IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.124103

Control & Telemetry System for an All-Terrain Vehicle – A Review

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Abstract: The most challenging terrains can be traversed by all-terrain electric vehicles. The low cost of ownership of electric ATVs and UTVS, an increase in the use of ATVs for military and recreational purposes, and growing public awareness of the need to reduce greenhouse gas emissions are all likely to contribute to the growth of the global market for electric all-terrain vehicles (ATVs). The expanding range of applications for electric ATV is influenced by rising EV safety standards, rising consumer demand for a better driving experience, and EVs' cheap maintenance costs. Therefore, our objective is to design and construct an effective, reliable, safe, and powerful electric ATV as well as to provide a versatile data collecting and telemetry system for EVs.

Keywords: eVCU, Electronic Control Unit, Formula car control system

I. INTRODUCTION

The transition from a traditional internal combustion engine (ICE) to an electric motor powered by a battery is a result of rising greenhouse gas (GHG) emissions. Thus, the power source for an electric vehicle can be either entirely or part of electricity. Compared to their petrol or LPG-powered counterparts, electric vehicles (EVs) are less complicated to drive, quite energy efficient, and also more affordable. The first little electric car model was created by Professor Stratingh in Groningen in the year 1835, but it was not scaled up at that time due to a shortage of batteries. EVs have been around for a very long time. There has been a resurgence of such eco-friendly modes of transportation in recent years as a result of the rising popularity of renewable sources. Table 1 shows a comparison chart of existing conventional vehicles and upcoming electric vehicles.[7]

Table 1: Comparison of conventional and electric vehicles.[7]

Conventional vehicles	Electric Vehicles
Runs on nonrenewable sources	Runs on renewable sources
Requires more maintenance	Requires less maintenance
Produces noise	Does not produce noise
Costly refueling	Cheaper refueling

An electronic system that permits the monitoring and control of multiple ATV functions is known as a control and telemetry system (C&T). It typically consists of a variety of sensors, actuators, and control units that cooperate to deliver real-time information on the operation of the vehicle as well as control over its many components. The system is designed to improve the safety, efficiency, and reliability of the ATV, by enabling operators to remotely monitor and control various functions of the vehicle. This includes monitoring the engine and transmission, steering and braking systems, as well as the suspension and other critical components.[2]

Data is sent from the numerous sensors and control units to a centralized monitoring station as part of the system's telemetry component. Informed decisions concerning the operation of the vehicle can be made by operators using this data to track the position, speed, and other critical performance characteristics of the vehicle.[12]

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II. LITERATURE REVIEW

Jobit Joseph et al.,[1] This paper explains the Hall effect sensor's operating system. He describes how the Hall Effect works as well as how the Hall Effect Sensor functions. These sensors are made of a thin, rectangular piece of p-type semiconductor material, such as silicon, gallium arsenide, or indium arsenide. The Hall element is the p-type semiconductor compound in question. Allowing a constant current to pass through the Hall element. The force that the magnetic flux lines apply to the semiconductor material while the device is in a magnetic field causes the charge carriers, electrons and holes, to be deflected to either side of the semiconductor.

P. Visconti et al.,[2] In this work, a telemetry system for continuous and real-time monitoring of the key motion parameters of the Salento racing team's SRT16 single-seat Formula SAE car was proposed. The system consists of a number of sensors, including Hall effect speed sensors, LM35 temperature sensors, thermistors for cooling liquid temperature, and potentiometers for detecting suspension extension. Figure 1 shows the block diagram of proposed system.

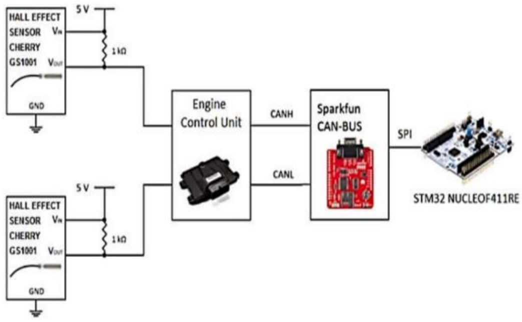

Figure 1: ST Nucleo board and Cherry GS1001Hall sensors connections

A control board built on an STM32 Nucleo board and programmed with firmware specifically created for this application collects and processes data related to physical and mechanical quantities. The control unit communicates the sensor data via a WiFi radio module to the WiFi reception unit inside the base station, where it is received and presented on a PC terminal by another ST Nucleo board linked via USB to the PC.

S. M. E. Fadul et al.,[3] The paper begins with an introduction to electric cars and their powertrain systems, highlighting the importance of modeling and simulation for the design and development of these systems. The EV comprises a battery pack, electric motor, both AC-DC and DC-DC power converters, vehicle interface and power management/control unit which monitors the power flow as depicted in Figure 2.

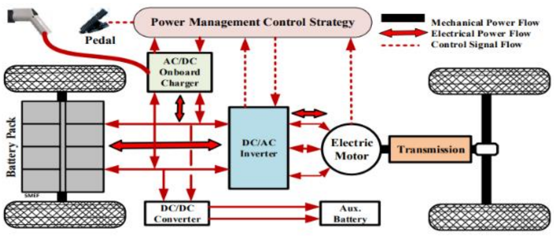

Figure 2: Structure of general EV based on the energy point of view

They have highlighted the key components of EV powertrain along with FOC approach. Below Figure 3 shows the block diagram FOC.

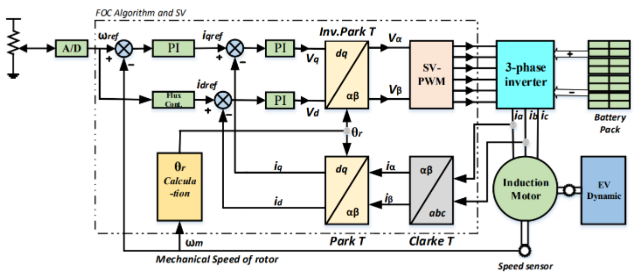

Figure 3: A block diagram of FOC

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Moreover, the results of simulation indicated that the vehicle model had good dynamic performance. This modelled powertrain shows that the vehicle reached about 70km/h during a 10-second acceleration time. Such result confirmed that the car speed fulfilled the acceleration index for powered road vehicles.

Z. Leonowicz et al.,[4] The software and hardware solution for a formula SAE electric vehicle is fully designed and implemented. In order to maintain a safe operation at all times, real-time software architecture was built to work with vehicle hardware systems. The main processing unit (main brain), the tractive system control board, the dashboard design, and the shutdown circuit were all described in detail, along with how they interact with the software. The team's driving test validated the hardware and software solution in real time.

A. Sivakumar et al.,[5] This essay discusses how a Formula Student Electric Vehicle's data acquisition system, battery management system, and other safety circuits are designed. The master-slave topology of the data acquisition system allows it to make use of the sensor network in the car in real-time. The fundamental function of this battery management system is to ensure that the system operates safely. Utilizing more recent Analogue LTC IC models that give the cells active balancing will improve it. It may also link with the Charger to enable cell balancing during the charging process, cutting down on the hazards and length of time required for charging. A battery charger circuit is shown in below Figure 4;

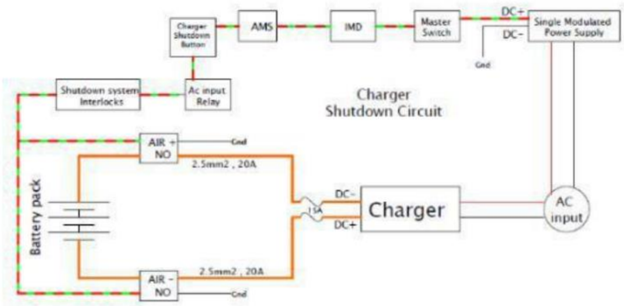

Figure 4: Battery Charger Circuit

To dynamically modify the power drawn from the Battery Pack, the system can be interfaced with the motor controller. To provide a clearer picture of the car's performance and to pinpoint the source of various problems seen during testing, the Data Acquisition System can be expanded to include more sensors.

J. Najmy et al.,[6] The Electrically Controlled Continuously Variable Transmission's structure and coding were the author's primary areas of attention. He began by concentrating on the structure and operation of the ECVT. In his junior level design class in the spring of 2019, he created a complete concept for an ECVT, giving him prior experience working with ECVTs. The ECVT concept was created by him and his team, but the system lacked the electrical control and testing required to complete the project.

A. K. Basu et al.,[7] The authors begin by outlining the advantages of EVs, including their ability to lessen reliance on fossil fuels and their lower environmental effect. After that, they go over the fundamental parts of an EV, such as the battery, motor, power electronics, and sensors that keep an eye on and regulate the car's performance. The many types of sensors used in EVs, including as temperature sensors, current sensors, voltage sensors, position sensors, and speed sensors, are also covered in detail by the writers. They explain each sort of sensor's purpose and give instances of its application in various EV parts. Overall, the essay offers a thorough analysis of the state of EV technology at present and the function of sensors in this quickly developing area. It is a helpful tool for scientists, engineers, and anybody else interested in creating sustainable transportation alternatives.

J. Du et al.,[8] The conventional unbalanced electric bridge technique estimates the insulation resistance value for the DC-IM circuit of EVs by sampling the positive and negative bridge voltages and switching the positive and negative bridge resistances. The measuring time is lengthy when the DC positive and negative poles, however, have GC because the bridge voltages must be sampled after the capacitor has fully charged. This study suggests a brand-new DC-IM technique that makes use of the three-point climbing algorithm. By measuring the voltage of the positive and negative bridges three times while maintaining an equal sampling interval, the insulating resistance can be computed. The three sampling voltages are also filtered and automatically corrected by the approach, which might increase the accuracy of the computation findings.

J. Forysiak et al.,[9] Real-time data visualization application's deployment should employ an appropriate design and architecture. The first step in developing a system to gather data from many sources within the car is to appropriately visualize and present each collected piece of data. The system overview is shown in below Figure 5.

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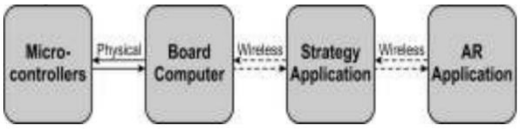

Figure 5: System Overview

The effort to offer a better and more user-friendly solution is currently ongoing. They claimed that while displaying information on the Hololens screen is more exciting and appealing, 2D applications like websites can occasionally be simpler to utilize. It can be because augmented reality has to improve in terms of engagement and people are still more accustomed to them. Figure 6 shows the architecture of telemetry system.

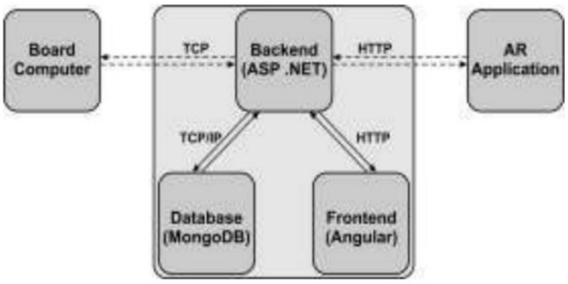

Figure 6: Telemetry system architecture

Università di Genova et al.,[10] A combinational-logic-based drivetrain control system is created and put into use for a Formula SAE electric vehicle. To keep the vehicle operating safely, this tractive system control board (TSCB) collaborates with other subsystems like SCADA, motor controllers, motors, BMS, GLV, and shutdown circuits. Extensive laboratory experiments and test drives were used to validate the TSCB.

Victor Andrei Iriciuc et al.,[11] The suggested solution satisfies the performance and quality requirements for the targeted application, specifically the Formula Student Car competition. The functional block diagram is shown in Figure 7.

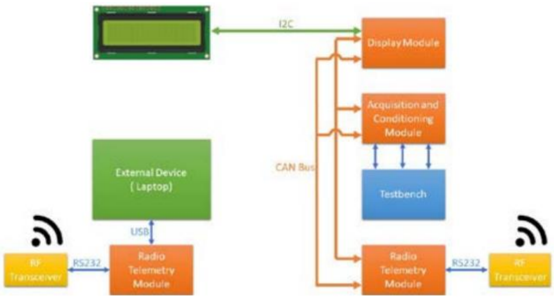

Figure 7: The functional block diagram

The use of the two Microchip-built components successfully enables local communication at baud rates of 500 kilobits per second and three nodes: Display, Telemetry, and SDAC—for the CAN interface. The wireless solution also performs admirably, with 8-bit addressed messages and CRC - Cyclic Redundancy Check - techniques for error correction working properly at distances of about 500 meters.

H. Kılıçkır et al.,[12] Promising alternatives to today's transportation and environmental issues include electric automobiles. With online monitoring and recording of the key parameters of the vehicle throughout its working lifetime, improvements to electric vehicles and their safe use may be achievable. However, it is a challenging issue with certain limitations on the range, dependability, and stability. This paper presents a telemetry system to get around these difficulties. The suggested system transfers data using RF signals, and communication assignment is handled by dependable and stable ARM microprocessors. Multiple communication modules are included in the designed telemetry system to enable various communication protocols. The receiver module receives data from the transmitter module about the temperature, speed, and battery status within the car. Through CAN bus communication, the transmitter module receives this data from the vehicle's main controller unit (MCU). The NRF24L01 communication module transmits data from the transmitter module to the receiver module. Traceability of the vehicles and directives according to the findings of this monitoring is crucial in electric vehicle competitions. For this reason, a telemetry system that is dependable and consistent and can carry out the necessary activities is needed. The general telemetry system design is shown in Figure 8.

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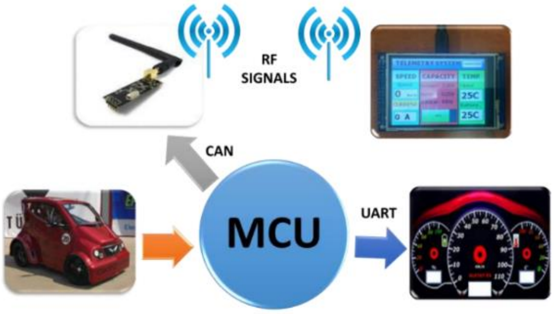

Figure 8: General telemetry system design

As a result, in this study, a telemetry system was created and successfully employed in the International Tubitak Efficiency Challenge Electric Vehicle competition. The flow chart of telemetry system that used to implement in this paper is shown in Figure 9.

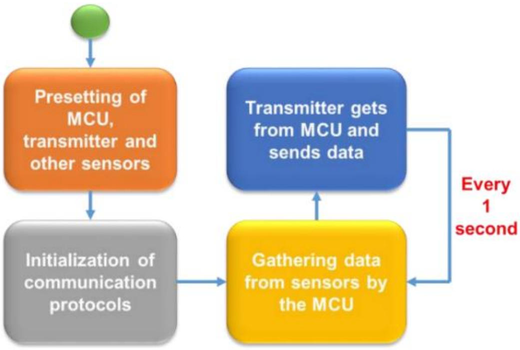

Figure 9: Telemetry system flow chart

O. Prakash Sharma et al.,[13] More and more electronic-controlled systems will start to show up in real-time applications for vehicles, which will advance technology. The important component of control systems has been and will continue to be networking, and CAN will stay cutting edge. Applications needing a high volume of reliable brief messages in harsh operational settings are best suited for CAN. CAN is especially well suited when data is needed by multiple locations and system-wide data consistency is required because it is message-based rather than address-based. In order to avoid a network from being brought down by a single node and to guarantee that bandwidth is always available for the transmission of important messages, faulty nodes are immediately removed from the bus. This error containment also permits hot-plugging, or the addition of nodes to a bus while the system is running.

H. Potdevin et al.,[14] This paper explains the significance of monitoring insulation in high voltage systems for hybrid and electric automobiles. According to the author, insulation is necessary for these cars' high voltage systems to stop electrical leakage and guarantee the security of both drivers and passengers. The paper gives a general review of various insulation monitoring methods, including both touch and non-contact procedures, and evaluates the benefits and drawbacks of each. The author also emphasises the necessity of uniform testing methodologies and the significance of ongoing insulation resistance monitoring. The importance of insulation monitoring is emphasised in the paper's conclusion in order to guarantee the safe and dependable operation of high voltage systems in hybrid and electric cars. The design factors for insulation monitoring systems in electric and hybrid vehicles are also covered in the study, including the usage of high-voltage isolation amplifiers and the requirement for minimal power consumption. The paper's overall conclusion emphasises the significance of insulation monitoring in maintaining the secure and dependable functioning of high voltage systems in electric and hybrid cars.

E. D. Mitronikas et al.,[15] In order to detect and record significant mechanical and electrical parameters in real time, an experimental prototype electric vehicle must always incorporate a data acquisition and telemetry system. In the current work, the creation of a flexible data collecting and telemetry system for prototype electric vehicles is detailed in detail together with its technical specifications. A hybrid, solar vehicle, or solely electric car's key operating parameter can be measured by the data acquisition and telemetry system that is being described, and the measured values can be transmitted to a host computer through GPRS. The car can transmit from anywhere as long as a provider's cell phone network is available in the area because data is transmitted utilizing the conventional communication network. Architecture of the proposed interconnection is shown in below Figure 10.

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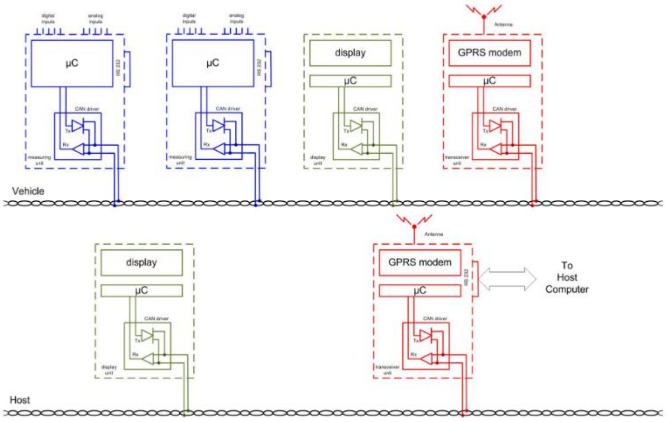

Figure 10: Architecture of the proposed interconnection

Future related uses, such as telemetry applications for wind and solar parks, can be simply improved and changed thanks to the established system's adaptability and potential for bidirectional operation.

III. SUMMARY

An all-terrain vehicle (ATV) requires a control and telemetry system that enables precise control and monitoring of the vehicle's performance. The control system includes components such as steering, throttle, brake, and suspension, which must be designed to provide both precision and safety. The telemetry system is responsible for collecting data from various sensors located throughout the vehicle, such as speed, temperature, and fuel level, and transmitting it to a central control unit. A modern ATV control and telemetry system may include advanced features such as GPS tracking, wireless connectivity, and remote-control capabilities, enhancing safety and convenience for the rider. A reliable control and telemetry system is essential for the safe and efficient operation of an ATV.

IV. CONCLUSION

The control and telemetry system are a critical aspect of all-terrain vehicle (ATV) operation. The control system must provide precise control over the vehicle while also ensuring the rider's safety and comfort. The telemetry system is responsible for collecting data from sensors and transmitting it to a central control unit, enabling real-time monitoring of the vehicle's performance. Advanced features such as GPS tracking, wireless connectivity, and remote-control capabilities can enhance the safety and convenience of the rider. A reliable control and telemetry system is essential for the safe and efficient operation of an ATV in a variety of terrains.

ACKNOWLEDGMENT

We extend our gratitude towards the institute for the constant support. We would also like to acknowledge our sincere thanks to the HOD of ECE Department and HOD of MTR Department for the constant encouragement. Finally, we would like to thank all the faculties of the departments and the institute for their support.

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