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IOT BASED ELECTRIC VEHICLE BATTERY MANAGEMENT SYSTEM WITH CHARGE MONITOR AND FIRE PROTECTION (DOMAINS IOT)

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Abstract: This paper explores the design and implementation of an Electric Vehicle Battery Management System (EV-BMS) with Charge Monitoring and Fire Protection. Developed for Li-ion battery packs in electric vehicles, the system ensures continuous monitoring and protection. Utilizing hardware components such as Li-ion batteries, monitoring systems, microcontrollers, LCD displays and sensors, the EV-BMS facilitates safe charging and proactively prevents accidents. Integrated fire protection utilizes advanced sensors and algorithms to detect and mitigate fire hazards. Through microcontrollers and user-friendly interfaces, the project offers a comprehensive solution, contributing to the safety and efficiency of electric vehicles.

Keywords:EV,BMS,Arduino,Safety.

I. INTRODUCTION

The transition towards electric vehicles (EVs) represents a paradigm shift in the automotive industry, driven by the pursuit of sustainable and eco-friendly transportation solutions. As the adoption of electric vehicles accelerates, the efficient management of electric vehicle battery systems becomes imperative. Our project, the Electric Vehicle Battery Management System with Charge Monitor and Fire Protection, addresses this critical need by integrating advanced technologies to optimize battery performance, enhance user safety, and prolong battery life. The popularity of EVs is fast rising as the globe moves towards a cleaner, more sustainable future. Governments all around the world are granting incentives to stimulate the use of EVs, and numerous automakers are already selling a variety of EV models. An EV typically catches fire because of excessive heating.

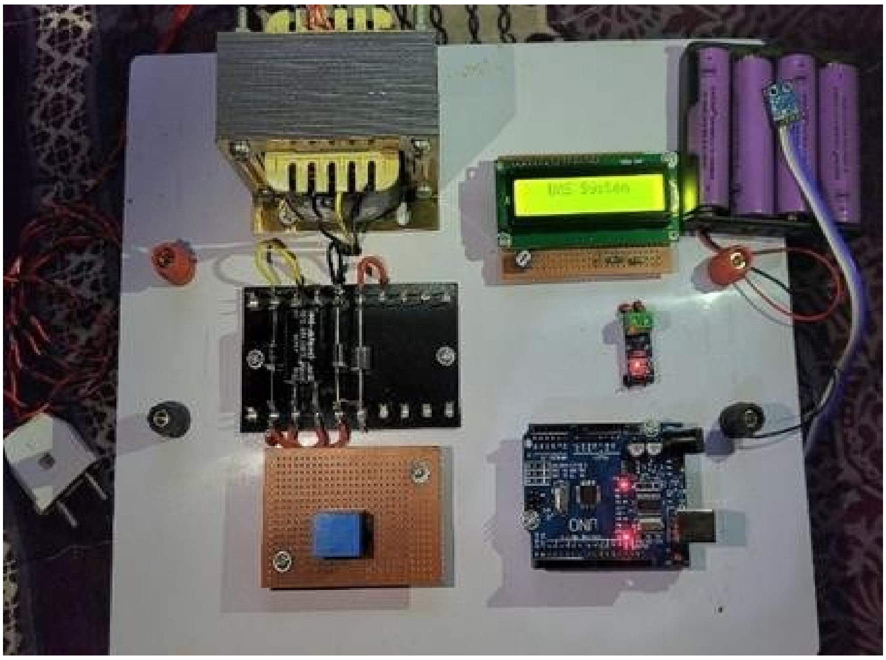

Fig.1.1 CircuitModule

The system makes use of a li ion Battery, Battery charging and monitor system, LCD Display, current sensor, voltage sensor, temperaturesensortodevelopthissystem.ThesystemmonitorsaswellasprotectsanEVbatteryatalltimes.We here develop the system as per a 3S li ion battery. The system we design will not only monitor the battery and charge it safely butalsoprotectitto avoidaccidentsfromoccurring. Throughtheutilization ofadvanced sensors and algorithms, the system detects potential fire hazards within the battery pack. In the event of a critical condition, the system autonomously initiates a cutoff mechanism, isolatingthebatteryfromtheloadandmitigatingtheriskoffire.

II. LITERATUREREVIEW

Lithium-ion batteries have emerged as the cornerstone of the electric vehicle (EV) industry, owing to their remarkable energy and power density, extended life cycles, high voltage output, and low self-discharge rates. However, these batteries are not without their challenges. Susceptibility to aging and temperature variations necessitates vigilant management to prevent physicaldamage,prematureaging,andthermalrunaways(Bhowmiketal.,2020).

TheBatteryManagementSystem(BMS)servesasakeyelementintheoptimalfunctioningofEVs,particularlyinsafeguarding lithium-ion batteries. An effective BMS is tasked with a multitude of responsibilities, including data acquisition, communication with battery components, user interface feedback, temperature regulation, fault diagnosis and handling, and prolongingbatterylife.

Charge Monitoring: Charge monitoring stands out as a critical aspect of BMS functionality emphasize the importance of precise voltage and current sensing, alongside state-of-charge estimation algorithms, to optimize charging efficiency and mitigatetheriskofovercharging-induceddamage.Furthermore,studiesbyZhangetal.(2019)andLietal.(2021)delveintothe integrationofsmartchargingstrategiesandenhancechargemonitoringaccuracyandadaptability.

Fire Protection: Given the potential hazards associated with lithium-ion batteries, effective fire protection mechanisms are indispensable.Zhangetal.(2018)stressthesignificanceofearlyfiredetectionandsuppressionsystemstomitigatefirerisksand ensurepassengersafety.

III. CASESTUDY

Astheglobalautomotiveindustrytransitionstowardssustainablemobilitysolutions,electricvehicles(EVs)haveemergedasa promisingalternativetotraditionalinternalcombustionenginevehicles.However,theefficientmanagementandsafety of EV battery systems are critical factors influencing their widespread adoption. This case study delves into the design and implementation of an Electric Vehicle Battery Management System (EV-BMS) with Charge Monitor and Fire Protection, aimingtooptimizebatteryperformance,enhanceusersafety,andextendbatterylife.

The EV-BMS project focuses on integrating advanced technologies to develop a comprehensive battery management system tailored for electric vehicles. The system comprises hardware and software components carefully selected to monitor, protect, andoptimizetheEVbattery'soperation.Keycomponentsincludelithium-ionbatteries,monitoringsystems,microcontrollers, LCDdisplays,andvarioussensors.

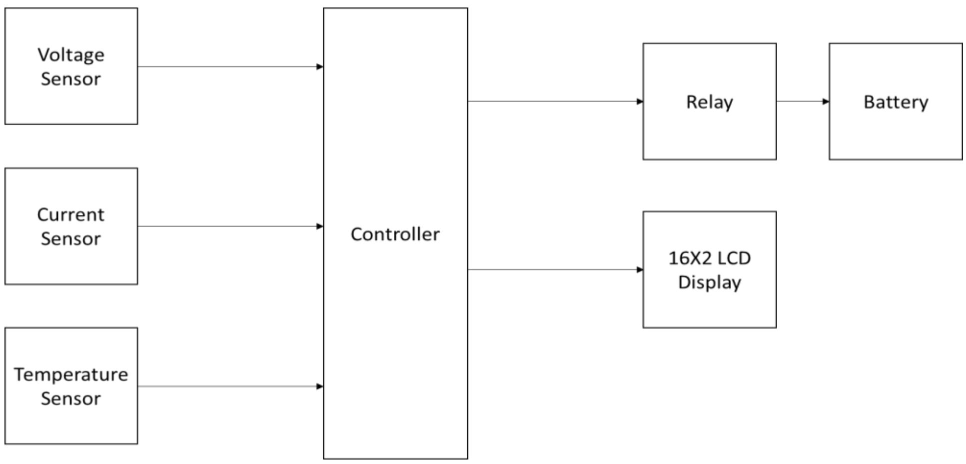

Fig.3.1 BlockDiagram

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3.2.Arduino-Microcontroller:ATmega328:

Fig.3.2..ArduinoUNO

ArduinoUnoisanopen-sourcemicrocontrollerboardbasedontheMicrochipATmega328Pmicrocontrolleranddevelopedby Arduino.cc. The board is fitted with a set of digital input and analog / output (I / O) pins connected to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and is programmed with Arduino IDE (Integrated CommunicationArea)onaUSBtypeB.ItcanbesuppliedwithaUSBcableor9-voltexternalbattery.

3.3Currentsensor:

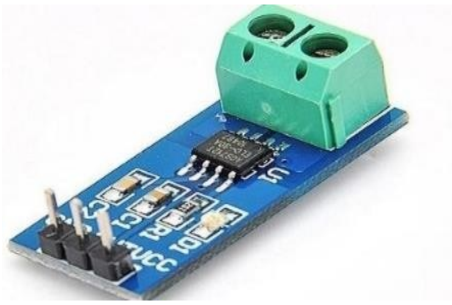

Fig. 3.3 ACS712HallEffectCurrentSensor

The load current is 10A hence current sensor having current rating greater than twice the rated current is desired. ACS 712 hall effectcurrentsensorisselected.

3.4. Voltagesensor:

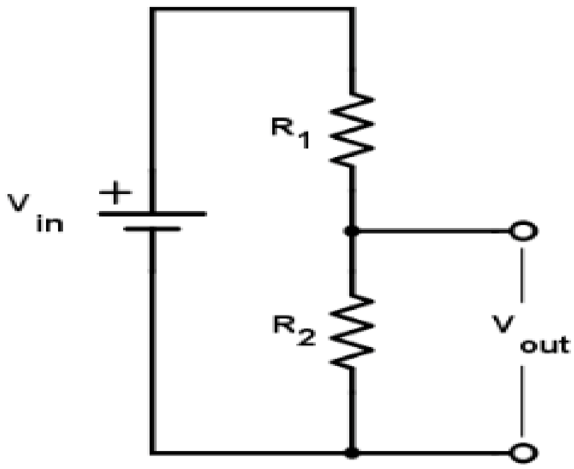

Fig. 3.4 Voltage Divider Circuit

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For voltage sensing, a voltage divider arrangement is used as shown in figure. The maximum possible input voltage is considered to be 50V. The Arduino board can withstand maximum of 5V voltage level. Hence voltage divider components shouldbedesignedtogetoutputvoltageof5Vmaximum.

3.5. Temperaturesensor:

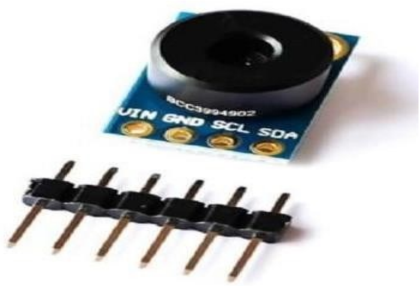

Fig. 3.5 GY906 MLX 90614 IR Sensor

The MLX90614 is an infrared thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASIC are integrated in the same TO-39 can. Integrated into the MLX90614 are a low noiseamplifier,17-bitADCandpowerfulDSPunitthusachievinghighaccuracyandresolutionofthethermometer.

3.6. LCD:-

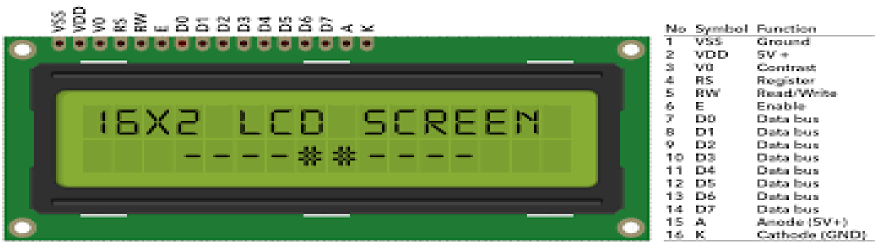

Fig.3.6 LCDDisplay

TheLCDisa14pindeviceinarow.ThevoltageVccandVssareprovidedby+5VandgroundrespectivelywhileVeeisusedfor controllingLCDcontrast.VariablevoltagebetweenGroundandVccisusedtospecifythecontrastofthecharactersontheLCD 16*2LCDisusedtodisplaycurrent,voltageandtemperaturevalues.

IV. METHODOLOGY

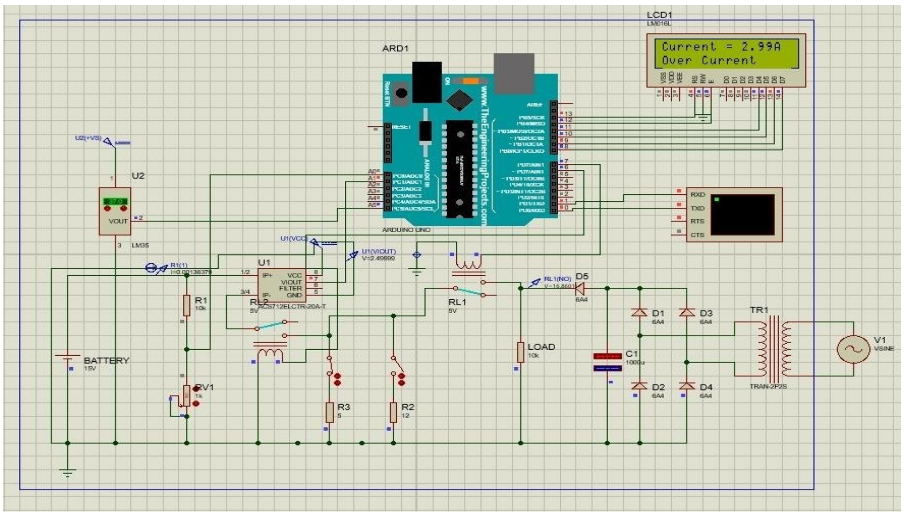

Fig.4.1 WiringDiagram

The Electric Vehicle Battery Management System with Charge Monitor, Fire Protection, and Safety Cutoff Mechanism operates through a series of integrated components and sensors, providing comprehensive management, monitoring, and protectionfortheelectricvehicle(EV)battery.

Real-time Monitoring: The system employs the IR temperature sensor, voltage sensor, and current sensor to provide continuousreal-timemonitoringoftheEVbattery'scrucialparameters.

Safety Cut-off Mechanism: In the event of detected anomalies such as low voltage, overcurrent, or overtemperature, the Arduino-based control system swiftly activates a relay to cut off the load from the battery. This proactive approach prevents potentialdamageandensuresusersafety.

Fire Protection: The inclusion of an IR temperature sensor serves a dual purpose. Not only does it contribute to real- time temperaturemonitoring,butitalsoactsasafirepreventionmeasure.Inthepresenceofunusuallyhightemperatures,the system triggersanimmediateresponsetomitigatetheriskoffireincidents.

Charge Control: The charge controller functionality optimizes the charging process for the EV battery. By dynamically adjustingchargingparametersbasedonreal-timesensordata,itensuresasafeandefficientchargingexperience.

V. SIMULATIONRESULT

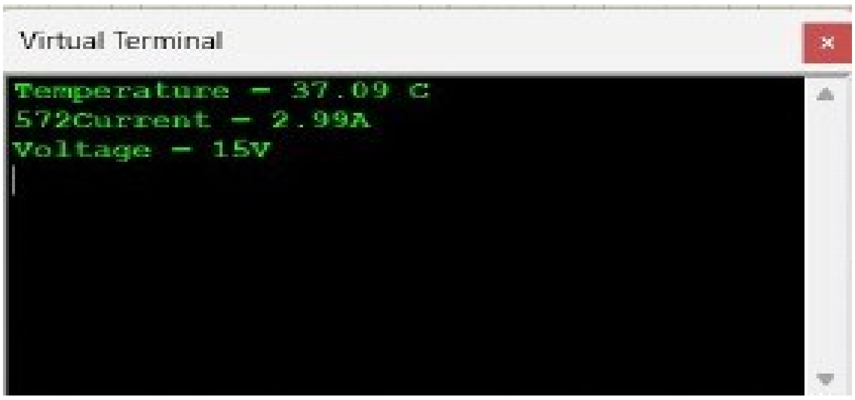

Fig.5.1 SimulationResultsin proteus8

Results:

VoltageConditions:
Warning:HighVoltage:15V+
Warning:LowVoltage: 12VUnder
Voltage:12V(relaytrips)Over
Voltage:15V+(relaytrips)

Ifthevoltagereturnstothenormalrange(between12Vand15V),theBMSdeactivatesthewarningmessages.Ifthe relaywas trippedduetohighorlowvoltage,it resets,allowingthebatterytoresumenormaloperation.

CurrentConditions:
Warning:OverCurrent:
OverCurrent:2A(relaytrips).

Once the current is within the normalrange, the BMS deactivates warning messages. Ifthe relay was tripped dueto overcurrent,itresets,enablingthebatterytoresumenormaloperation.

Temperatureconditions:
Warning:OverTemperature
Temperature:40.C(relaytrips)

Ifthetemperaturereturnstothenormalrange(below40°C),theBMSdeactivatesthewarningmessages.Iftherelaywastrippeddue toover-temperature,itresets,allowingthebatterytoresumenormaloperation.

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VI. CONCLUSION

Inconclusion,thisprojectisabigstepforwardinmakingelectriccarsbetter.TheElectricVehicleBatteryManagementSystem withChargeMonitorandFireProtectionislikethebrainofanelectriccar's battery. Asmorepeoplearechoosing electric cars, having a smart system to manage and protect the battery is crucial. The system uses different parts like a special battery, a charging and monitoring system, buttons, a screen, and sensors to keep an eye on the electric car's battery all the time. It's designedtobesafeandpreventaccidentswhenchargingthebattery.WhatmakesitstandoutisitsFireProtectionsystem,which islikehavingasmartfirefighterinsidethebattery.Itcansenseandstoppotentialfiresbeforetheyhappen,makingelectriccars evensafer.Theprojectalsomadesurethatpeoplecaneasilyuseandunderstandthe system. With a simple interface, users can interactwithandcheckonthebatterywithoutanyhassle.

Insummary,thisprojectismakingelectriccarsbetterandsaferbytacklingthechallengesofmanagingthebattery.It'sa smart solution that brings together new ideas, easy use, and extra safety features, pushing electric cars forward in the world of technologyandmakingthemmorewidelyaccepted.

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