFRC522
  delay(4);                                    // Optional delay. Some board do need more time after
init to be ready, see Readme
          mfrc522.PCD_DumpVersionToSerial();       // Show details of PCD - MFRC522
Card Reader details
          Serial.println(F("Scan PICC to see UID, SAK, type, and data blocks..."));

}
void loop() {


  if (!mfrc522.PICC_IsNewCardPresent()) {
    return;
  }
  // Select one of the cards
  else if (!mfrc522.PICC_ReadCardSerial()) {
    return;
  }
  String content = "";
  byte letter;
  for (byte i = 0; i < mfrc522.uid.size; i++) {
    Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    Serial.print(mfrc522.uid.uidByte[i], HEX);
```

```
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  content.toUpperCase();

  if (content.substring(1) == "83 14 70 FC" && flag == 0)  // && flag == 0)  //change here
the UID of the card/cards that you want to give access
  {
    digitalWrite(engine, LOW);
    flag = 1;
    delay(2000);
    content = "";
  }

 if (content.substring(1) == "83 14 70 FC" && flag == 1)  // && flag == 0)  //change here
the UID of the card/cards that you want to give access
  {
    digitalWrite(engine, HIGH);
    flag = 0;
    delay(2000);
    content = "";
  }

}
```

For Blynk

```
#define BLYNK_PRINT Serial

/* Fill-in your Template ID (only if using Blynk.Cloud) */
#define BLYNK_TEMPLATE_ID "TMPL6L3NOYwR_"
#define BLYNK_TEMPLATE_NAME "IoT based Car Accident monitoring"
#define BLYNK_AUTH_TOKEN "iMns3G0AEohO2VWNek_s1ixNs66kMf42"
```

```
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <Wire.h>
#include "I2Cdev.h"
#include <MPU6050.h>

// for gyro
MPU6050 mpu;
int16_t ax, ay, az;
int16_t gx, gy, gz;
int x, y;

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "student";
char pass[] = "iotstudent";

// int light;
int power_control;

// int buzzer = D5;

// int alcohol = A3;
// int alcoholdata;

void setup() {
  Serial.begin(9600);
  digitalWrite(power_relay, LOW);

  Wire.begin();
  mpu.initialize();

  Blynk.begin(auth, ssid, pass);
}
```

```
BLYNK_WRITE(V0)  // V0 is the number of Virtual Pin
{
 power_control = param.asInt();
 Serial.println(power_control);

 if (power_control == 1) {
   digitalWrite(power_relay, HIGH);
 }

 if (power_control == 0) {
   digitalWrite(power_relay, LOW);
 }
}

void loop() {
 Blynk.run();

 mpu.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);
 x = map(ax, -17000, 17000, 300, 400);  //Send X axis data
 y = map(ay, -17000, 17000, 100, 200);  //Send Y axis data

 Serial.print(x);
 Serial.print("|");
 Serial.println(y);



 if (x > 360 || x < 330 || y > 170 || y < 130) {
   Serial.println("Accident Detected");
   Blynk.virtualWrite(V1, "Accident Detected");
   Blynk.virtualWrite(V2,1);
   // digitalWrite(buzzer, HIGH);
 }

 if (x < 360 && x > 330 && y < 170 && y > 130) {
```

```
    Serial.println("Everything Ok");
    Blynk.virtualWrite(V1, "Ok");
    Blynk.virtualWrite(V2,0);

  }
  delay(1000);
}
```

Program for Location:

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include "Ubidots.h"
/*
   This sample sketch demonstrates the normal use of a TinyGPS++ (TinyGPSPlus) object.
   It requires the use of SoftwareSerial, and assumes that you have a
   4800-baud serial GPS device hooked up on pins 4(rx) and 3(tx).
*/

const char* UBIDOTS_TOKEN = "BBUS-xEj89qGKLOROn25zg3v1BmxsrNaLHE";  //
Put here your Ubidots TOKEN
const char* WIFI_SSID = "student";                               // Put here your Wi-Fi SSID
const char* WIFI_PASS = "iotstudent";

Ubidots ubidots(UBIDOTS_TOKEN, UBI_HTTP);

// Ubidots ubidots(UBIDOTS_TOKEN, UBI_TCP);

static const int RXPin = D5, TXPin = D6;
static const uint32_t GPSBaud = 9600;

float lat = 00.000000;
```

```
float lng = 00.000000;
char latar[20] = { ' ' };
char lngar[20] = { ' ' };
int lat_int;
int lng_int;
float lat_float;
float lng_float;
int lat_fra;
int lng_fra;

// The TinyGPS++ object
TinyGPSPlus gps;

// The serial connection to the GPS device
SoftwareSerial ss(RXPin, TXPin);

void setup() {
  Serial.begin(9600);
  ss.begin(GPSBaud);
  ubidots.wifiConnect(WIFI_SSID, WIFI_PASS);
}

void loop() {
  // This sketch displays information every time a new sentence is correctly encoded.
  if (ss.available() > 0) {
    gps.encode(ss.read());
    Serial.print(F("Location: "));

    if (gps.location.isValid()) {
      // Serial.print(gps.location.lat(), 6);
      lat = gps.location.lat();
      // Serial.print(F(","));
      // Serial.println(gps.location.lng(), 6);
      lng = gps.location.lng();
```

```
  }
  Serial.print(lat);
  Serial.print(",");
  Serial.println(lng);

  lat_int = (int)lat;  // compute the integer part of the float
  lng_int = (int)lng;  // compute the integer part of the float

  lat_float = (abs(lat) - abs(lat_int)) * 1000000;
  lng_float = (abs(lng) - abs(lng_int)) * 1000000;

  lat_fra = (int)lat_float;
  lng_fra = (int)lng_float;

  sprintf(latar, "%d.%d", lat_int, lat_fra);  //
  sprintf(lngar, "%d.%d", lng_int, lng_fra);  //
  Serial.print(latar);
  Serial.print(",");
  Serial.println(lngar);

  ubidots.addContext("lat", latar);
  ubidots.addContext("lng", lngar);

  char* context = (char*)malloc(sizeof(char) * 60);
  ubidots.getContext(context);
  int Value = 1;
  ubidots.add("position", Value, context);  // Change for your variable name
  // ubidots.send();
  bool bufferSent = false;
  bufferSent = ubidots.send("gps");  // Will send data to a device label that matches the
device Id

  if (bufferSent) {
    // Do something if values were sent properly
```

```
    Serial.println("Values sent by the device");
   }

   smartDelay(60000);
  }

  if (millis() > 5000 && gps.charsProcessed() < 10) {
   Serial.println(F("No GPS detected: check wiring."));
   while (true)
    ;
  }
}

static void smartDelay(unsigned long ms) {
  unsigned long start = millis();
  do {
   while (ss.available())
    gps.encode(ss.read());
  } while (millis() - start < ms);
}
```