

## **Group - 5**

### **Assignment: Sensors and Instrumentation**

#### **Objective:**

Analyse real-world sensor data and apply instrumentation concepts to understand sensor behaviour, signal noise, and system interactions.

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#### **Instructions:**

- Answer all the questions with detailed explanations and justifications.
  - Use graphs, tables, and statistical analyses where applicable.
  - Submit a report along with Python code for data analysis and visualization.
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### **1. Data Exploration**

- a) Load the dataset and display the first five rows. Identify the key sensor readings available.
- b) Identify the data types of each column. Which ones are numerical and which are categorical?

### **2. Sensor Behaviour Analysis**

- a) Plot the **THERMISTOR (F)** readings over time. What trends do you observe?
- b) The **PIR\_SENSOR** detects motion. Identify the time periods with the highest motion detection values.
- c) Does the **AC STATUS** (on/off) have any correlation with the **THERMISTOR (F)** readings? Justify with a graph.

### **3. Sensor Fusion and Correlations**

- a) Do the **SMOKE\_DETECTOR** and **FIRE\_DETECTOR** activate simultaneously? Use statistical methods to analyse.
- b) Are there any locations (**GPS\_X**, **GPS\_Y**) where motion detection is consistently high?
- c) Investigate if the **CONTACT SENSOR\_DOOR** and **CONTACT SENSOR\_WINDOW** are related to motion detection (**PIR\_SENSOR**).

### **4. Data Noise and Processing**

- a) Sensor readings often contain noise. Calculate the mean and standard deviation of **THERMISTOR (F)** readings.

- b) Apply a **moving average filter** (window size = 3) to smooth the temperature readings and compare it with the original data.
- c) Suggest methods to reduce noise in real-time sensor applications.

## 5. Practical Implementation

- a) If you were designing a fire alarm system based on this data, what logic would you use to trigger an alarm?
- b) How can GPS data be used to enhance security monitoring in this system?
- c) Based on **WEIGHT\_OF\_PACKAGE**, how can sensors be used for automated package handling?

## 6. Advanced (Bonus Questions)

- a) Fit a regression model to predict **THERMISTOR (F)** based on other sensor values.
  - b) Use clustering techniques to group similar sensor behaviours over time.
  - c) Analyse the dataset to detect any anomalies in sensor readings and propose a method to identify faulty sensor behaviour.
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### Submission Requirements:

- A detailed report with answers, graphs, and explanations.
- Python/MATLAB code (if applicable) for analysis and visualization.
- Recommendations on improving sensor-based monitoring systems.