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DESIGN AND IMPLEMENTATION OF AN EMBEDDED SYSTEM FOR DATA TRANSFER IN A CAR USING CAN PROTOCOL

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ABSTRACT

Automobiles have been an inextricable feature of daily life. The impacts that cars with improved safety systems require in order to compensate for deadly fiascos. Therefore, the present work cites a system based on the protocol Controller Area Network (CAN) which provides an effective and real-time information transfer solution between nodes, is used for preventing vehicle failures and assists drivers with information and message-based instructions. The proposed framework, which uses the CORTEX ARM LPC 1768 chip, specifies four key objectives related to automobile protection in this article. The proposed device uses the CAN protocol, which only requires two wires to communicate, rather than complex wiring.

I.INTRODUCTION

Vehicles are changing these days, with higher speeds and technical advances, as well as more serious accidents. Automobile producers were more focused on improving vehicle safety and avoiding accidents and deaths. People generally prefer automatic transmission vehicles because of the ease with which they can operate. Four safety measures are incorporated in our project. An obstacle detection system employs ultrasonic sensors located on the front and/or rear bumpers. Ultrasonic sensors assess the distance between the driver and surrounding obstacles immediately around the front or rear bumper, and the vehicle's speed decreases. Beeps or the dashboard monitor

notify the driver. When the vehicle approaches the barrier, the vehicle's speed decreases. The speed can vary depending on the distance between the obstacle and the driver. If a crash is inevitable, the vehicle will come to a complete stop. Our first safety measure in this project is a speed limit based on obstacle detection. Increased engine temperature is the second safety factor. Increased engine temperature may be caused by a broken thermostat or a failed water pump gasket. If the temperature rises too high, the engine could be overheating. A temperature sensor may be used to verify this. Auto headlight ON/OFF is the third safety feature. Headlights are not needed during the day, but they will turn on automatically at night. When someone driving in the opposite direction uses a high, light beam while driving at night, a sudden glaring impact occurs for a brief period of time. As a result, depending on the light intensity of the opposite vehicle, the driving car's headlights can dim automatically. CAN (Controller Area Network) is a LAN (Local Area Network) controller that can transfer serial data one by one. The construction of an automobile is seen in Fig 1. Both representatives of the CAN bus subsystems send and receive data via the control unit on the CAN bus interface. A multichannel transmission scheme, the CAN bus. When one device crashes, it has no bearing on the rest of the system.

II.METHODOLOGY

A) System Architecture

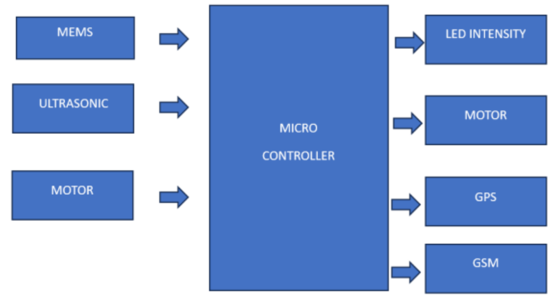

Fig1 .Block Diagram

The architecture starts with embedded controllers or microcontrollers (MCUs) installed in different subsystems of the car, such as the engine control unit (ECU), infotainment, and safety systems. Each MCU is equipped with a CAN transceiver, which allows communication over the car's CAN bus. The CAN protocol facilitates high-speed, reliable data transfer between these ECUs by transmitting messages in a robust and fault-tolerant manner. A central processing unit (CPU) is often used to coordinate data exchange, interpret received data, and control the various subsystems. The system may include sensors for monitoring parameters like speed, temperature, and fuel levels, and actuators to control components like brakes and air conditioning. The embedded system also features a user interface for monitoring real-time data, diagnostic information, and alerts.

B) Proposed Raspberry pi

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The Raspberry Pi Pico is an affordable microcontroller board created by the Raspberry Pi Foundation. Unlike full-fledged computers, microcontrollers are small and have limited storage and peripheral options, such as the absence of devices like monitors or keyboards. However, the Raspberry Pi Pico is equipped with General Purpose Input/Output (GPIO) pins, similar to the ones found on Raspberry Pi computers, allowing it to connect with and control a variety of electronic devices. Introduced in January 2021, the Raspberry Pi Pico is based on the RP2040 System on Chip (SoC), which is both cost-effective and highly efficient. The RP2040 SoC includes a dual-core ARM Cortex-M0+ processor that is well-known for its low power consumption. The Raspberry Pi Pico is compact, versatile, and performs efficiently, with the RP2040 chip as its core. It can be programmed using either Micro Python or C, providing a flexible platform for users of various experience levels. The board contains several important components, including the RP2040 microcontroller, debugging pins, flash memory, a boot selection button, a programmable LED, a USB port, and a power pin. The RP2040 microcontroller, custom-built by the Raspberry Pi Foundation, is a powerful and affordable processor. It features a dual-core ARM Cortex-M0+ processor running at 133 MHz, 264 KB of internal RAM, and supports up to 16 MB of flash memory. The microcontroller provides a wide range of input/output options, such as I2C, SPI, and GPIO. The Raspberry Pi Pico has 40 pins, including ground (GND) and power (Vcc) pins. These pins are grouped into categories such as Power, Ground, UART, GPIO, PWM, ADC, SPI, I2C, System Control, and Debugging. Unlike the Raspberry Pi computers, the GPIO pins on the Pico can serve multiple functions. For instance, the GP4 and GP5 pins can be set up for digital input/output, or as I2C1 (SDA and SCK) or UART1 (Rx and Tx), though only one function can be used at a time.

C) Design Process

The design of embedded systems follows a methodical, data-driven process that requires precise planning and execution. One of the core elements of this approach is the clear separation between functionality and architecture, which is crucial for moving from the initial concept to the final implementation. In recent years, hardware-software (HW/SW) co-design has gained significant attention, becoming a prominent focus in both academia and industry. This methodology aims to align the development of software and hardware components,

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addressing the integration challenges that have historically affected the electronics field. For large-scale embedded systems, it is essential to account for concurrency at all levels of abstraction, impacting both hardware and software components. To facilitate this, formal models and transformations are employed throughout the design cycle, ensuring efficient verification and synthesis. Simulation tools are vital for exploring design alternatives and confirming the functional and timing behavior of the system. Hardware can be simulated at different stages, including the electrical circuit, logic gate, or RTL level, often using languages like VHDL. In certain setups, software development tools are integrated with hardware simulators, while in other cases, software runs on the simulated hardware. This method is generally more suited for smaller parts of an embedded system. A practical example of this methodology is the design process using Intel's 80C188EB chip. To reduce complexity and manage the design more effectively, the process is typically divided into four main phases: specification, system synthesis, implementation synthesis, and performance evaluation of the prototype.

APPLICATIONS

Embedded systems are being increasingly incorporated into a wide range of consumer products, such as robotic toys, electronic pets, smart vehicles, and connected home appliances. Leading toy manufacturers have introduced interactive toys designed to create lasting relationships with users, like "Furby" and "AIBO." Furbies mimic a human-like life cycle, starting as babies and growing into adults. "AIBO," which stands for Artificial Intelligence Robot, is an advanced robotic dog with a variety of sophisticated features. In the automotive sector, embedded systems, commonly referred to as telematics systems, are integrated into vehicles to offer services like navigation, security, communication, and entertainment, typically powered by GPS and satellite technology.

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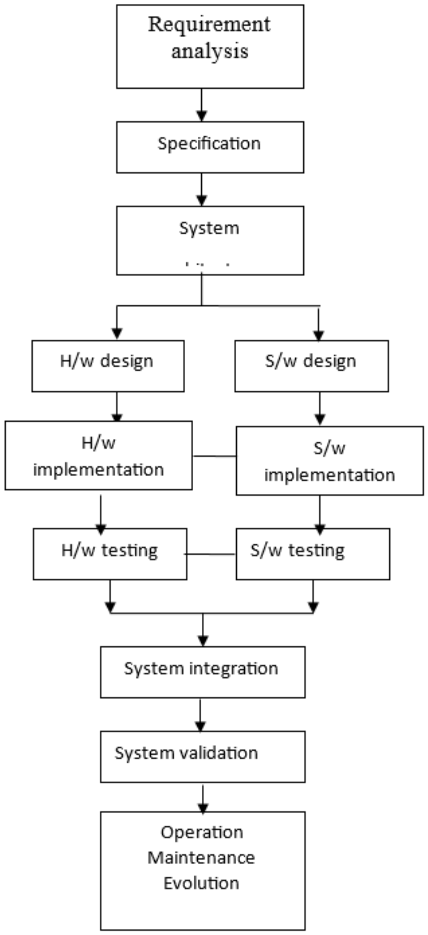

Fig 2. Embedded Development Life Cycle

The use of embedded systems is also expanding in home appliances. For example, LG's DIOS refrigerator allows users to browse the internet, check emails, make video calls, and watch TV. IBM is also developing an air conditioner that can be controlled remotely via the internet. Given the widespread adoption of embedded systems across various industries.

III.CONCLUSION

Instead of complex wiring, the suggested device communicates using the CAN protocol, which only needs two wires. The parameters in a vehicle are managed using the CAN protocol, and appropriate controls are made for each parameter. We can use the automatic car parameters in any vehicle because they are very inexpensive. CAN is the best protocol for communicating between multiple controllers. Various conditions, such as automatic horn volume change, wheel pressure and temperature, automated fuel indicator with mileage display, automatic exhaust gas controller, and so on, will be monitored and controlled in the future. This process can be used in businesses to simplify them. Our project focuses on vehicle-to-vehicle connectivity, although it can be extended to include vehicle-to-vehicle (V2V) communication (vehicle to vehicle communication). Protection precautions could be added to car communication in order to render it driverless.

IV.FUTURE SCOPE

The future scope of an embedded system for data transfer in a car using the CAN protocol is vast and promising, with numerous advancements and innovations on the horizon. As vehicles continue to become more connected and automated, the role of embedded systems in enabling efficient communication between subsystems will grow significantly. One of the key future developments will be the integration of Advanced Driver Assistance Systems (ADAS) and autonomous driving technologies, where the CAN protocol will need to support faster data transfer rates, enhanced reliability, and real-time decision-making for critical vehicle functions such as collision avoidance, lane-keeping, and adaptive cruise control. Another important trend is the integration of wireless communication alongside the CAN bus, such as Wi-Fi or 5G, to allow for seamless interaction with cloud services, vehicle-to-vehicle (V2V) communication, and vehicle-to-infrastructure (V2I) communication. This could enable more advanced functionalities like remote diagnostics, over-the-air (OTA) software updates, and predictive maintenance. Additionally, the development of electric vehicles (EVs) and hybrid electric vehicles (HEVs) will require more sophisticated power management and energy-efficient communication systems, which can be incorporated into the CAN-based embedded architecture. The adoption of CAN FD (Flexible Data-rate), which allows for higher data throughput, will also play a crucial role in supporting the increasing data demands of future automotive applications. In terms of safety and security, cyber security will become a critical focus, with embedded systems needing to incorporate advanced encryption, authentication, and intrusion detection mechanisms to protect sensitive vehicle data from cyber threats. Furthermore, as the automotive industry moves towards smart cities, embedded systems will be integral to the seamless interaction between vehicles, infrastructure, and users, contributing to safer, more efficient transportation systems. In summary, the future scope of embedded systems using the CAN protocol in automotive applications will be shaped by the convergence of connectivity, automation, electrification, and security, driving innovation in vehicle design, functionality, and user experience.

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