Design Overview

Outdoor Air Pollution Monitoring on IIIT H Campus

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Architectural design

The system has been modularized as follows:

1. **Heat Mapping:** This module deals with plotting heat map of chosen parameters (PM2.5, PM10, Air Quality).
2. **Line Chart:** This module is used to plot line charts of the various parameters.
3. **Histogram:** This module plots the histogram of all the parameters.
4. **Statistics:** This module does statistical analysis of raw data and presents tables of each parameter with statistics like hourly average, daily average, min and max values, time slot wise data etc.
5. **User Interface:** This module integrates all the above components into web application and presents them to the end user in a readable and intuitive format.

System interfaces

User Interface

The UI of this system is a web application which helps in visualizing the raw data from the sensors. It consists of :

- Home Page: the home page contains a heat map of IIIT corresponding to the overall air quality reading by default, along with options to change which heat map to be displayed and links to pages of the other statistics. This page would also include the feature of displays upon hovering and would enact linkups between pages.
- Line Chart Page: Page containing all the line charts for each sensor and parameter along with the ability to stack them to spot trends and relations.
- Histogram page: Similar page as the line char page, except with histograms instead.
- Statistics: Page which displays selected statistics according to sensor and parameter in tabular format for user to view.

APIs

Python3: main logic of all software modules and integration.

Thingspeak/Onem2m: acquiring the raw data for use.

Django: Server Backend

Bootstrap, HTML, CSS: Front End implementation

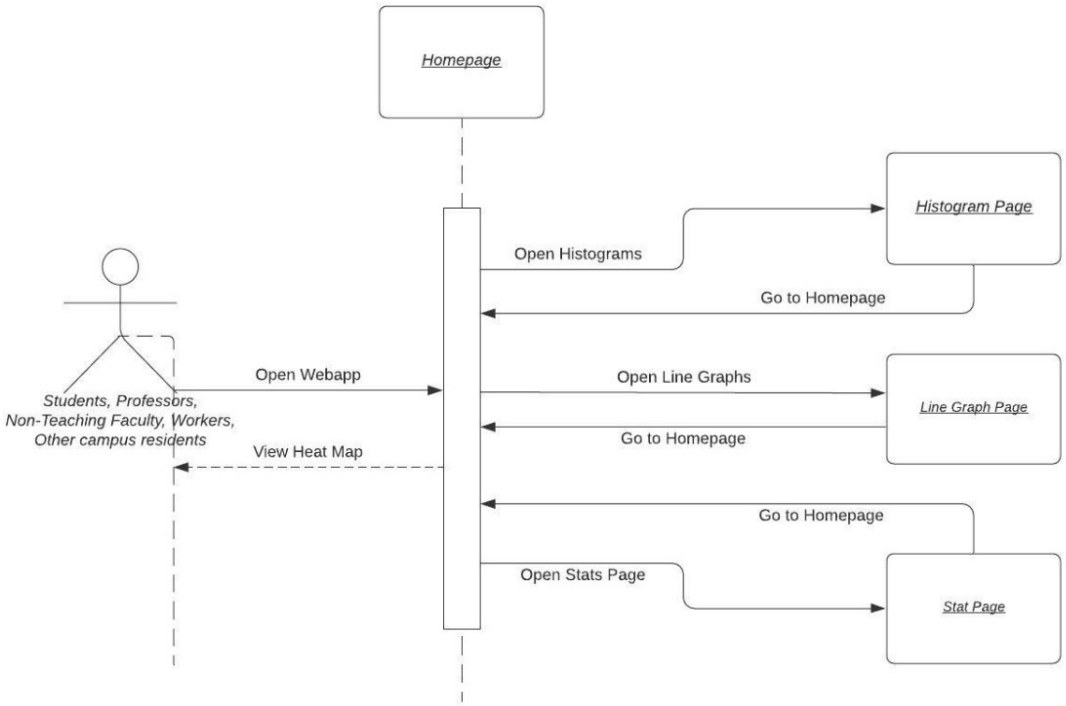
Java Script and libraries like vue.js and other graphical and pictorial libraries.

Python Libraries like Pandas, Matplotlib, numpy etc. for plotting graphs and processing data.

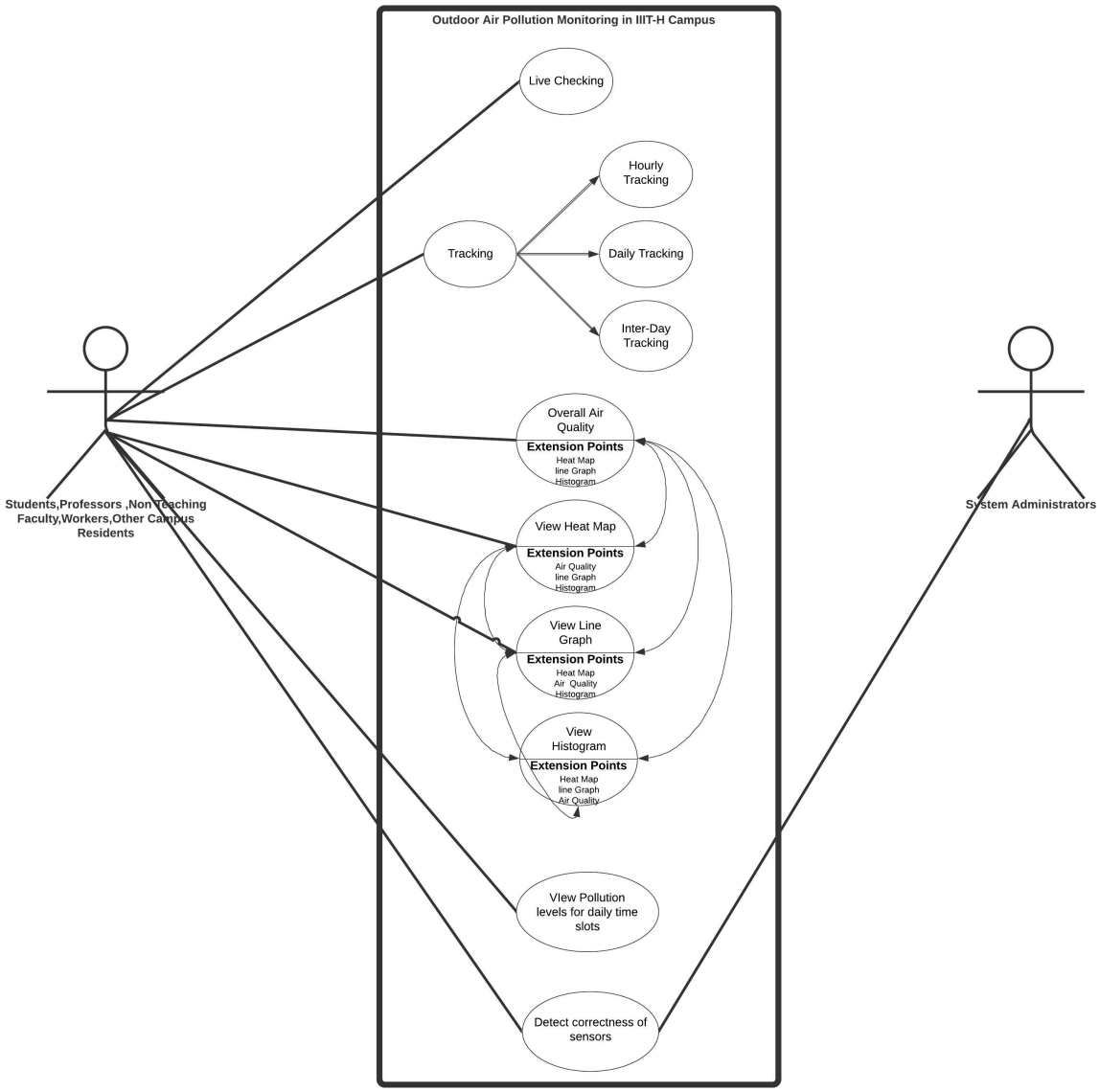
NOTE-** We might also use some wrapper of python libraries like seaborn.

Sqlalchemy: Managing database of all data.

Sequence Diagram



UML Diagram


Outdoor Air Pollution Monitoring in IIIT-H Campus
Live Checking
Hourly Tracking
Tracking
Daily Tracking
Inter-Day Tracking
Overall Air Quality
Extension Points
Heat Map
line Graph
Histogram
View Heat Map
Extension Points
Air Quality
line Graph
Histogram
View Line Graph
Extension Points
Heat Map
Air Quality
Histogram
View Histogram
Extension Points
Heat Map
line Graph
Air Quality
VIew Pollution levels for daily time slots
Detect correctness of sensors
Students,Professors ,Non Teaching Faculty,Workers,Other Campus Residents
System Administrators

Model

Heat Map Module	Takes in the last hourly average of the parameter's reading of each node and plots a heat map from it, then lays it on top of a static IIIT map to give an idea of pollution levels across campus. It is updated every one hour, with the mean of all readings in that time period being considered for plotting.
Line Chart Module	Takes in a number of readings of each parameter and plots a line chart for it. It is live updated, i.e. it gets updated every time a new reading is received
Histogram Module	Takes in a number of readings of each parameter and plots a histogram for it. It is live updated, i.e. it gets updated every time a new reading is received
Statistical Analysis Module	Gives various statistics for each and every parameter of each sensor: Live reading, Hourly average, daily average, average in time slots, min and max reading over a time period, parameter wise and node wise.
UI Module	Integrates all the above modules into a web application accessible by and easy to use for by the entire user base.

Design Rationale

During the discussion, the main point of contention was the selection of which statistical analyses to provide to the end user, and how to visualize these to make it more intuitive for a naive user without specialised knowledge in statistics. For this,

1. Statistical analyses:
    a. Live Reading: allowing users to view the current reading was considered a fundamental part of the project and hence it was included without any objections.
    b. Hourly average: since live readings can sometimes be misleading, we decided to include hourly averages to give the users a better idea of the levels.
    c. 8 hours and daily averages: these help in spotting general pollution trends across longer time periods (such as morning/evening/night or weekdays/weekends).
    d. Time slot averages: these help with spotting trends during specific intervals of the day and we believed them to be helpful in many use cases of the system such as event scheduling and allocating air filtering resources to locations, hence we decided on including them in the system.
2. Visual Representations:
    a. Line Charts: Line charts are very intuitive to naive users to understand and can also help in spotting general trends for individual parameters. We chose to include them for their easy interpretability for the naive user.
    b. Histograms: Histograms, especially with stacking, allow spotting trends between multiple variables very intuitively and are not very difficult to interpret. Hence we

incorporated them with multivariate analysis in mind.

c. We also considered using correlation matrices instead of histograms, but after some discussion decided against them as they are not easy to understand without the knowledge of how these matrices work. Since our user base is not expected to have such knowledge, we omitted them from the final draft.
d. Another multivariate representation we considered was a pie chart combining each of the parameters, however, since each parameter's level is defined by its own unique safety levels, combining them in a pie chart was giving us no useful information and thus we decided against it completely.
e. In the Heat Map feature we would enable the feature where when you hover above the location of a particular node in the map . It will give the statistics of that particular node and upon clicking on it , you will be redirected to the statistics page where you can view the data of that node in detail, or you can select other nodes from the drop down facility available.