PROJECT REPORT

DATA COLLECTION MODULE

OF DIGITAL TWIN FOR DIESEL GENERATOR (PHASE-1)

PRODUCT DEVELOPMENT COURSE

DIP004U3M & DIP005U3M

BY-

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1. Introduction

In the era of Industry 4.0, digital twin technology has emerged as a transformative approach for optimizing industrial processes and equipment. The Digital Twin of a Diesel Generator project aims to leverage this technology to enhance the monitoring, control, and maintenance of diesel generators. This report focuses on the first phase of the project: the Data Collection Module (DCM).

2. Literature Review

Digital twin technology involves creating virtual replicas of physical assets or systems, allowing real-time monitoring, analysis, and simulation. Companies like GE and IBM have pioneered the implementation of digital twins across various industries, demonstrating their potential to improve operational efficiency and reduce downtime.

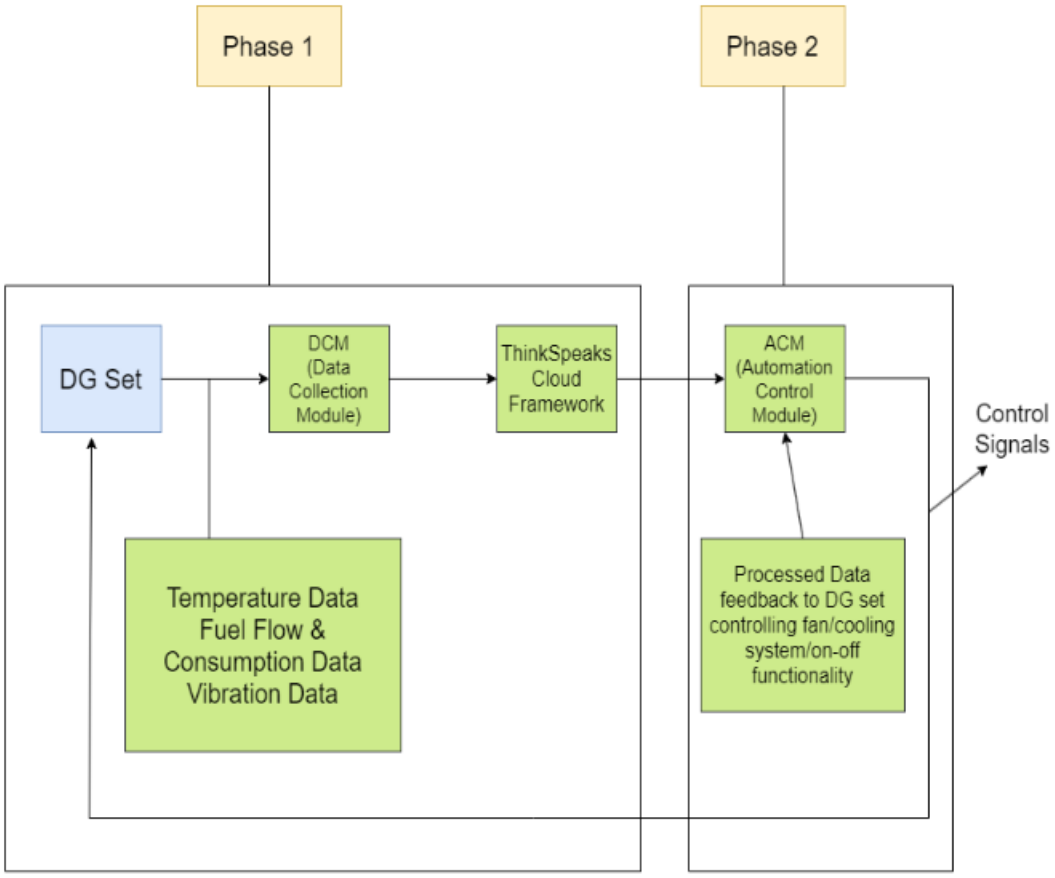
Data collection is a crucial aspect of digital twin development, providing the foundation for accurate modeling and analysis. By integrating sensors with physical assets, relevant data can be continuously gathered and transmitted for further processing.

3. Project Overview

The project is divided into two phases:

I. **Data Collection Module (DCM):** The DCM phase focuses on implementing sensors to collect essential data from the diesel generator. This data will serve as input for the creation and operation of the digital twin.

II. **Automation Control Module (ACM):** The ACM phase focuses on automating the operation of dg-set, as well as providing remote control for various parameters of dg-set.



4. Methodology

For the DCM phase, we selected the following sensors:

- OF05ZAT G1/2 DN15 Oil Flow Sensor: Measures diesel flow rate

- MAX6675 Thermocouple Sensor Module and K-type Thermocouple: Measures temperature of radiator, engine, and environment

- MPU-6050 3-Axis Accelerometer: Measures body vibration of the diesel generator

These sensors are connected to an ESP32 module, which processes the data and transmits it to the ThingSpeak cloud platform via Wi-Fi.

5. Implementation

Each sensor was carefully integrated into the diesel generator setup:

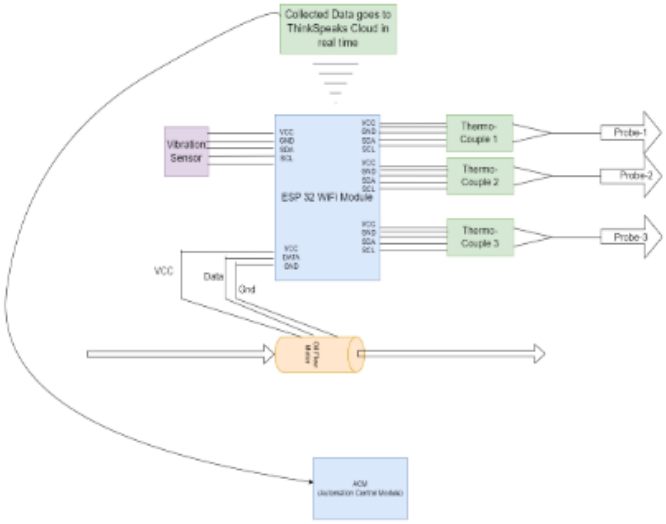
- The oil flow sensor was installed in the fuel line to measure diesel flow.

- Thermocouples were placed at strategic points to monitor temperature variations.

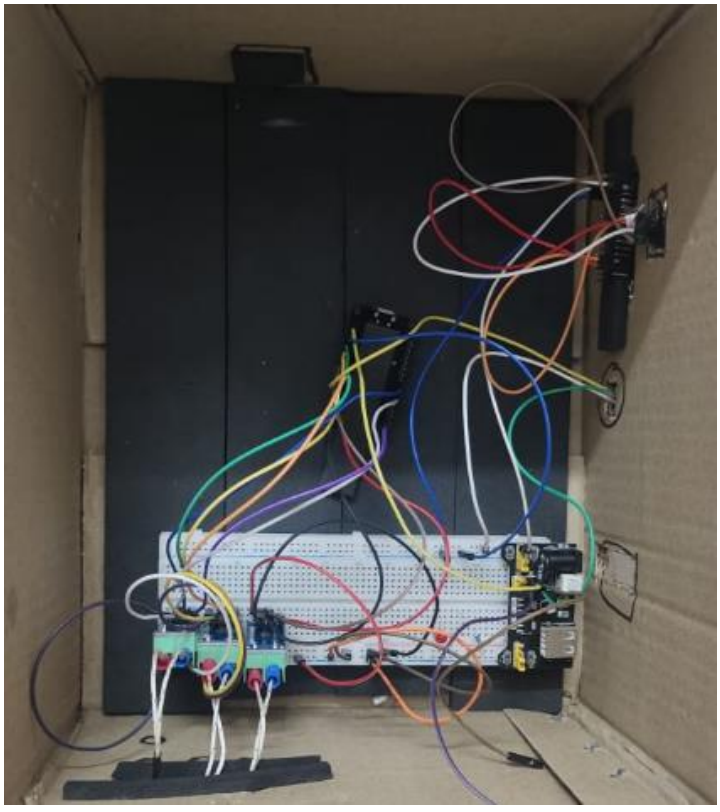
- The accelerometer was mounted on the generator body to capture vibration data.

- All the sensors are set into one module the DCM.

Hardware setup and wiring diagrams were created to ensure proper connectivity. Software was developed to manage data processing and transmission, considering the specific requirements of each sensor.



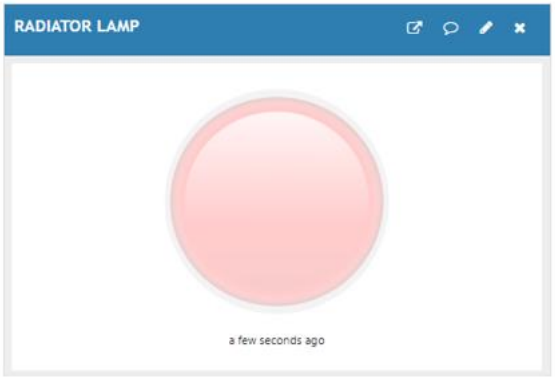
- Wiring Diagram



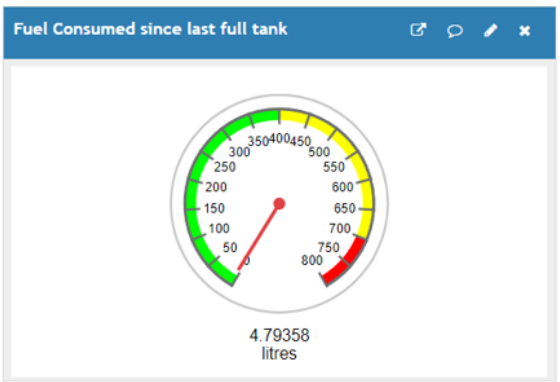
- Hardware Implemented

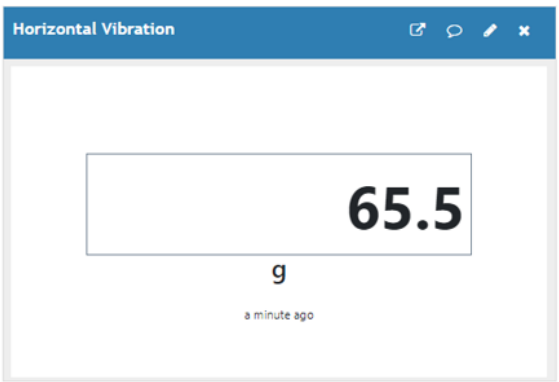
6. Results and Analysis

Data collected from the sensors will provide valuable insights into the performance and behaviour of the diesel generator. Analysis of the data revealed patterns, trends, and anomalies that will inform the development of the digital twin.

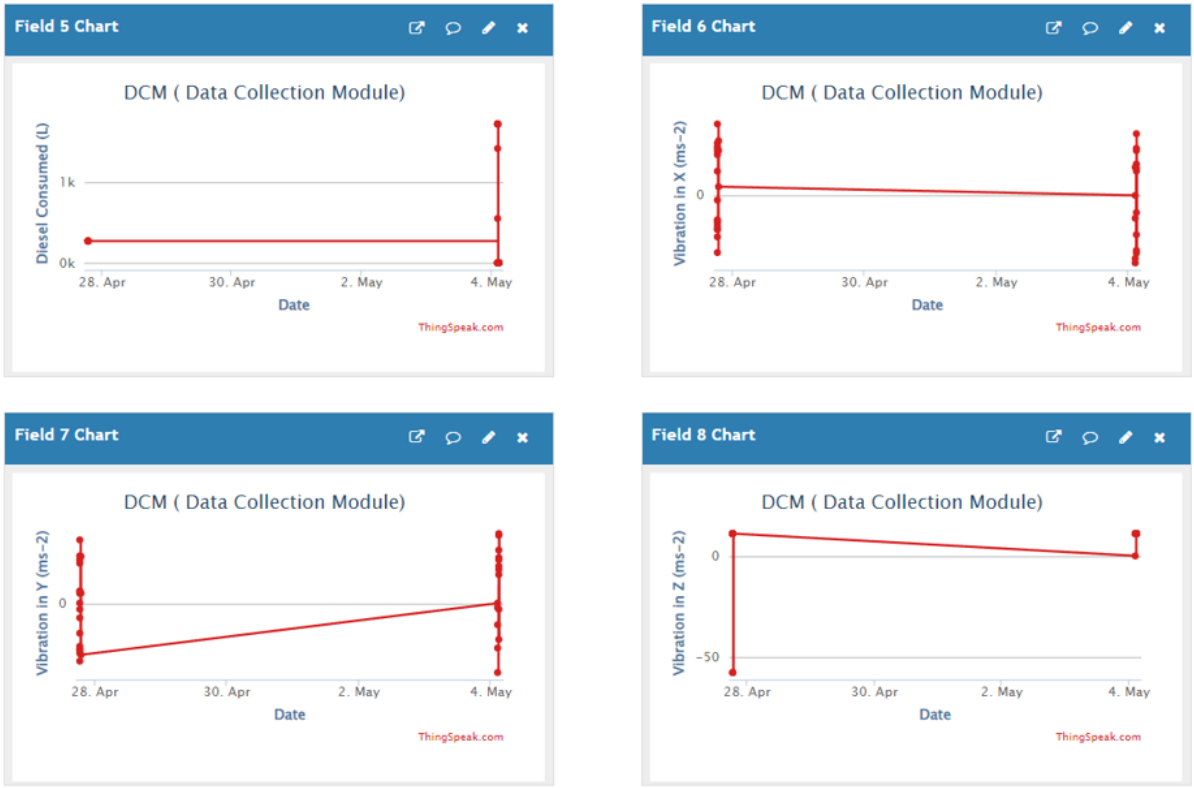


- Lamps turn on under different conditions (High Temperature, Low Fuel etc)





- Gauge & Numerical Meters (for Temperature, Vibration, Fuel etc)



- **Real-time data plotted against time (for analysis of different parameters)**

```
02:57:25.405 -> Thermocouple 2 temperature: 27.00 °C
02:57:25.405 -> Thermocouple 3 temperature: 28.75 °C
02:57:26.626 -> Problem sending data to ThingSpeak
02:57:26.626 -> Flow rate: 0.00 ml/second
02:57:26.626 -> Thermocouple 1 temperature: 27.00 °C
02:57:26.626 -> Thermocouple 2 temperature: 27.50 °C
02:57:26.626 -> Thermocouple 3 temperature: 28.25 °C
02:57:27.824 -> Problem sending data to ThingSpeak
02:57:27.862 -> Flow rate: 0.07 ml/second
02:57:27.862 -> Thermocouple 1 temperature: 27.25 °C
02:57:27.862 -> Thermocouple 2 temperature: 27.50 °C
02:57:27.862 -> Thermocouple 3 temperature: 28.25 °C
02:57:29.087 -> Problem sending data to ThingSpeak
02:57:29.087 -> Flow rate: 0.23 ml/second
02:57:29.087 -> Thermocouple 1 temperature: 27.00 °C
02:57:29.087 -> Thermocouple 2 temperature: 27.25 °C
02:57:29.087 -> Thermocouple 3 temperature: 28.25 °C
02:57:30.287 -> Problem sending data to ThingSpeak
02:57:30.287 -> Flow rate: 0.24 ml/second
02:57:30.287 -> Thermocouple 1 temperature: 26.50 °C
02:57:30.287 -> Thermocouple 2 temperature: 27.25 °C
02:57:30.321 -> Thermocouple 3 temperature: 28.25 °C
02:57:31.520 -> Problem sending data to ThingSpeak
02:57:31.520 -> Flow rate: 0.25 ml/second
02:57:31.520 -> Thermocouple 1 temperature: 26.75 °C
02:57:31.520 -> Thermocouple 2 temperature: 27.00 °C
02:57:31.520 -> Thermocouple 3 temperature: 29.00 °C
```

- Software data (Real Time)

7. Future Work

Moving forward, the project will focus on the Automation Control Module (ACM), which will involve implementing control algorithms based on the insights gained from the DCM phase. Additionally, further enhancements to the data collection module, such as the integration of additional sensors, will be explored to improve the accuracy and comprehensiveness of data collection.

8. Conclusion

The Data Collection Module represents a significant milestone in the Digital Twin of Diesel Generator project. By successfully implementing sensors to gather essential data, we have laid the groundwork for the development of a comprehensive digital twin that will enable proactive monitoring, predictive maintenance, and optimization of the diesel generator.

9. Appendices

Link to access project : Data Collection Module

To access, do login using your existing MATHWORKS account.

Additional data on sensors-

OF05ZAT G1/2 DN15:

- Thread size : Male 1/2” / 0.8 INCH

- Flow rate: 5-300L/Hour (flow pressure should start-up to run oval gear) Different liquid, different flow rate range.
- Flow Pulse: F(Hz)=2.5ML/ P
- Working Voltage: DC 3.5V~12V
- Working pressure : < 1.75Mpa
- Operating Working Temperature:-25 Degree centigrade to +70 Degree centigrade Liquid Temperature

MAX6675:

- High impedance differential inputs.
- Thermocouple break detection.
- 2000V of ESD signal.
- Embedded thermocouple break detection circuitry.
- Compatible with K-type temperature probe
- Simple SPI serial output temperature.

MPU6050:

- Chip built-in 16bit AD converter, 16-bit data output
- Driver Chip: MPU6050
- Operating Voltage: 3-5V DC
- Communication: I2C/IIC Protocol
- Gyro Range: ± 250, 500, 1000, 2000 °/s
- Accelerometer Range: ± 2 ± 4 ± 8 ± 16 g

ESP MODULE –

ESP32:

- Ultra-low-power management.
- 4 MB Flash.
- Current: 80 mA.
- Supply Voltage: 3.0 V ~ 3.6 V.

- Data Rate: 150 Mbps.
- Frequency: 2.4 GHz.

Link to code, photos & other relevant project data.

End of Report