Final Year Project

Statement report

Energy optimization of HVAC systems using supervised learning

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# Background

## Motivation

### Energy consumption on air handling:

Hong Kong is a high-density city with intensive business activity. According to the energy end use report 2018, commercial building occupied 43% of the total energy used in this small town which is twice the residential usage and three times higher than the industrial usage. (Electical and Mechanical Services Department, 2018)

“Air conditioning” has the highest energy consumption which had used up 24% of the total.

General speaking, air-conditioning in commercial building has occupied around 10% of the total energy used in Hong Kong. Therefore, I am looking forward to finding out the way to improve the energy end use efficiency in this aspect.

### problem of HVAC system

HVAC, heating ventilation, and air conditioning is a widely used technology to provide indoor thermal comfort and proper air quality. Some building automation like lighting has a well-defined behavior, however, HVAC control system is not the case. Some may think HVAC should have well-defined behavior as well. Theoretically, it is true. However, in real life application, it does not. Typically, the control logic of a HVAC system is defined in the design stage. The control logic only works well, if and only if the operation environment is same as the defined one and consistent overtime. The fact is, the installation always varies from the design criteria, also, the behavior will change when the system starts to age.

### The rise of Machine learning

In recent years, machine learning has become widely used. Alpha Go - One of the most well-known machine learning project of DeepMind has shown the world the capability of AI. Machine learning is not a new technology. Nonetheless, with more advanced computing technology we are having these day’s, machine learning become more effective and feasible than the old days.

## What is machine learning

Machine learning, using algorithm and statistic models to perform specific “human task”. The fundamental idea is using a set of “training data” for the program. The program is built to find out the correlation between different parameter. There is no doubt that machine learning could easily find out the correlation between parameters and making prediction as well as a human being could be and even better. What makes machine learning appealing is that machine learning often come out with the result which sounds intuitive to a human being. There are different approaches in machine learning, supervised and unsupervised learning are two best known approaches. Different approach is selected to solve different kind of problem. This project will mainly be conducted with the supervised approach.

## How HVAC control system can be benefited from Machine Learning

In term of HVAC, there are a lot of way to improve the efficiency. Even we already have some advanced control system in the industry, there are some bottlenecks that are hard to solve with conventional methodology. Some parameters could not be easily predicted in a traditional scripted control logic. For instance, even if the system is well-defined, it is hard to tell the occupancy tendency of a building. Therefore, in most of the HVAC control systems, they only response to real time parameter and will not predict the future condition. Impressing oh, with a machine learning-based controller, the system could predict the upcoming parameters. For example, the occupancy of a room in next hour. Or more complicatedly, the machine can understand how the indoor temperature react with the supply air temperature, occupancy, humidity ration and such. So that, the machine knows what how to select the best set point in term of both efficiency and performance. In conventional control system, it is hard to strive the balance between performance and efficiency. And machine learning can help HVAC system to perform a more cost-effective and high efficiency control to minimize the parameters’ offset and energy usage.

# Introduction

## Objective and scope

The main objective of this project is to optimize the HVAC controlling with supervised learning. The sample data collected some input and output parameters of a group of Chillers of a commercial building in Hong Kong. The following is the tentative milestones of my project.

As mentioned, supervised learning will be implemented. For the predictive model, regression algorithm will be used. Neural network will be used for classification, e.g. selecting the best operation mode.

## Milestones

|  |  |
| --- | --- |
| September | Data Visualization |
| October | Make hypothesis and create model |
| November | verify hypothesis |
| December | Interim Report | apply different models |
| January | Figure out the best models |
| February | Examine if AI performs a better job |
| March | Review the work |
| April | Preparation of presentation |
| May | Final report and presentation |