**Abstract**

Modern vehicles use the Electronics Control Unit (ECU) to control and monitor all the activities within the vehicle. The number of ECUs are increasing as the complexity of vehicles increases. All the ECUs present in the vehicles are communicated with each other via CAN protocol. Any malfunction in the ECU or abnormal behaviour of ECU is detected or understood by diagnostic services. CAN Protocol does not have advanced features like Diagnostic. The CAN protocol covers only the Physical and Data link layer of the OSI model. There is a need for a standardised diagnostic protocol which can use CAN as underlying technology. Standardised diagnostic protocols used in the automotive domain are On Board Diagnostics (OBD) and Unified Diagnostic services (UDS). UDS protocol is defined under the ISO 14229 standard and provides a standardized framework for in-vehicle communication and fault diagnosis. This project focuses on the **design and implementation of the UDS protocol** on an embedded system using **STM32F407 microcontrollers**. The project involves developing a diagnostic communication system between two Electronic Control Units (ECUs), a **Body Control Module (BCM)** and a **Light Control Module (LCM)** connected over a **CAN bus**.

**Keyword:** Unified Diagnostic Services (UDS),ISO 14229,Electronic Control Unit (ECU),Body Control Module (BCM),Light Control Module (LCM), Controller Area Network (CAN),Diagnostic Trouble Code (DTC),Routine Control Identifier(RID) , Data Identifier (DID),ISO-TP (Transport Protocol)

**Introduction**

In modern automotive systems, the ability to diagnose and troubleshoot Electronic Control Units (ECUs) efficiently is critical for ensuring vehicle reliability and performance. The **UDS** protocol, defined by **ISO 14229**, is widely adopted in the automotive industry to facilitate standardized communication between diagnostic tools and vehicle ECUs over the **CAN network**. UDS enables functions such as **fault detection, software updates, parameter tuning, and remote ECU diagnostics**, making it an essential part of vehicle maintenance and repair processes.

This paper presents the **design and implementation of a UDS-based diagnostic communication system using STM32F4 microcontrollers**. The project involves two distinct ECUs **Body Control Module (BCM)** and **Light Control Module (LCM)** that communicate via **CAN bus** and respond to UDS diagnostic requests. The system supports essential UDS services, including **Read Data by Identifier (0x22), Write Data by Identifier (0x2E), Routine Control (0x31), ECU Reset (0x11), and Read DTC Information (0x19)**.

To validate the robustness of the system, **fault injection techniques** are utilized, simulating real-world ECU failures such as **Overvoltage and Under-Voltage conditions,** **CAN bus disconnection, ECU power loss, and LED circuit failures**. The diagnostic response to these failures is analyzed using **a Waveshare USB-to-CAN module and Python-based UDS test scripts**. By implementing UDS on embedded automotive ECUs, this project aims to **demonstrate the practical application of standardized diagnostic services in real-world vehicle systems, improving the efficiency of vehicle fault detection and maintenance processes**.

**System Overview**

1. Block Diagram

