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EV POWER SAVING SYSTEM

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ABSTRACT

This project presents an energy-efficient EV power-saving system that integrates a dynamo, voltage converter,Booster module, ESP8266,Relaymodule andtemperature-controlled cooling mechanism.The dynamo is connected to the EV's wheels and converts mechanical energy into electrical energy .The generated power is regulated by the charge controller before being stored in the battery. A battery temperature-based cooling mechanism is implemented, where a fan activates automatically when overheating is detected, enhancing battery lifespan . Additionally, an IoT-enabled emergency SOS button is integrated, allowing real-time distress alerts to be sent in case of emergencies. This system enhances energyefficiency, improves vehicle safety, and ensures sustainable operation for Evs.

The increasing adoption of Electric Vehicles (EVs) has intensified the need for efficient energy management to enhance driving range and reduce energy consumption. This paper presents a comprehensive study and implementation of a power saving system designed to optimize the energy usage of EVs through intelligent control strategies and advanced power management techniques. Key components such as smart Battery Management Systems (BMS), regenerative braking, efficient drive trains,andpowerelectronicsareintegratedtoimprov eoverallsystemefficiency.Additionally,real-time drivingdataandrouteoptimizationalgorithmsaree mployedtofurtherreducepowerconsumptionbased ontrafficconditionsandterrain.Theproposedsyste mdemonstratesasignificantimprovementinenergy efficiency, contributing to prolonged battery life, enhanced performance, and greater sustainability in electric transportation. This work highlights the potential of combining hardware innovations with software-based solutions to create a more energy-efficient EV ecosystem.

INTRODUCTION

Anelectric vehicle (EV) is a motor vehicle whose propulsion is powered fully or mostly by electricity.[1]EVsencompassawiderangeoftra nsportationmodes,including roadand railvehicles,electric boats and underwater vessels,electric aircraft and electric spacecraft.

Early electric vehicles first came into existence in the late 19th century, when theSecond IndustrialRevolution broughtforthelectrificationandmassutilizatio nofDCand ACelectricmotors.Using electricity was among the preferred methods for motor vehiclepropulsion as it provides a level of quietness, comfort and ease of operation that could not be achieved by the gasoline enginecars of the time,but rangeanxietyduetothelimited energystorageofferedbycontemporarybattery technologies hinderedanymassadoptionofprivateelectricve hiclesthroughoutthe20th century. Internal combustion engines (both gasoline and diesel engines) were the dominant propulsion mechanisms for carsand trucksfor about 100 years, but electricity-powered locomotion remained commonplace in other vehicle types, such as overhead line-poweredmass transit vehicles likeelectrictrains,trams,monorailsandtrolley buses, as well as various small, low-speed, short-range battery- powered personal vehicles such as mobility scooters.

Plug-inhybridelectricvehicles,whereelectricmotor scanbeusedasthepredominantpropulsionrathe

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thanasupplement,didnotseeanymassproductionuntilthelate2000s,and batteryelectriccarsdidnot become practical options for the consumer market until the 2010s.

Progress inbatteries, electric motors and power electronics have made electric cars more feasible than during the 20th century. As a means of reducing tailpipe emissions of carbon dioxide and other pollutants, and to reduce use of fossil fuels, government incentives are available in many areas to promote the adoption of electric cars and trucks.

Fig1.1.Electricvehicle

BREIFHISTORY:

Electricmotivepowerstartedin1827whenHungarianpriestÁnyosJedlikbuiltthefirstcrudebut viable electric motor; the next year he used it to power a small model car.[3] In 1835, Professor Sibrandus Stratingh of the University of Groningen, in the Netherlands, built a small-scale electric car, and sometime between 1832 and 1839, Robert Andersonof Scotland invented the first crude electric carriage, powered by non-rechargeableprimary cells.[4] American blacksmith and inventor ThomasDavenport built a toy electric locomotive, powered by a primitive electric motor, in 1835. In 1838, a Scotsman named Robert Davidson built an electric locomotive that attained a speed of four miles per hour (6km/h). In England, a patent was granted in 1840 for the use of rails as conductors of electric current, and similar American patents were issued to Lilley and Colten in 1847.

Thefirstmass-producedelectricvehiclesappearedinAmericaintheearly1900s.In1902, theStudebaker Automobile Company entered the automotive business with electric vehicles, though it alsoenteredthegasolinevehiclesmarketin1904.However,withtheadventofcheapassemblylinecars by Ford Motor Company, the popularity of electric cars declined significantly.[6]

Duetolackofelectricitygrids[7]andthelimitationsofstoragebatteriesatthattime,electriccarsdidnot gain much popularity; however, electric trains gained immense popularity due to their economies and achievable speeds. Bythe 20thcentury, electric railtransport became commonplace dueto advancesin thedevelopmentofelectric locomotives.Overtimethegeneral-purposecommercialuseofelectriccars wasreducedto specialist rolesasplatformtrucks,forklift trucks,ambulances,[8]towtractors,andurban delivery vehicles, such as the iconic British milk float. For most of the 20th century, the UK was the world's largest user of electric road vehicles.[9]

Fig1.2ThomasEdisonndGeorgeMeisterinaStudebakerelectricrunabout, 1909

Electrifiedtrainswereusedforcoaltransport,asthemotorsdidnotusethevaluableoxygeninthemines. Switzerland's lack of natural fossil resources forced the rapid electrification of their rail network. One oftheearliest rechargeablebatteries–thenickel-ironbattery–wasfavoredbyEdisonforuseinelectric cars.

EVs were among the earliest automobiles, and before the preeminence of light, powerfulinternalcombustionengines (ICEs), electric automobiles held many vehicle land speed and distance records in theearly1900s.TheywereproducedbyBakerElectric,ColumbiaElectric,Detroit Electric,andothers, andatonepoint inhistoryoutsoldgasoline-poweredvehicles.In1900,28percentofthecars ontheroad intheUSwereelectric.EVsweresopopularthatevenPresident WoodrowWilsonandhis secret serviceagents toured Washington, D.C., in their Milburn Electrics, which covered 60–70 miles (100– 110km) per charge.

Most producers of passenger cars opted for gasoline cars in the first decade of the 20th century, but electric trucks were anestablished niche well into the 1920s.[11][12][7]Severaldevelopments contributed to a decline in the popularity of electric cars.[13]Improved road infrastructurerequired a greater range thanthatoffered byelectric cars, andthe discoveryoflarge reserves ofpetroleuminTexas, Oklahoma, and California led to the wide availability of affordable gasoline/petrol, making internal combustion powered cars cheaper to operate over long distances.[14] Electric vehicles were seldom marketed as women's luxury car, which may have been a stigma among male consumers.[15] Also, internal combustion-poweredcarsbecameever-easiertooperatethankstotheinventionofthe electricstarterbyCharlesKettering in1912,[16]whicheliminatedtheneedofahandcrankforstartingagasoline engine, and the noise emitted by ICE cars became more bearable thanks to the use of the muffler, whichHiram Percy Maxim had invented in 1897. As roads were improved outside urban areas, the electric vehicle range could not compete with the ICE. Finally, the initiation of mass production of gasoline-powered vehicles byHenry Ford in 1913 reduced significantly the cost of gasoline cars as compared to electric cars.[17]

Fig1.3AchargingstationinSeattleshowsanA MCGremlin

Inthe 1930s, NationalCityLines, whichwas a partnership ofGeneralMotors, Firestone, andStandardOil of California purchased many electric tram networks across the country to dismantle them and replace them with GM buses. The partnership was convicted ofconspiring to monopolize the sale of equipmentandsuppliestotheirsubsidiarycompanies.Still,itwasacquittedofconspiringtomonopolize the provision of transportation services.

TheCopenhagen Summit, conducted amid a severe observable climate change brought on by human-madegreenhousegasemissions,washeldin2009.Duringthesummit,morethan70countriesdeveloped plans to reach net zero eventually. For manycountries, adopting more EVs will help reduce the use of gasoline.[18]Inrecent years, the market for electric off-road motorcycles, including dirt bikes, has seen significant growth. This trend is driven by advancements in batterytechnologyand increasing demand for recreational electric vehicles.

2.1Literaturesurvey:

1. Zhangetal.(2020)– “SmartBatteryManagementSystemsinEVs”
   This study explores advanced Battery Management Systems (BMS) that utilize machine learning to monitor and optimize batteryusage. Their proposed modelreduces energy loss by 8–12% byadapting charging patterns based on driving behavior.
2. ChenandWang(2019)– “EfficiencyofRegenerativeBraking inUrbanEVs”
   Focused on improving energy recovery through regenerative braking, this paper analyzes different braking strategies. Results showed a 20–30% energy gain during stop-and-go city driving.
3. Liuetal.(2021)– “DriveTrainOptimizationforEVEfficiency”
   The paper presents a two-speed gearbox and dual motor drive configuration that optimizes power distribution. Simulation results indicate a 15% increase in overall efficiency.
4. KumarandPatel(2022)– “PowerElectronics inElectricVehicles”
   This research compares traditional silicon inverters with Silicon Carbide (SiC) based inverters. SiC devicesreduceswitching lossesand improvethermalperformance, leadingtohighersystemefficiency.
5. Parketal.(2020)–“Real-timeRouteOptimizationtoSaveEVEnergy”
   Introduces a route planning algorithm based on traffic and elevation data. The system predicts energy consumption and

selects the most efficient path, reducing energyusage by up to 10%.

6. Nguyenetal. (2018)–“ImpactofLightweightMaterialsonEVEfficiency”
Investigateshowadvancedcompositematerialsreducevehicleweight.Lightweightbodyframescancut energy consumption by 10–15% without compromising safety.

7. Sharmaetal.(2023)–“Solar-AssistedElectricVehicles:AHybridApproach”
DiscussesintegratingsolarpanelsonEVrooftopsto supportauxiliarypowersystems.Testsshowsolar panels can supplement 5–8% of daily driving energy in sunny regions.

8. Alietal.(2021) –“ThermalManagementandEnergyEfficiency”
Explores how thermal management of battery and motor systems affects energy consumption. Active cooling systems with smart control saved up to 7% in high-temperature conditions.

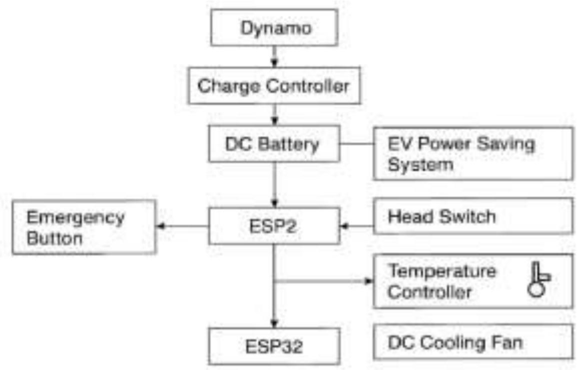
9. Huangetal.(2022) –“AI-DrivenDrivingBehaviorAdaptation”
Introduces a real-time adaptive driving system that adjusts motor torque and power delivery based on driving style and environment, improving energy efficiency by 12%.

10. WangandLee(2020)–“EnergyHarvesting inEVSystems”
Proposes auxiliary energy harvesting systems using piezoelectric materials and thermoelectric generators embedded in the vehicle structure. While still experimental, early data show potential for micro-energy contributions

3. PROPOSED SYSTEM

DESIGN

CONTENTDIAGRAMOFTHEPROJECT:



OPERATION:

1. Introductionto theSystem

This electric vehicle (EV) system is designed with smart energy management and safety features. It uses a combination of traditional energy harvesting through a dynamo and intelligent control using microcontrollerslikethe ESP8266.Theentiresetup aimstooptimizepoweruse,improvesafety,and provide emergency support.

2. DynamoPowerGenerationBasics

Thecoreenergygenerationbeginswithadynamo mechanicallylinkedtotheEV’swheels. Whenthe wheelsrotate during motion, the dynamo convertsthe vehicle’skinetic energy into electricalenergy, turning motion into a usable power source.

3. RegulatingPowerwithBooster Module

Therawpowergeneratedbythedynamo isirregularand maynot besafe fordirect batterystorage.A booster module is employed to regulatethis power. It ensures that the voltage and current are stable, safe, and suitable for charging the battery without causing damage.

4. BatteryChargingProcess

Oncethe boostermodulestabilizesthepower, it is sent to a6VDCbatteryfor storage.This battery actsasareservoir,collectingenergythat canlaterbeusedtopowerdifferent componentsintheEV, even when the vehicle is stationary or the dynamo isn't generating power.

5. ImportanceofSafeCharging

Theboostermodulenotonlyregulatesinputfromthe dynamobutalso ensuressafechargingby

preventingovervoltageorundercharging.Ithelpsm aintainbatteryhealth,improvesefficiency,and extends the overall battery lifespan.

6. PoweringEssentialLoads

Thestoredenergyinthebatteryisprimarilyusedtopo weressentialsystems, suchas lighting, motor controls, sensors, and the ESP8266 microcontroller. This energyreserve ensures that these systems remain operational regardless of whether the vehicle is moving.

7. TemperatureMonitoringSystem

To preventthermaldamage,atemperaturesensorisinte gratedintothesystem.Itconstantlymonitors the temperature of boththe batteryand motor, providing real-time data to the ESP8266 for dynamic cooling and power adjustments.

8. AutomaticCoolingFanActivation

Whentemperaturesexceedsafe limits, thetemperaturesensor signalstheESP8266, whichactivatesa cooling fan. This fan helps regulate heat buildup in the system, protecting critical components and ensuring optimal operating conditions.

9. RoleofESP8266inthe System

TheESP8266microcontroller isthecentralprocessingunit ofthesystem. It monitorsbatterystatus, temperature, and other sensors to make intelligent decisions about energydistribution, emergency responses, and system optimization.

10. SmartLoadManagement Concept

OneoftheESP8266'smain functionsissmart loadmanagement. Itensuresthattheenergyfromthe battery is distributed efficiently. When power is abundant, all systems operate normally. However, during low-battery conditions, it conserves power by shutting down non-essential systems.

11. PowerConservationStrategy

Inlowchargescenarios,theESP8266disconnectsco mponentslikeadditionallights,displays,or charging ports, whichare not immediatelyneeded. This ensures power is preserved for essential operations like cooling, control circuits, and alert mechanisms.

12. EmergencyAlertSystemOverview

The ESP8266 also handles the emergencyalert system. It detects criticalconditions suchas battery failure,overheating,orotherinternalmalfunctions. Oncedetected,the microcontroller initiatesalert mechanisms to notify the user or external support.

13. AlertMechanismsExplained

Alerts can be communicated in various ways: through LED indicators that flash in warning patterns, buzzeralarms foraudible feedback, orwireless messagessentto externaldevicesormobilephonesvia Wi-Fi for remote monitoring.

14. ImportanceofReal-TimeAlerts

Immediate alerts help in preventing serious failures. For example, an overheating warning allows the drivertostopthevehiclebeforecomponentsgetdam aged, oralowbatteryalert canprompt arecharge before total power loss.

15. EmergencyButtonFunctionality

Thesystemisequippedwitha manualemergencybutton.Whenpressed, itoverridestheautomatic controls and immediately activates emergency protocols, including sending alerts and prioritizing essential systems.

16. ManualOverride Benefits

Thisbuttonisespeciallyusefulwhentheuser sensesanissuenot yet detectedbysensors. Itprovides a failsafe mechanism for added safetyand gives the driver a wayto quickly respond to uncertain or urgent situations.

17. LoadPrioritizationDuringEmergencies

Whenthe emergencybuttonistriggered, the ESP8266 initiates load prioritization—disconnecting entertainment systems,secondarydisplays,orothernon-vitalloadsto preservepowerforsteering, motor functions, cooling, and alert systems.

18. SystemEfficiencyThroughAutomation

Byautomating most of these functions with the ESP8266, the system ensures high efficiency and reliability.Thevehiclecanrespondtointernalchangesquickly,adaptitspowerusage,andmaintain performance without user intervention in most scenarios.

19. IntegratedSafetyandPerformance

The integrationofthedynamo,boostermodule,sensors, and microcontrollerbuildsaholisticenergy management system. It combines sustainable energyrecoverywith smart electronics, offering both performance and safety in one package.

implementationofanEV(ElectricVehicle)powersavingsystem:

SystemComponents

1. EnergyStorageSystem:Thisincludesthebattery management system(BMS),batteries,and charging system.
2. PowerElectronics:Thisincludesthemotorcontroller,DC-DCconverter,andotherpowerelectronic components.
3. EnergyEfficiencyAlgorithms:Thesealgorithms optimizeenergyconsumptionandreducelosses.
4. RegenerativeBraking:Thissystemcaptureskineticenergyandconverts itintoelectricalenergy.

ImplementationSteps

1. DesignandDevelopment:Designthepowersavingsystem, includingtheenergystoragesystem, power electronics, and energy efficiency algorithms.
2. ComponentSelection:Selectcomponentsthatare efficient,reliable,andsuitablefortheapplication.
3. SystemIntegration:Integratethecomponents intoacohesivesystem.
4. TestingandValidation:Testthesystemtoensureit meetsperformanceandefficiencyrequirements.
5. Optimization:Optimizethesystemformaximumefficiencyandperformance.

KeyTechnologies

1. AdvancedBatteryManagement Systems(BMS):Thesesystemsoptimize batteryperformance, extend battery life, and ensure safe operation.
2. RegenerativeBrakingSystems:Thesesystemscapturekineticenergyandconvert it intoelectrical energy, reducing energy consumption.
3. Efficient PowerElectronics:Thesecomponentsminimizeenergylossesandoptimizepower conversion.
4. ArtificialIntelligence(AI)andMachine Learning(ML):Thesetechnologiescanbeusedtooptimize energy efficiency and predict energy demand.

4. RESULTS

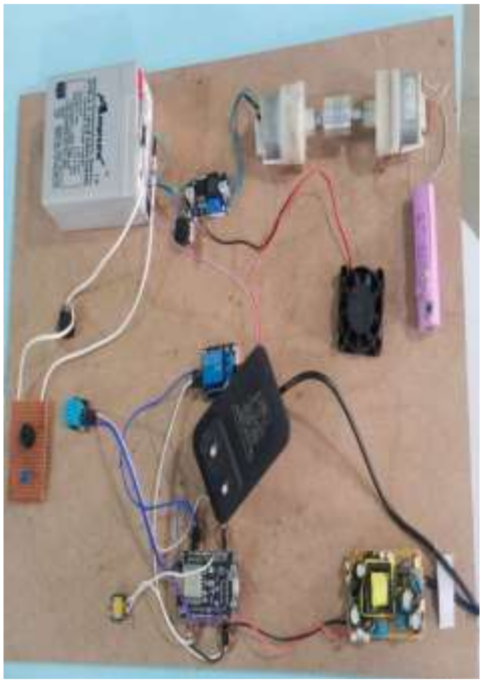


Fig4.1EVpowersavingsy stemcircuitdiagram

Backemf

When the armature revolves, its coils cut acrossthe field flux, but we know that ifa conductor cuts across lines of force, an e.m.f is induced in that conductor. This is the principle ofthe generator. So applying Fleming'sright-hand rule, we see that the induced e.m.fisopposing the supply voltage.This induced e.m.f is called the, ''back emf''. Ifthe back emfwere ofthe same magnitude as the supply voltage, no current would flow and the motor would not work.As the current must flow inthe armatureto producerotation, andasthearmaturehasresistance, thenthere must bevoltagedropinthe armature circuit. This voltage drop is the product of the armature current (Ia)and the armature circuit resistance (Ra).
Armature voltage drop=IaxRa
Itisthisvoltagedropthat isthedifferencebetweenthesupplyvoltageandthebackemf. Therefore, E = V – (IaRa)

Emfgeneratedinloadbattery=4v

Torque

Weknowthat,work=ForcexDistance
Therefore,turningworkortorque=Force(F) xRadius(r) We also know that:
Force=B xLxI
Therefore,TorqueT=BxLxIaxr
Onceagain, foragivenmachine,a,L,andrwillallbeconstant.
Hence, T α Φ x Ia
Also,mechanicaloutput powerinwattsisgivenby P = 2πnT
WherePistheoutput powerinwatts,nisthespeedinrevs/secondandTisthetorqueinnewton metres.
IfwemultiplyE=(V–IaRa)byIawegetEIa=VIa–Ia2Ra
VIa isthepower suppliedtothearmatureandIa2Raisthepower loss inthearmature;thereforeEIamust be the armature power output. Hence
EIa =P
Therefore, EIa = 2πnT Torque=0.15to0.60Nm.

Speed

Speed isthe measureof*howfast*something isgoingatacertaintime. If you'veever lookedatacar's speed gaugewhile it's moving, you'veseenspeed being measured — thefarthertheneedlegoes,the higherthecar'sspeed is.Thereareafewdifferentwaysto calculatespeeddependingonwhichtypes of information you have. For generalpurposes, the equation speed = distance/time (or s = d/t) is usually the easiest way to calculate speed.
The formula forspeed isspeed=distance/timeors=d/t. Speed = 30rpm.

Power

Poweristherateat whichworkisdoneorenergyistransferredovertime.

Itquantifies howquickly energy is used or work is performed in a system.
Mathematically,powerisdefinedastheamountofworkdoneorenergytransferreddivided bythe time it takes.
It isexpressed inunitsofwatts(W) inthe InternationalSystemofUnits(SI),where1 watt equals1 joule of energy per second.
Powerplaysacrucialrole inunderstandingandanalysingtheefficiencyandperformanceofsystems, such as machines, electrical devices, and physical movements.
FormulaofPowerorPowerEquations Power = Work / Time
Power=12w

Efficiency
Theratio betweenmotorOutput andInputiscalledefficiencywhichis indicatedbythesymbolof “η” and represented in the “%”. or
Thisisthefactorwhichtellsabout performanceofthemotor.Itistheratio betweenoutputand input power at shaft it can be written as efficiency(e) = output power / input power i.e.
MotorEfficiency=MotorEff=MotorOutPut Power/ MotorInputPower Motor efficiency is denoted by the symbol of eta= η.
Efficiency=η=(Output/Input)x100 Efficiency of the motor = 70%

5. CONCLUSION

Theintegrationofadynamosystemwithintheelectricvehicleenhancesenergyefficiencybyconverting the mechanicalmotionofthewheels into electricalenergy.Thisenergyiscarefullyregulatedthrougha booster module to ensure that only stable and usable power reaches the battery, thus improving the overall reliability and sustainability of the system.
Batterycharging and management playa crucialrole in the system’s performance. The 6V DC battery acts as a core power reserve, providing energy to vital components even when external input is unavailable.Withthe help ofthe boostermodule, the batteryischarged safelyand efficiently, ensuring prolonged usage and minimizing the risk of overcharging or damage.
To maintain optimal operating temperatures, a temperature monitoring and cooling system is implemented. Using sensors to track battery and motor heat levels, the ESP8266 microcontroller intelligentlyactivates a cooling fan whenever overheating is detected. This not onlyprotects hardware components but also ensures consistent system performance during extended or heavy use.
Thesmart load management system, poweredbytheESP8266, isessentialforenergyconservation. By continuously monitoring the battery’s charge level, it automatically prioritizes power distribution to essential components. In low battery conditions, non-critical systems are temporarily disconnected, thereby extending the operational time and enhancing overall efficiency.
Finally, the emergency alert system and manual safety mechanisms provide an additional layer of protection. The ESP8266 identifies critical failures and sends alerts via LEDs, buzzers, or wireless signals for remote assistance. A manual emergency button allows users to quickly respond to urgent situations by preserving essential functions while cutting off unnecessary loads. Altogether, this comprehensivesystemensuresasafe,energy-efficient,andintelligent EVpowermanagement solution.

FUTUREENHANCEMENT:

AdvancedRegenerativeBrakingIntegration:
In future iterations, the system can be enhanced by integrating regenerative braking alongside the existingdynamo

setup.ThiswouldallowtheEVtorecoverevenmoreenergyduring braking,thereby increasing overall efficiency and extending the battery's range without requiring additional energy input.

SolarPanelChargingSupport:

Tosupplementthedynamo-basedcharging, lightweightandflexiblesolarpanelscanbeinstalled on the EV'sbody.Thiswould enable passive energyharvesting fromsunlight, especiallyusefulduring long daylight travels or when the vehicle is parked outdoors.

UpgradedBatteryTechnology:

The current 6V DC batterycan be upgraded to a more advanced lithium-ion or solid-state battery. Thesetypesofbatteriesoffer higherenergydensity, fastercharging,andlonger lifespan,resultingin improved performance and reliability of the overall system.

AI-BasedLoadManagement:

Insteadofsimplethreshold-based load management,anAI-poweredsystemcould bedevelopedusing machine learning algorithms. This would allow predictive power distribution based on driving patterns, weather conditions, and batteryhealth, improving both efficiency and user experience.

MobileAppIntegration:

Adedicated mobile application could be developed to give users real-time insights into power generation,batterystatus,temperaturelevels,and alerts.Remotecontroloptionsforemergency shutdowns or system reboots would enhance user control and safety.

IoTandCloudConnectivity:

ByconnectingtheESP8266toacloud-basedIoTplatform, usersandservicecenterscouldremotely monitor and diagnose the EV system. This would allow predictive maintenance, real-time notifications, and even OTA(Over-The-Air) firmware updates for the controller.

EnhancedCoolingSystem:

Thecurrent fan-basedcoolingsystemcouldbeupgradedto asmartthermalmanagement systemthat includes liquid cooling or phase-change materials. This would offer better performance under high loads or hot weather conditions, further protecting internal components.

ModularEmergencyResponseUnit:

Future designs can incorporate a modular emergencyresponse unit with GPS tracking and GSM capabilities.Incaseofcriticalfailure,thesystemcan notonlyalert nearbyhelp but alsotransmit exact location and fault data to ensure quick and informed assistance.

EnergyUsageAnalytics:

Incorporatingdataloggingandanalyticsforenergyusageovertimewouldallowuserstounderstand consumption patterns. This could help in better planning routes, charging schedules, and system upgrades based on real-world performance data.

Eco-DrivingFeedbackSystem:

AfeedbacksystemusingLEDsoraudio cuescanguidedriverstowardmoreenergy-efficient driving habits. Byanalyzing acceleration, braking, and speed, the system could suggest real-time tips to maximize range and minimize unnecessary power consumption.

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