How to get a safer and cozier kitchen by using AIoT

Abstract

Fig. 1 Cooking in a Chinese restaurant

Food culture plays an important role in Chinese culture. However Chinese dishes is usually cooked with much oil and stir-fried, which leads to harsh working conditions for cooks and waiters in the kitchen. Chinese kitchens, especially those in the restaurant, often have problems as high temperatures, high humidity, high smoke concentrations and the risk of fire in some situation [1].

Our project is a kitchen comfort monitoring system based on machine learning intelligent classification controlled by Raspberry Pi and cloud computer. We hope to improve the situation and solve these problems with our kitchen comfort monitoring system.
It has three main functions:
1. Real - time monitoring:
monitor environment around from sensors
2. Intelligetn classification:
invoke machine learning model to classify the state of environment
3. Automatic Control:
automatically control the actuator by judging the state

Structure

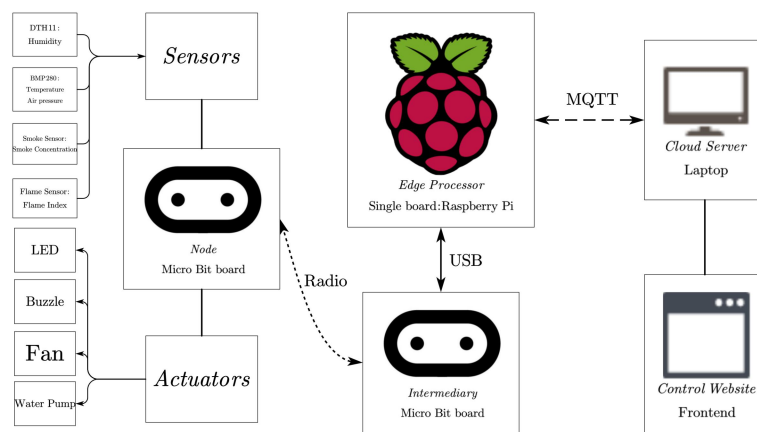This is graph about structure of devices.

Fig. 2 Structure of devices

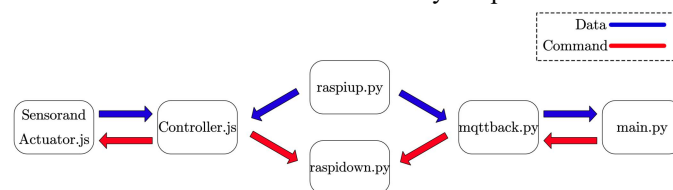This is the data and command flow controlled by scripts.

Fig. 3 Message flow controlled by scripts

Function

This is our web front end "Smart Kitchen". The upper part is a table showing the parameters of kitchen environment and the assessment result. The lower part is some control options. We can control the system by two mode: Manual Mode and Detect Mode.

Smart Kitchen

Environmental Parameters

Parameter	Data
Temperature	29.11
Pressure	99720.0
Humidity	56.0
Smoke	283.0
Flame	795.0
Assessment	Uncomfortable!

Control Options

Manual Mode

LED: ON | OFF Buzzer: ON | OFF Fan: ON | OFF Water Pump: ON | OFF
GET Real Time Information

Detect Mode

START | END

Manual Mode
· Turn on/off Actuators: LED, Buzzer, Fan, Water Pump;
· Get real time information: collect from sensors, assess by machine learning model, and send corresponding commands back. We assess the kitchen environment into three comfort categories: Comfortable, Uncomfortable, and Dangerous. We will do something to to improve the kitchen environment or take prompt actions to prevent fire, suffocation and other safety accidents according to different assessments.

Assessment	LED	Buzzer	Fan	Water Pump
Comfortable	OFF	OFF	OFF	OFF
Uncomfortable	ON	OFF	ON	OFF
Dangerous	ON	ON	ON	ON

Detect Mode
When starting detect mode, cloud server will get real time information form sensors and send commands back **every 3 seconds** until ending detect mode. The intelligent system could monitor our kitchen continuously through the mode.
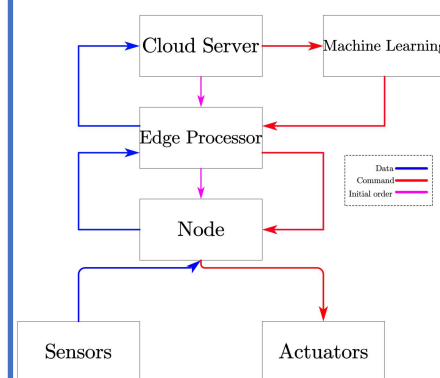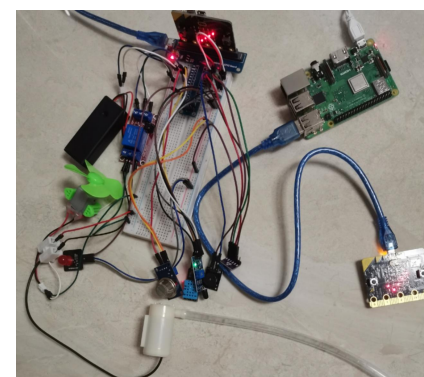

Fig. 4 Flow chart of the Detect process

Fig. 5 The equipment and electrical conditions involved

Experiment

Devices
Shown in Fig. 5.

Data Set
1. Composition:
Temperature, Humidity, Air Pressure, Smoke Concentration, Flame Index.
2. Collecting methods:
We have created some distinctive environment to collect data.
For comfortable environment: in cooling study with air-conditioner;
For uncomfortable environment: hair dryer for high temperature, cigarette for strong smoke;
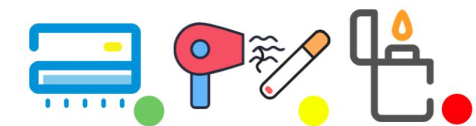For dangerous environment: lighter for fire.

Fig. 6 Equipments used for creating environment

3. Sample original data: (String) "11.T:29.18;P:100887;H:66;S:717;F:943"
4. Final Size of data set: about 180 records.

Machine Learning
Step 1: KMeans Cluster: split data into 3 groups;
Step 2: Adding Label: label each cluster from daily experiences;
Step 3: Random Forest [2]: Classify labeled data;
Step 4: Model Assessment:
1.Silhouette score of Cluster: 0.564;
2.Accuracy of Classification: 98.61% on train set; 97.22% on test set.

Conclusion

1. Our project starts from our daily life and have a certain commercial value and innovation.
2. Our project took full advantage of the AIOT elements, but the front-end web page is relatively simple, the lack of software design considerations are also need to solve.

Reference

[1] Liu Xuhua. Study on risk analysis and preventive measures of kitchen fire in catering industry [D]. South China University of Technology, 2013.

[2] Juliqin. Study on evaluation of Students' achievement based on random forest algorithm [D] . Anhui University of Technology, 2017.