SENIOR PROJECT SD2-2022

Smart Lighting in Campus: The Web Application and Data Analytics

Project Concept

Submitted to

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Sirindhorn International Institute of Technology
Thammasat University

September 2022

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Contents

Chapter 1

Project Concept

1.1 Summary

This project implements and develops an easy-to-use control and maintenance platform for a smart street light system installed inside Thammasat University, Rangsit campus, Thailand. This project is separated into 2 parts: the web application and the data analytics. In the web application, we provided the dashboard for visualizing data from the environmental sensor and various devices, the interface for monitoring and controlling devices, and APIs for connecting with CMS API which is the interface for controlling the smart street light on the campus. For data analytics, we build prediction models using the feature extraction technique and machine learning to optimize light dimming values based on the campus environment.

1.2 Motivation

In this project, we aim at the automatic system to adjust the proper lighting environment for the campus. Smart street lighting devices along six main roads in Thammasat University, Rangsit campus are scheduled to turn on and off at the specified time daily, allowing safety and convenience for the public. However, the static scheduling does not guarantee the optimized lighting solution for the campus, and weather conditions are always changed by the influence of the environment which is uncontrollable and mostly unpredictable. Lighting devices may need to turn on or off to respond according to those weather conditions which is not reflect the normal specified time period, thus generating unnecessary electrical usage or reducing road safety. A number of cities have implemented smart street lighting systems. For example, Amsterdam Smart City (ASC) in Amsterdam, the Netherlands, developed an automatic system used with smart lighting devices to adjust luminance according to the surrounding environment in the area to serve different weather conditions and control the pedestrian flow [1]. Another example can be seen in the smart street light

project in Barcelona, Spain, which installed an LED lighting system. They developed Application Programming Interface (API) to communicate with the management system [2] and integrated it with data collection of meteorological data [3].

When considering the availability of devices including 167 smart lighting devices, each connected by one of three gateways, and measured meteorological and environmental surroundings by using the environmental sensor, we are able to collect the data to predict environmental conditions in the future using a SparkBeyond platform, which is an AI-assisted machine learning framework, and send commands to control the light dimming value of lighting devices for adjusting it accordingly. By developing the web application to monitor and control the system and integrating data analytics from the environmental sensor data, we expand the following potential to users which are university maintenance personnel, and benefit students and residents. Moreover, it may reduce unnecessary electrical usage and cost, enhance road and public safety, and improve the Quality of Life (QoL) of residents at Thammasat University, Rangsit Campus.

1.3 Users and Benefits

There are two main groups of users who will receive benefits from this project. The first group is students, staff, and residents who live around Thammasat University, Rangsit Campus. They will benefit from this project because there will be sufficient lighting in the area, which improve their security and Quality of Life (QoL).

The other group is the staff who monitor and control the light system of the campus. Most of them are from the building and ground services department. The easy-to-use web application interface will help them monitor and control the light system and respond to maintenance easier and faster than before. They can also help the executives in energy saving and cost reduction. They will have insight into power usage based on different weather conditions and help them plan the power usage plan in the future.

1.4 Typical Usage

The typical scenario to use this web application is for monitoring and controlling the lighting devices in the area automatically and maximizing energy efficiency. To achieve maximum efficiency, the installed environmental sensor first collects the data from the surroundings. The collected data consists of meteorological data such as temperature, humidity, illuminance, Ultra Violet A, Ultra Violet B, wind velocity, wind direction, and air pressure. Then, the prediction model can be constructed using the SparkBeyond platform

by using feature extraction techniques based on the collected data. The model is later used to predict the future illuminance value and find the optimal light dimming value. This process is done to ensure sufficient luminance in the area at all times, instead of the default setting that is only turned on and off based on the threshold value. The application then executes the command to lighting devices around the university for adjusting the light dimming value accordingly.

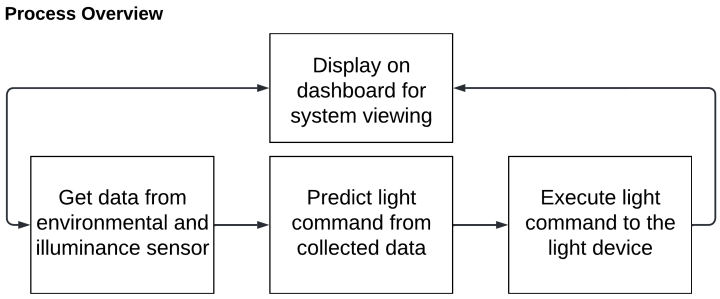

Figure 1.1: The overview of the web application process

After all, the web application is provided for maintenance staff for system viewing by showing data on the dashboard in both numerical and graphical forms to show the current environmental condition in the area. It can also display the connection status of installed devices and notify staff to repair and make the maintenance correctly Moreover, the web application can be used to control lighting devices in the university area, and report the power usage and lighting control back to the system. The overall process of the web application and the system is illustrated as shown in 1.1

1.5 Main Challenges

The main challenge of web application development is the system instability related to the electrical grid connected to the devices on the campus. Blackouts and electricity drops happen frequently during severe weather conditions and cause devices to malfunction and data loss. Therefore, the web application may not work as intended during those downtimes. Meanwhile, the challenge of data analytics is the use of the SparkBeyond platform to create a prediction model. Since this platform is new to all project members, thus we need to learn how to use it for our project. To ensure the prediction model gets the most accurate result and reflects the real-world data as much as possible, the study of the data collected from the environmental sensor must be carried out thoroughly.

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