VEHICLE TELEMATIC CONTROL UNIT

- **Overview**

The Telematics Control Unit (TCU) is a sophisticated system designed for real-time monitoring and data acquisition of various vehicle parameters. Utilizing a combination of Raspberry Pi 4B, Arduino Uno boards, and multiple sensors, the system collects, processes, and displays critical information both locally and on a web server.

System Components

Master Unit
- Raspberry Pi 4B (2GB)
    - Acts as the master unit in the system.
    - Collects serial data from all sensors and Arduino Uno boards.
    - Processes data and uploads it to the server and LCD display.

Communication and Interface
- MCP2515 CAN BUS Module
    - Interfaces between CAN communication and SPI communication.
    - Allows Arduino Uno to read data from the OBD2 port.
- Flask
    - A micro web framework written in Python.

- Functions as a local and web server.
- Receives data, processes it for display on the LCD, and uploads it to the cloud.
- Sockets and MQTT
  - Real-time accessibility of sensor data via on-screen dashboard (LCD).
  - Data packets are encrypted using AE Symmetric encryption before being sent to the MQTT server.
  - Ensures secure data transmission.

Sensors and Data Acquisition

- Vehicle Speed Sensor
  - Measures vehicle speed with modifications to the reference voltage for interfacing with Arduino Uno.
  - Speed sensor from Pulsar used.
- Voltage Sensor
  - Range: 0-25V.
  - Measures vehicle battery voltage.
- Rotary Encoder
  - Measures steering angle.
  - Helps detect accidents and driver's alertness.
- MPU6050
  - Measures vehicle acceleration in all three axes.
  - Detects rollover in all three axes, aiding in accident detection.

- Neo 6M GPS Sensor
    - Connected directly to Raspberry Pi 4B via serial communication.
    - Provides vehicle location coordinates.

- Fuel Level Sensor
    - Fuel level sensor from KTM with modified floating resistance for Arduino Uno interfacing.

Data Processing and Storage

- **Arduino Uno (Slave Units)**

    - Unit 1 (AT-Mega328P)
        - Collects data from the fuel sensor, voltage sensor, and rotary encoder.
        - Prints data on the serial monitor.
        - Provides serial data to Raspberry Pi 4B via USB communication.

    - Unit 2 (AT-Mega328P)
        - Collects data from MCP2515, speed sensor, and MPU6050.
        - Prints data on the serial monitor.
        - Provides serial data to Raspberry Pi 4B via USB communication.

Data Handling

- Offline Storage
  - Data is stored in CSV format on the SD card of Raspberry Pi 4B.
  - Offline storage ensures data is saved even when connectivity is unavailable.
- Online Storage
  - Data is encrypted and sent to the MQTT server.
  - Stored data is uploaded to a MongoDB database.

Connectivity Check

- Connectivity is checked every 300 seconds.
  - If connectivity is available, data is encrypted and sent to the MQTT server.
  - If connectivity is unavailable, data is stored locally and checked again after 300 seconds.

Display and Monitoring

- LCD Display
  - A 7-inch touchscreen display is used as the vehicle's dashboard.
  - Shows all parameters, including GPS location.
- App Monitoring
  - Real-time monitoring and control through the web server interface.

Summary

The TCU project integrates multiple hardware and software components to create a comprehensive vehicle monitoring system. With its robust data acquisition, secure data transmission, and real-time display capabilities, it provides essential insights into vehicle performance and safety.