CHAPTER 1
INTRODUCTION

1.1 Background

According to the roadmap of an acceleration development program of electric vehicles that are based on batteries in 2030 from the ministry of energy and mineral resources, it is being targeted that the two-wheels electric vehicle achieves 13 million units and 67,000 of a public battery swap station for electric vehicles [1]. The station is being implemented in public places, it is mainly because the swap system can reduce the charging time of the battery compared to the immediate charging method. However, the swap method can be detrimental to users when the battery pack that is being swapped has a bad condition, especially the health of the battery [2]. Until now, the station only shows the State of Charge (SoC) estimation of the battery. SoC can only see whether the battery is fully charged or not, but it cannot detect whether the battery is still in a good condition or not [3]. A battery that has a bad charging cycle can cause some negative impacts such a blast that can cause fire to the electric vehicle [4]. Therefore, it is important to estimate the State of Health (SoH) of the battery so that it will not endanger the users of the electric vehicles while riding them [5].

State of Health (SoH) of the battery is defined as a ratio of the current capacity and the initial capacity [6]. The SoH value also shows the current condition of the battery based on its capacity. The accuracy of the estimation and the prediction of the SoH holds the importance to the operational effectiveness and the safety of the two-wheels electric vehicle itself [7]. In other research, a method that has been used such a discrete incremental analysis that has high compability, low computation, and a small needed memory. However, there is a limitation that it only depends on some types of battery [7]. Another research is also found about the use of Neural Network Framework to predict the SoH of a battery, but there is still no potential area exploration such as adding the data resource and deepening the Neural Network architecture [8]. The further development is indeed needed to improve the accuracy and the reliability of the SoH estimation method [9]. A research in the Dynamic Bayesian Network method is also found that still has a weakness in the integration of the dynamic data for the prediction model and also the need for a more improved method to predict more accurately along with time [10].

Therefore, a method is needed to predict the lifetime of the battery. It has the purpose to give the information to the users or rental provider of the battery about the perfect time to change the battery. In this study, a machine learning method is being used to predict the battery health of the two-wheels electric vehicle. The algorithm that is being used has to be a non-linear fitting algorithm, such as Random Forest, K-Nearest Neighbor, Gradient Boosting, Neural Network, etc. The exploration to find the suitable algorithm is needed to improve the effectiveness [11]. According to the previous researches, there are both random forest and decision tree algorithms [12]. The algorithm that is being used will get the input of the battery cycle. The cycle that is being used is the charging and discharging cycle of the battery [13]. The result from the battery cycle will show the percentage that is called the SoH. SoH is a value for the current condition that shows the health of the battery based on the capacity [14]. The SoH value will be the prediction for some time in the future.

1.2 Problem Statements

The problem statements are:

1. Many public charging stations do not provide the information of the State of Health (SoH) of the battery
2. The users do not understand whether the battery is still more than 80% of the SoH

1.3 Research Objective

1. To predict the SoH of a battery in the two-wheels electric vehicle as a percentage so that the users will know if the battery is still more than 80%. In addition, the users will also know whether it is the time to change the battery or not, since it can be seen if a battery is not viable to use
2. To display the SoH percentage value at the public charging station

1.4 Hypothesis

In this study, the chosen machine learning algorithm-between Random Forest (RF), Neural Network (NN), Gradient Boosting (GB), K-Nearest Neighbor (KNN), and Decision Tree (DT)-will show the percentage of the SoH of the battery. In

addition, the machine learning algorithm that is being used in this study has to reach less than 5% of Mean Absolute Error (MAE) since it is considered great. When the result is achieved, this study is being considered a success in doing its job and can be developed further such as integrating the algorithm to the battery management system as the monitoring system using Raspberry Pi 4.

1.5 Research Methodology

The method that is being used in this study is a non-linear fitting algorithm for machine learning. The algorithm is being used to predict the health of the battery of two-wheels electric vehicle. The algorithm gets input from the battery cycle. The battery cycle includes both charging and discharging cycle that will show the SoH value. There are some parameters that the machine learning need, such as cycle counts, voltage, current, SoC, SoH, and temperature. These parameters are taken directly from the Battery Management System (BMS). There are also some factors that affect such as the amount of the cycle, Depth of Discharge value, the battery temperature, and both the overcharging and discharging cases.

Once the algorithm is determined, the chosen algorithm will be integrated to a Raspberry Pi to connect to the public charging station. The public charging station will show the user interface of 5 chargers, 3 slots for battery swap system and 2 slots for multiplug charger. These slots will show the percentage of the SoH, so that users will know if a battery is still viable to use.