Using Machine Learning for IoT

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Abstract

Using Machine Learning for IoT, also known as Maestro, is a Human-Computer Interaction system which uses ambient sensing to infer human activity. The goal is to enable smart applications in healthcare and energy. This allows for functionalities such as occupancy counting, user identification, and activity recognition. We have developed a webpage to display sensor data on dynamic plots which reflect changes in real-time.

Objective

- Constructing a user interface to serve as a visual representation of collected data by aligning and displaying data from various streams. By looking at signatures when there is a change in the environment, we hope to observe trends.
- Managing the system on the backend through modifications to the database and server to support changes.

Maestro Box

The hardware component of the system consists of two modules: the sensing node which contains external sensors measuring PIR, color, illumination, audio, pressure, humidity, temperature and IMU and is attached to an Arduino Uno, and the Raspberry Pi. These 9 sensors generate 18 data points per unit time. It updates the centralized database running on the local server every 10 seconds.

Smartbox Database

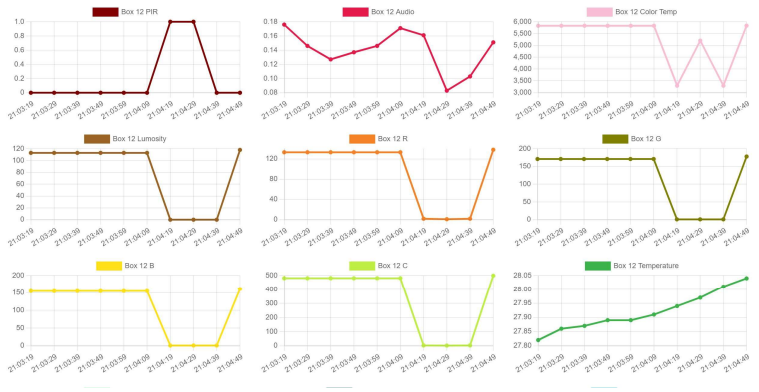
Retrieved data from and wrote data to the PostgreSQL database. This involved understanding set theory and learning SQL to query the database. Psycopg2, a python library, was used alongside to periodically read stored data. Further, the structure of the database was modified to minimize the number of rows used to store data from a single instance of time by 18-fold. TimescaleDB was used for the Data table as it is a time series optimized database which runs over Postgres.

box_name	channel_name	time	value	label
Box12	PIR	2021-07-29 21:45:00-04	1	Walking
Box12	Audio	2021-07-29 21:45:00-04	1.533	Walking
Box12	Color Temp (K)	2021-07-29 21:45:00-04	3468	Walking
Box12	Lumosity	2021-07-29 21:45:00-04	217	Walking
Box12	R	2021-07-29 21:45:00-04	694	Walking
Box12	G	2021-07-29 21:45:00-04	464	Walking
Box12	B	2021-07-29 21:45:00-04	395	Walking
Box12	C	2021-07-29 21:45:00-04	1503	Walking
Box12	Temperature	2021-07-29 21:45:00-04	24.84	Walking
Box12	Pressure	2021-07-29 21:45:00-04	1011.285	Walking
Box12	Approx. Altitude	2021-07-29 21:45:00-04	16.377	Walking
Box12	Humidity	2021-07-29 21:45:00-04	74.181	Walking
Box12	Accel X	2021-07-29 21:45:00-04	0.09	Walking
Box12	Accel Y	2021-07-29 21:45:00-04	-1.4	Walking
Box12	Accel Z	2021-07-29 21:45:00-04	9.83	Walking
Box12	Magnet X	2021-07-29 21:45:00-04	12.375	Walking
Box12	Magnet Y	2021-07-29 21:45:00-04	7.063	Walking
Box12	Magnet Z	2021-07-29 21:45:00-04	8.432	Walking

(18 rows)

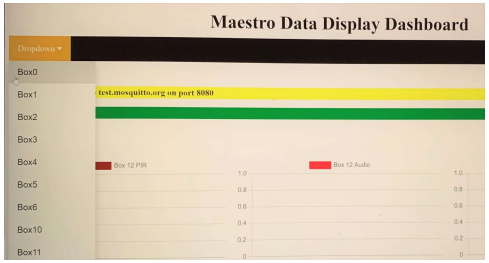
Webpage

HTML and Javascript were used to create the data display dashboard. MQTT is an open-source messaging tool which allows for the transfer of data from the database to the webpage. Another open-source tool chart.js supports the plots. On the webpage, there are 18-line graph plots being updated every 10 seconds and a drop-down menu to select the maestro box name to view the corresponding graphs.



Future Work

- Live video feed on the webpage
- Multiple maestro boxes collecting data in conjunction to increase accuracy
- Establish a user-driven experimental framework for practical and more realistic data collection
- Deploy this system into the industry
- Long term applications: automating changes to HVAC systems in buildings based on detected occupancy and comfort preferences to reduce energy consumption, and to monitor the health of elderly by identifying their actions and location



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References

Chowdhury, T., Aldeer, M., Laghate, S., Yu, J., Ding, Q., Florentine, J., & Ortiz, J. (2021). *Poster: Maestro -- An Ambient Sensing Platform With Active Learning To Enable Smart Applications.* International Conference on Embedded Wireless Systems and Networks (EWSN), Delft, The Netherlands. ISBN: 978-0-9949886-5-2.

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