IoT Alarm system with bed presence detection

Project's Architecture

- Hardware components

- Data Proxy Server

- Time-series database

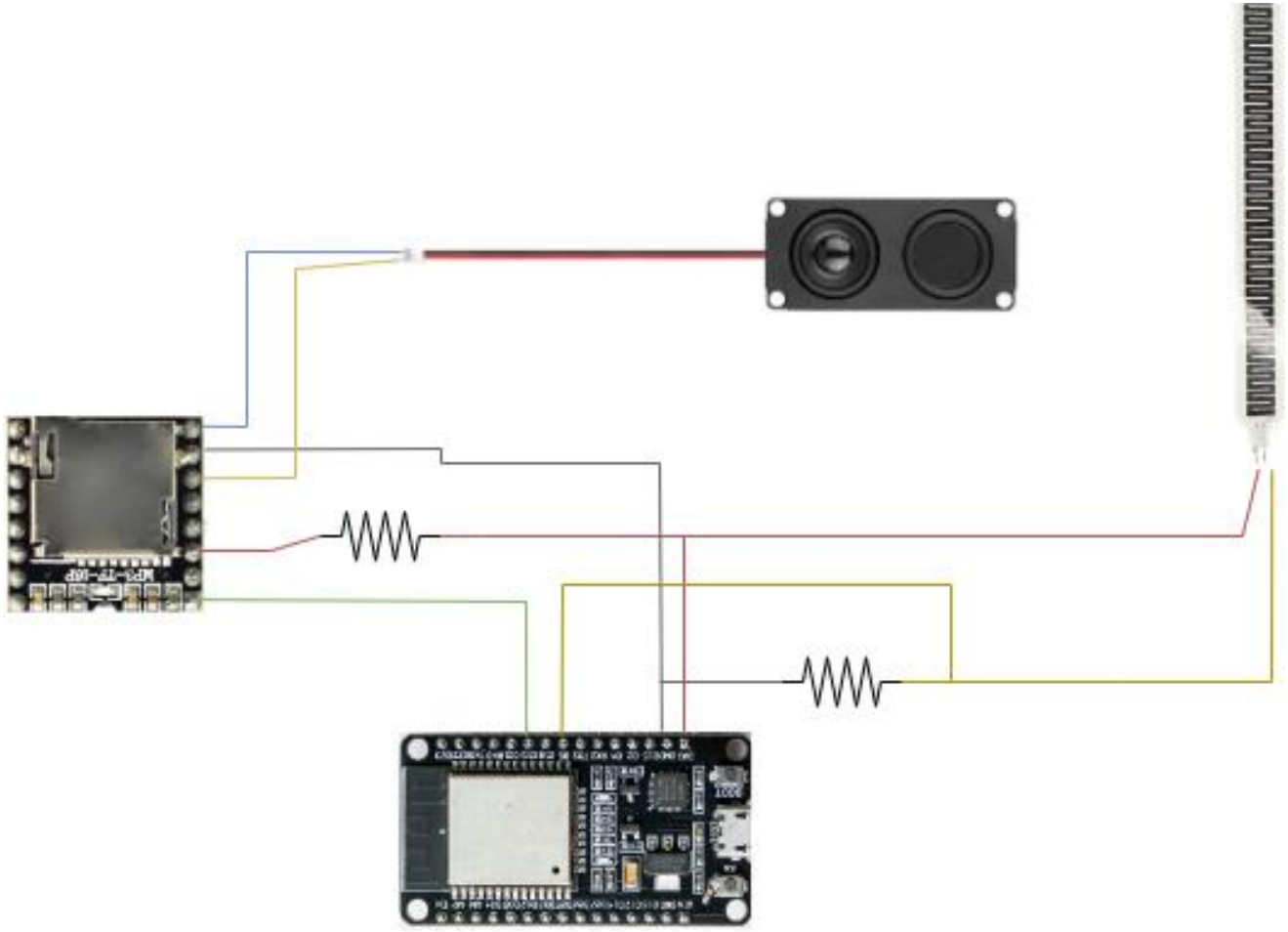
- Data-Analysis module

- Grafana Dashboard

- Data-evaluation module

Hardware components

- ESP32
- Pressure Sensor
- MP3 TF-ID
- Speaker



Software implementation

The software was implemented using the Arduino IDE.

Several libraries were used:

- SoftwareSerial.h
- DFRobotDFPlayerMini.h
- Wifi.h
- PubSubClient.h
- HTTPClient.h

Threshold configuration

Threshold can give rise to many false positives.

A simple threshold selection pipeline was followed:

1. Put the pressure sensor under the bed.
2. Check the value in an idle state.
3. Check the value with a person on it.
4. Decide a reasonable value between the two boundaries.

Data proxy server

Core component of the application, manages both the user and device interactions all via HTTP requests.

User list of commands:

- *set_time*
- *set_sleeping_hours*
- *set_threshold*
- *set_days*
- *sampling_rate*
- *stop_alarm*
- *show_variables*

ESP32 list of commands:

- *alarm_stopped*
- *data*
- *time*

Data proxy server - MQTT

Interactions with ESP32 is bidirectional, the server uses an MQTT broker to send data to the device.

ESP32 subscribed topics:

- *esp32/commands/stop_alarm*
- *esp32/commands/trigger_alarm*
- *esp32/commands/sampling_rate*

Data proxy server - InfluxDB

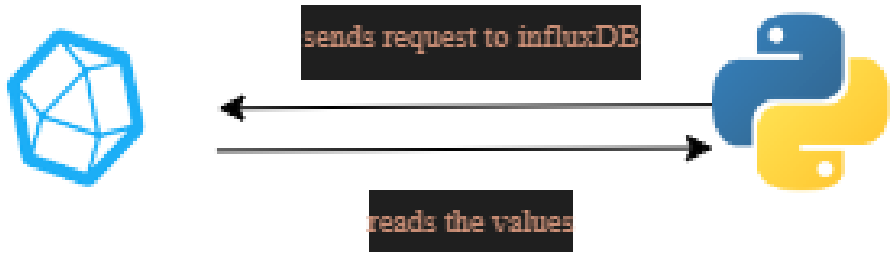
Also handles tranmission of device data to the time-series database.

After the *time* command is received.

Data analysis module

Takes as input four parameters:

1. start_date
2. start_time
3. end_date
4. end_time

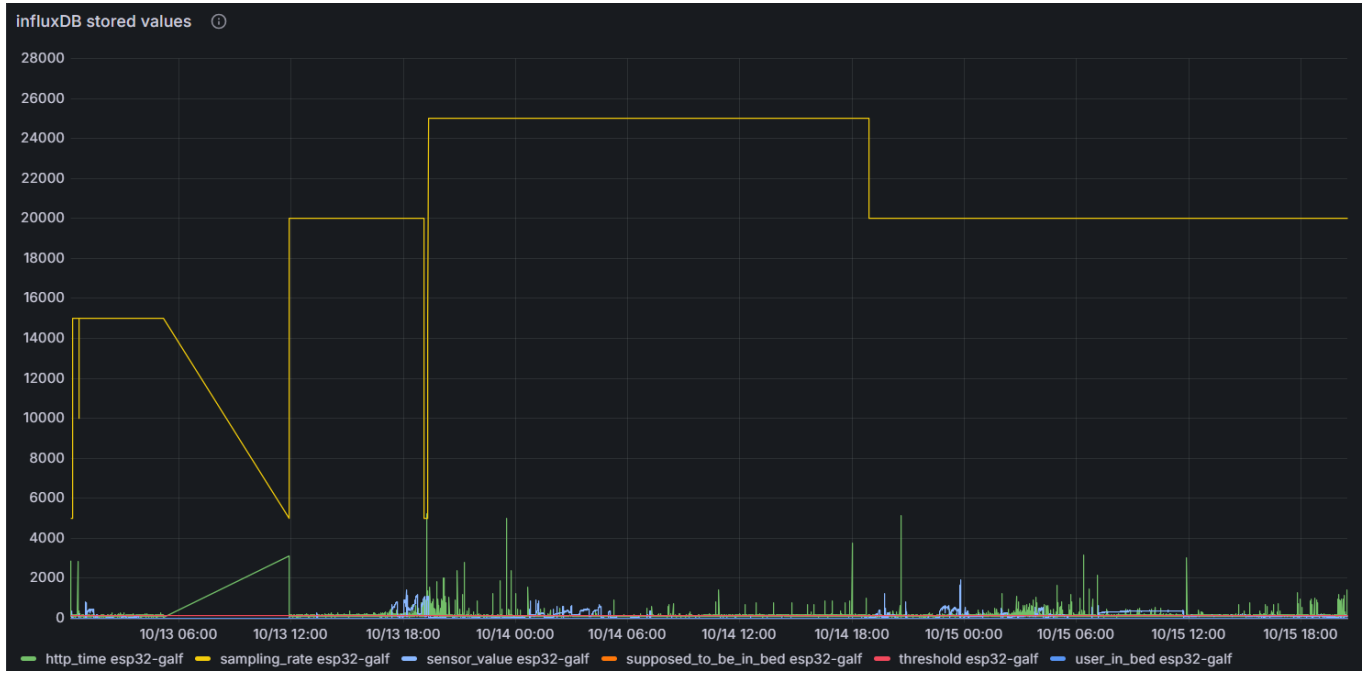


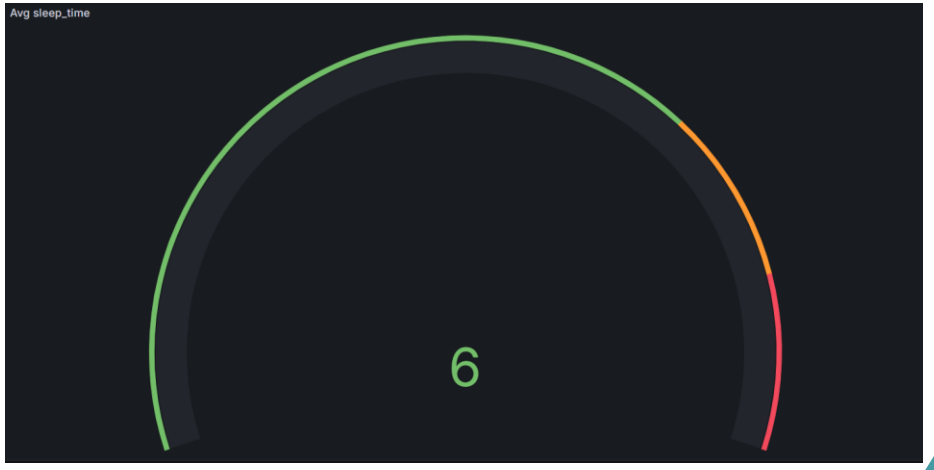
Computes sleep time and mean latency between those dates

```
query = f'''from(bucket: "evaluation")
|> range(start: -365d)
|> filter(fn: (r) => r["_measurement"] == "pressure_sensor")
|> filter(fn: (r) => r["_field"] == "threshold" or r["_field"] == "supposed_to_be_in_bed" or r["_field"] == "sensor_value"
or r["_field"] == "sampling_rate" or r["_field"] == "http_time" or r["_field"] == "user_in_bed")
|> filter(fn: (r) => r["user_id"] == "esp32-galf")
|> yield(name: "last")
'''
```

Grafana Dashboard

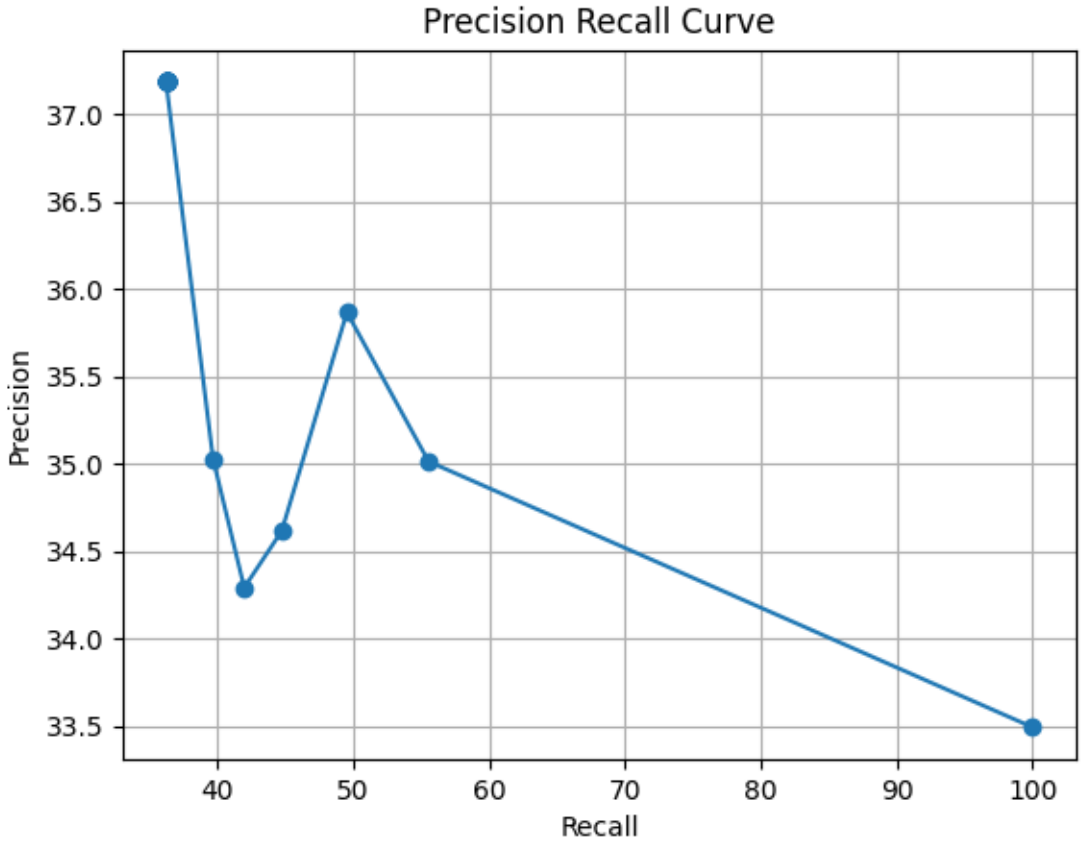
Used to display metrics and the average sleeping time





Data evaluation module

Used to compute accuracy, precision, recall as well as precision-recall curves.



Day	Accuracy (%)	Precision (%)	Recall (%)
Day 1	62.9	33.5	16.9
Day 2	64.1	35.4	22.0
Day 3	55.7	37.9	45.5
Whole evaluation	58.2	37.2	36.2

Thanks for the attention!