Project Title:

Smart Energy and Occupancy Monitoring using LoRa and Computer Vision

Mentor:

Dr Raja Vara Prasad Y

Done by:

P HARISH RAGAVENDER (S20220020301)

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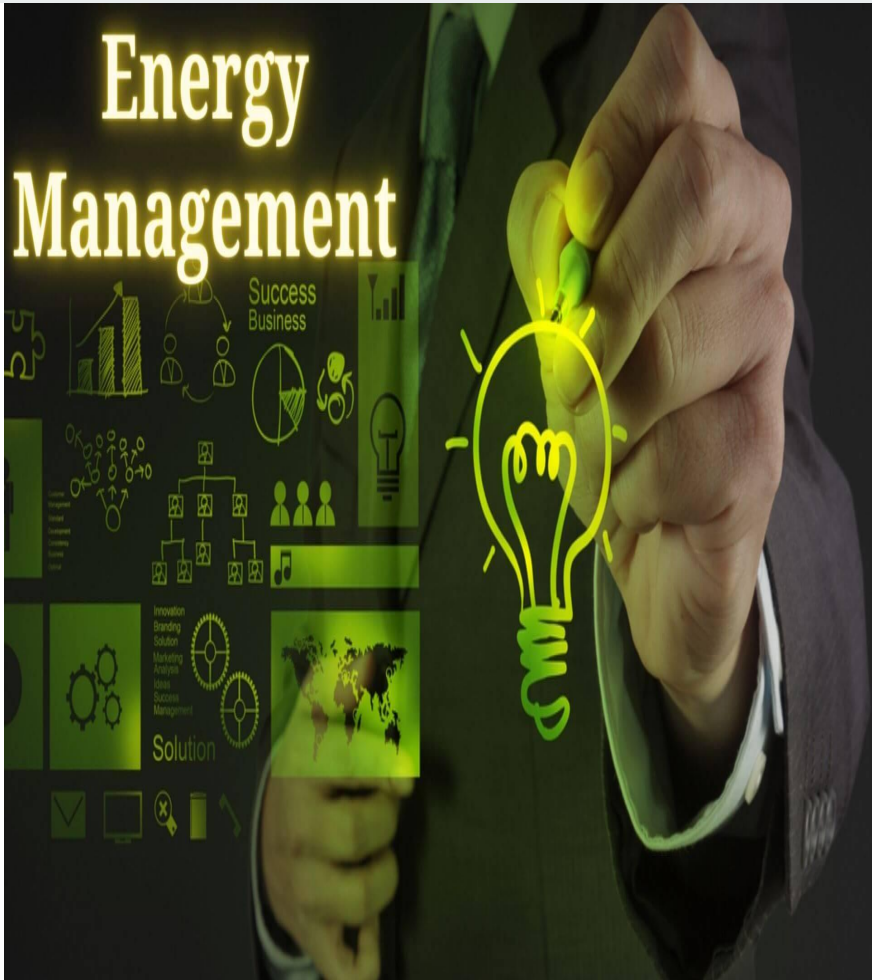


1. Project Overview

- **Aim:**

  Real-time monitoring of energy consumption and classroom occupancy using LoRa and Computer vision.

- **Key Areas:**
  - Energy data monitoring in BH3, BH4 hostels and substation
  - Student count detection using computer vision
  - Unified dashboard with Real time monitoring, analytics and prediction

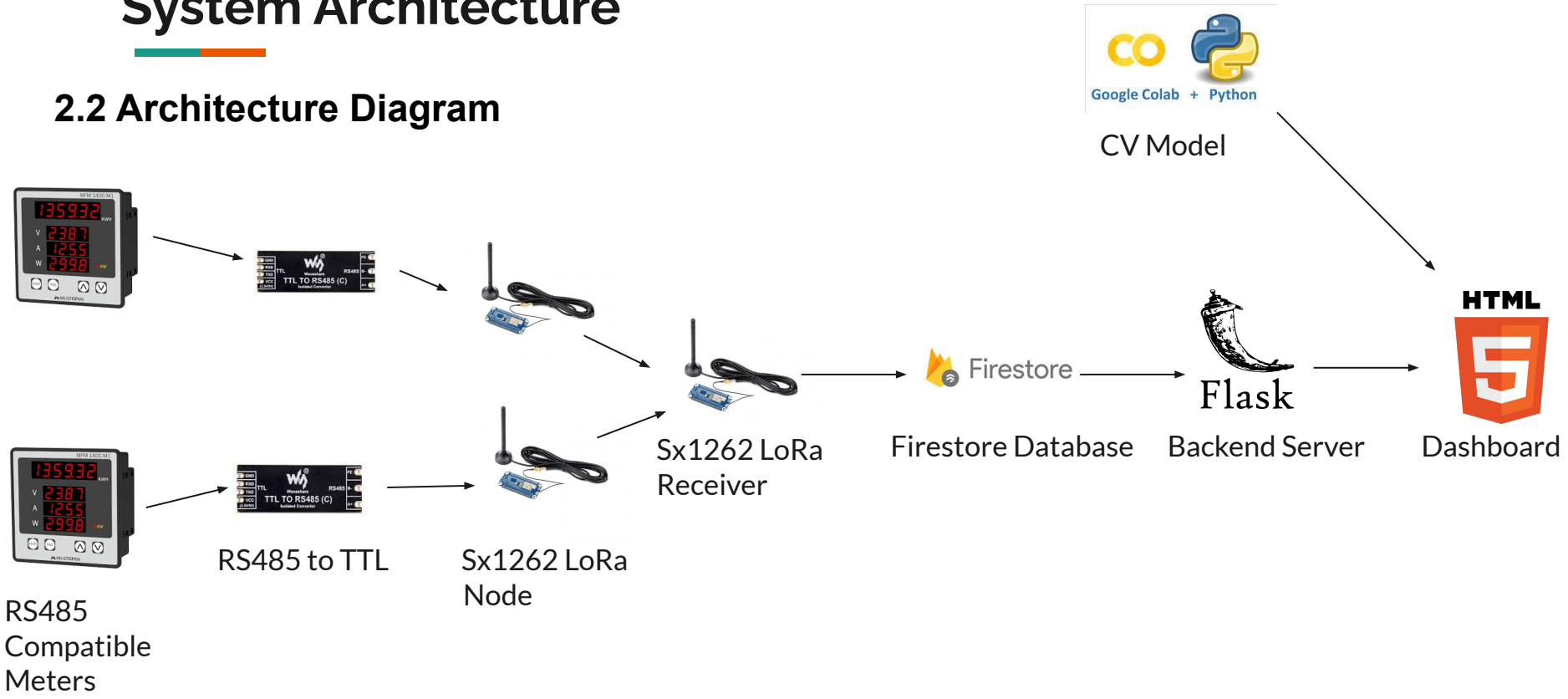
2. System Architecture

2.1 End-to-End Architecture

1.Energy Data Collection:
RS485-enabled energy meters transmit data via RS485 → TTL → LoRa (SX1262).
2.LoRa Node Units:
Each node (BH3, BH4, Substation) is powered by a **Raspberry Pi Zero 2W** connected to the LoRa module.
3.LoRa Receiver (IoT Lab):
A Central LoRa Receiver receives LoRa signals from all nodes and forwards them to the backend.
4.Backend Server:
A **Flask (Python)** server receives the data, processes it, and stores it in **Firebase Firestore**.
5.Dashboard Interface:
A responsive **HTML-based dashboard** displays real-time energy data, analytics, and predictions.
6.Computer Vision Model:
A **YOLOv11 Model**, hosted on **Google Colab**, detects student count in classrooms and pushes the data to Firestore and the dashboard.

System Architecture

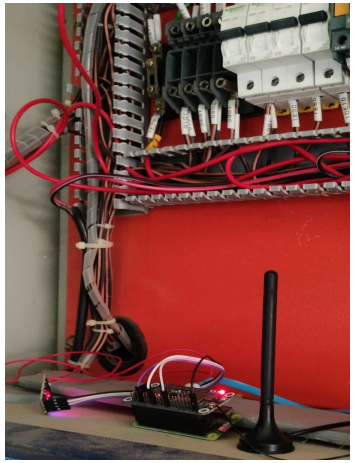
2.2 Architecture Diagram

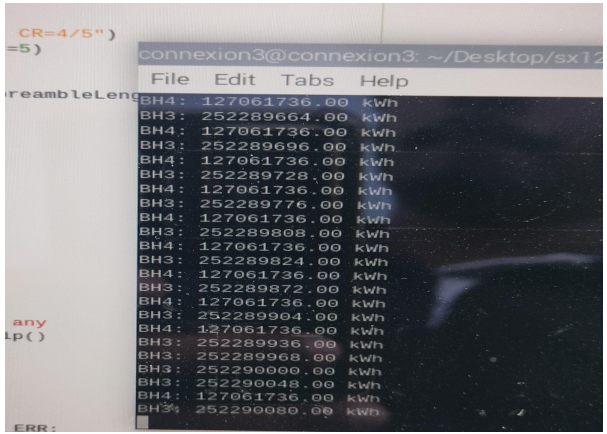


3. Hardware Setup

1. LoRa Node Setup

- Installed in BH3, BH4, and Substation
- Components used:
  - Energy Meters with RS485 pins
  - RS485 to TTL Converter
  - LoRa SX1262 Module
  - Raspberry Pi Zero 2W
- Configured as single LoRa nodes

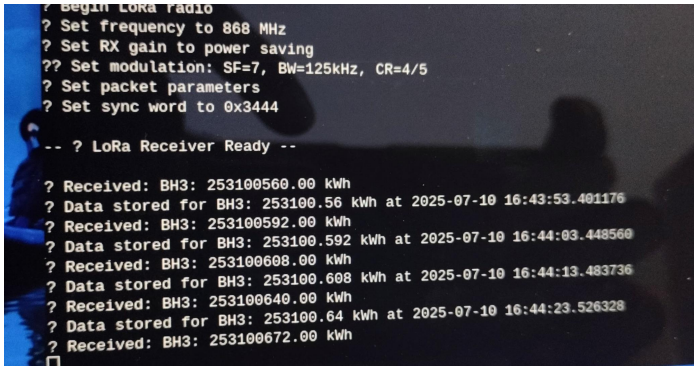




Hardware Setup

2. LoRa Receiver Setup

- LoRa Receiver Setted up in IoT Lab
- Components used:
  - LoRa SX1262 Module
  - Raspberry Pi 4
- Configured as single channel Gateway
- Receives data from all three LoRa nodes
- Uploads to Firestore



4. Database Setup

Database Used: Firebase Firestore

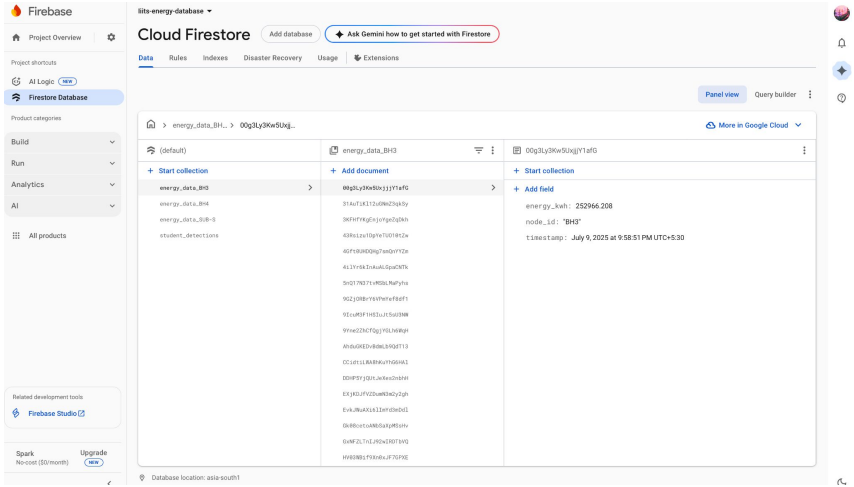
Collections Created:

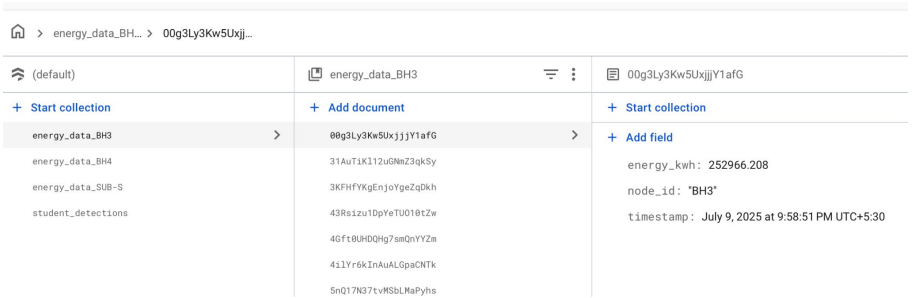
- `energy_data_BH3` – energy logs from BH3 hostel
- `energy_data_BH4` – energy logs from BH4 hostel
- `energy_data_SUB-S` – energy logs from Substation
- `student_detections` – student count data from classrooms

Document Structure (Example - BH3):

- `energy_kwh`: Energy consumed in kWh
- `node_id`: Identifier for the location (e.g., 'BH3')
- `timestamp`: Date and time of data entry

Data Flow: LoRa Receiver → Firestore via Flask API





5. Dashboard Setup

1.Dashboard Navigation

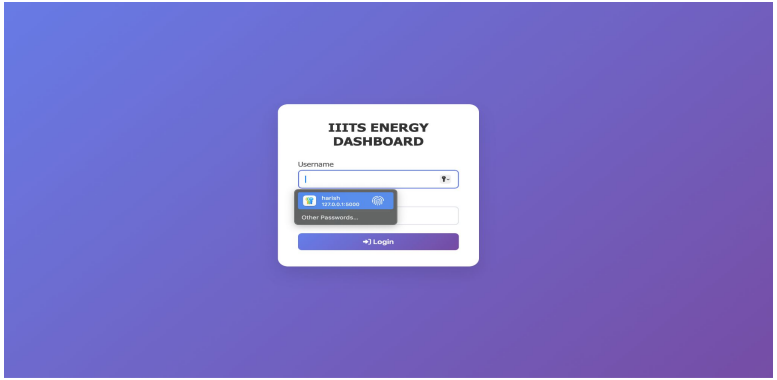
- **Login Page (Authentication)**
- **Navigation: Classroom, Hostels, Substation**

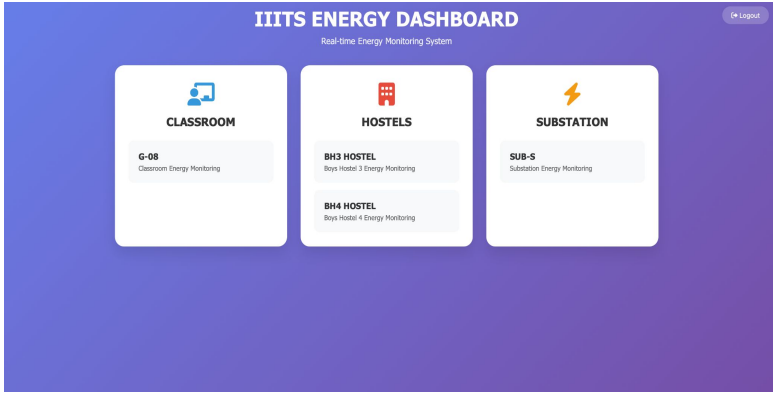
  CIASSROOM - G-08

  HOSTELS - BH3 HOSTEL, BH4 HOSTEL

  SUBSTATION - SUB-S

- **User can navigate and logout smoothly**

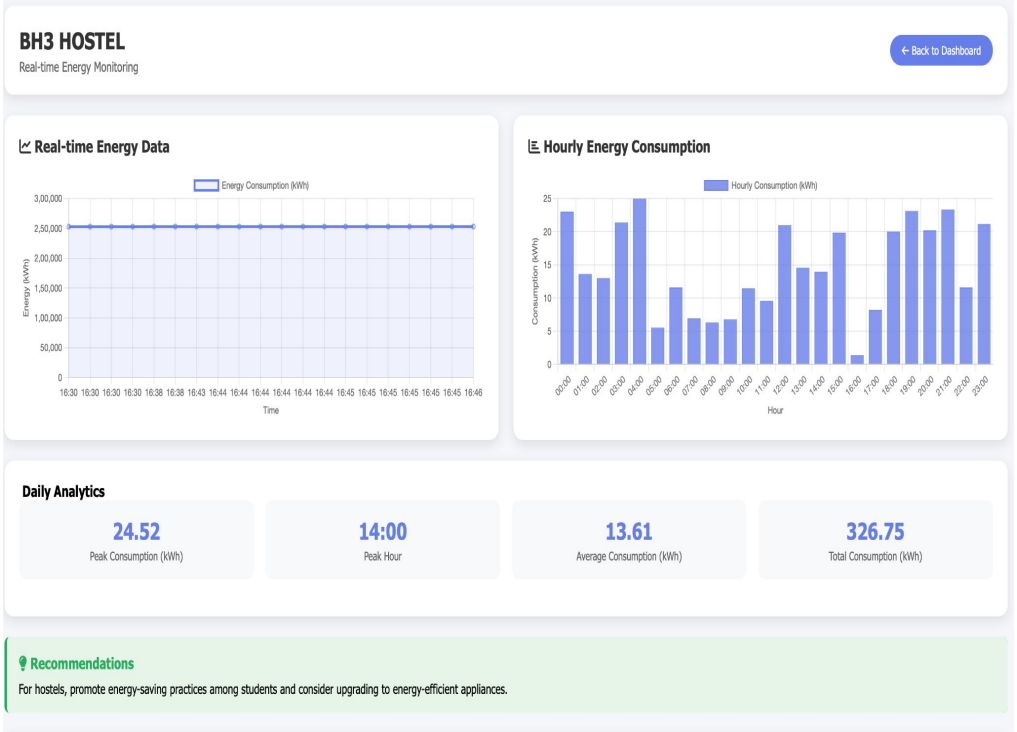




Dashboard Setup

2. Energy Analytics Per Block

- **<u>BH3, BH4 & Substation:</u>**
  - **Real-time energy data**
  - **Hourly Energy Consumption**
  - **Daily analytics:**
- Peak hour
- Peak consumption
- Average consumption
- Total consumption
  - **Recommendations**



Dashboard Setup

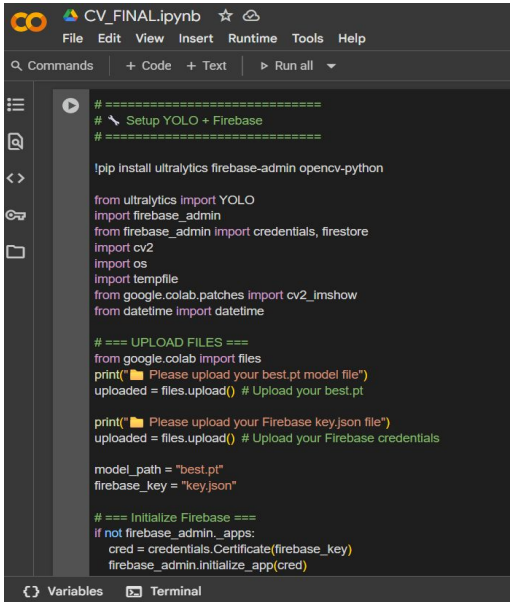
3. Energy Consumption Predictions

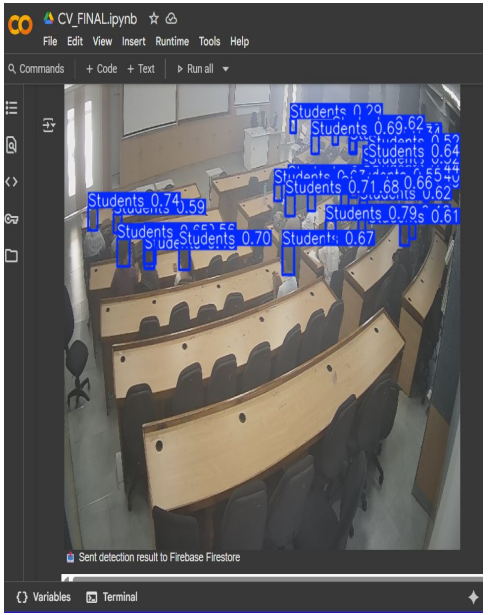
- Uses historical data to predict next 24-hour usage
- Model designed (Time Series Forecasting)
- Frontend integrated
- Backend integration of model pending
- Insights generated from predicted values

6. Occupancy Detection

Student Count using YOLOv11

- CV model detects number of students in classroom (e.g., G08)
- YOLOv11 based real-time inference
- Hosted on Google Colab
- Results sent to Firebase
- Displayed on dashboard under "Classroom > G08"





G-08 CLASSROOM

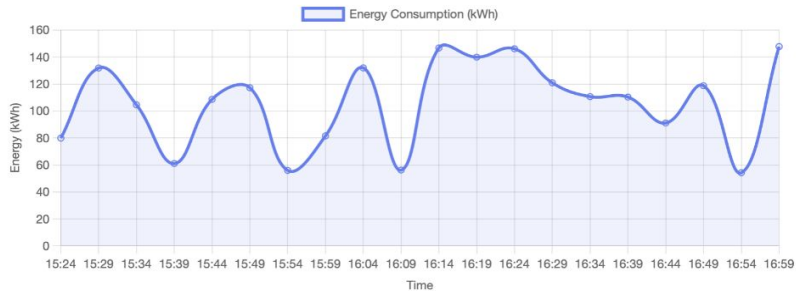
Real-time Energy Monitoring

← Back to Dashboard

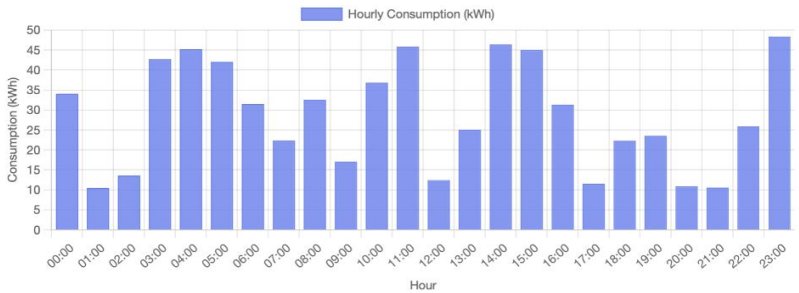
Number of Students

44

Real-time Energy Data



Hourly Energy Consumption



Daily Analytics

47.5	14:00	23.8	571.2
Peak Consumption (kWh)	Peak Hour	Average Consumption (kWh)	Total Consumption (kWh)

7. Conclusion

- Successfully built a complete energy and occupancy monitoring system
- Integrated LoRa, CV, and web tech for a smart campus
- Provided insights and predictions for energy optimization
- A scalable solution for smart infrastructure

THANK YOU