CHAPTER 1

INTRODUCTION

This chapter is about the introduction of this study. Chapter 1 consists of several subtopic, i.e. rationale that discusses about the things that being a background of this study, conceptual framework, problem statement, objective, scope and delimitation, and importance of the study.

1.1 Rationale

Air pollution is a phenomenon that is currently being discussed[18][9][21]. Air pollution which consist of many types has different characteristics and effects on the health of living things. These impacts have different levels of danger from good to very dangerous. All of these impacts can be affected by the type of air pollution and the levels of substances mixed with air.

Based on the information above, efforts are needed to determine the level of air pollution and the type of air pollution itself. This effort is the first step so that countermeasures can be taken later. The dissemination of air quality information has been carried out by several parties, especially the government in several countries including Indonesia, which was carried out by the Ministry of Environment and Forestry[1]. Besides that, the pollution problem does not only focus on the type and level of pollution. Air pollution that has been mixed with air is also influenced by the presence of wind. Wind speed and direction can affect the movement and distribution of air pollution. In the case of air pollution which exposed by the wind has several studies that have been conducted[6][12] but there are some features that have not been shown yet, such as wind direction not shown in the map so that multiple perceptions of heatmap visualization and air pollution distribution which is displayed by heatmap not been integrated with wind direction and speed.

Therefore, an Internet of Things (IoT) based system is needed that can inform air quality in an area by paying attention to the speed and direction of the wind. IoT devices that is built can capture data from several types of air pollution and are equipped with wind direction and speed. The delivery of air quality information to the public in the form of mapping with visualization in the form of heatmap that are affected by sensor data and wind speed and direction. In addition, the direction of the wind with a fast speed will also be displayed on the heatmap to make it easier for people to know the direction of the wind with its speed.

With this system, people can find out how dangerous the air in the environment where it is located with the system to be built. With the appearance of a maps, people can easily

[1] http://iku.menlhk.go.id/

see the location with the quality of the air in it which is also affected by the wind in the area so that people can predict the direction of air pollution distribution and make early prevention from the dangers of air pollution.

1.2 Conceptual Framework

This study consists of several variables that could affect the color of heatmap. Figure 1.1 shows the relationship between the variables related to this study.

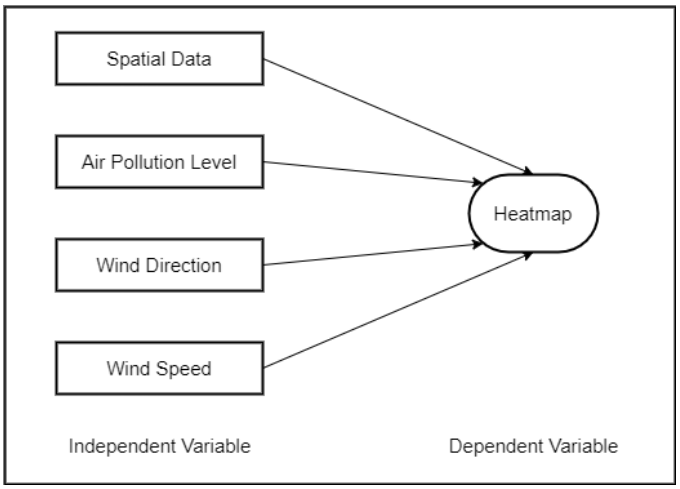

Figure 1.1: Theoretical Framework

Spatial data consists of latitude (lat) and longitude (lon). The value of lat and lon can be affected the location of the maps. The value of lat shows how far a location from the equator. Negative symbol in lat value represents that the location on the maps below the equator or in the south and plus value of lat represent the location on the maps above the equator [19].

Besides spatial data, the next variable that can affect the heatmap is the level of air pollution. There are many kinds of air pollution and its effect. Every kinds of air pollution has different effect and also the unit. The value of air pollution level represents how dangerous the quality of air of an area. Because air pollution have different units, the range of air pollution level have a different characteristic too. Because of that, the display of heatmap can be affected by the level of air pollution because there are many kinds of air pollution and heatmap only show a kind of air pollution. The greater value of air pollution level, the sharper the heatmap color will be displayed.

The heatmap color change by the time and follow the direction of the wind. The heatmap color is affected by wind speed. Wind speed generate a number of interpolation points. The faster the wind speed, the more interpolation points are generated. The generated interpolation points is plotted depend on the wind direction.

1.3 Problem Statement

The problems of the thesis are:

1. How to generate spatio-temporal interpolation of air pollution by considering wind speed and direction.
2. How to produce spatio-temporal heatmap to visualize spatio-temporal interpolation of air pollution by considering wind speed and direction.

1.4 Objectives

The objective of this thesis is to develop a spatio-temporal interpolation model of air quality that is affected by the wind speed and direction. The output of this system is a spatio-temporal heatmap. The type of interpolation used in this study is Kriging interpolation. Improvement that is implemented in this thesis is how to find the nearest value between prediction value and actual value of spatio-temporal Kriging interpolation that is affected by wind speed and direction.

1.5 Scope and Delimitation

The scope and delimitation of this study are divided into several aspects including kind of sensors, validation location and time, and validation process.

1. There are four kinds of sensors in this study, namely carbon monoxide (CO), carbon dioxide (CO_2), dust particle, wind speed, and wind direction monitoring sensor.
2. The wind speed value is represented by Beaufort Scale[10].
3. The wind direction consists of 8 cardinal directions consisting of north, northeast, east, southeast, south, southwest, west, northwest.
4. Validation process is held in Telkom University area with $250m \times 250m$ or 15×15 grid layout for locating the sensor station in the afternoon.
5. The process of validation use one of sensor station that is put in random location, so the value of one point of sensor station equal to 0.
6. The interpolation method that is used to validate the result beside Kriging interpolation is linear and inverse distance weighting (IDW) interpolation because the layout of sensor station make a consistent distance between one sensor station with the other.

1.6 Significance of the Study

Regarding the objectives of the thesis, we propose an alternative synthesized solution which is the contribution of the thesis. Because wind has an important role in the distribution of air pollution, the Kriging formula in this thesis is improvised. The result of this improvisation is a heatmap of the distribution of air pollution that is affected by the wind. In addition, improvisation was also carried out on the weight value assessment in the Kriging formula. This is because the sensor station layout is in the form of a grid. The results of this improvisation are expected to predict the distribution of air pollution at a point whose value is close to the actual value at that point. Based on that point, here area the lists of contribution of this thesis:

1. Improved weight calculation process.
2. Make the heatmap color moves based on the wind direction.
3. The speed for heatmap color movement is affected by the wind speed.
4. Modified the formula of Kriging interpolation for this case.