Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED HOME WEATHER STATION EQUIPMENT TO MEASURE WIND SPEED AND DIRECTION

MUHAMMAD SYAKIF IEMRAN BIN SABRI

Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

2023

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MUHAMMAD SYAKIF IEMRAN BIN SABRI

A project report submitted
in partial fulfillment of the requirements for the degree of
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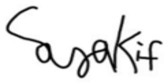
Signature	:	
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DEDICATION

This study is wholeheartedly dedicated to my beloved parents, who have been my source of inspiration and gave me strength throughout this journey, who continually provide their moral, faith, spiritual, emotional, and financial support.

To my brothers, sister, relatives, mentor, friends and course mate who shared their words of advice and encouragement to finish this study.

ABSTRACT

These days, unpredictable climate change occurs at anytime and anyplace without our consciousness that could affect our lives miserably through natural disaster or severe illness. This is where weather station that equip with IoT come into place where people can monitor real time weather data through smartphone device within WiFi connectivity. These systems are intended to keep an eye on critical occurrences in the physical world, producing information that can be uploaded to the cloud where it can be accessed by applications and from which early precaution can be taken. This project employs 32-bit microcontroller, anemometer sensory part, ESP32 Wi-Fi module where data sends transmissions to cloud service which is Blynk server where it is processed and stored. An application which is Blynk IoT can connect to the intended device to show users the rcorded weather data through smartphone. Therefore, wind vane and 3 cup anemometer has been calibrated against reliable tools to ensure their preciness before installing weather station outdoor for analysis purpose. The wind speed of this weather station has been verified against digital anemometer and has percentage error less than 5%. Wind direction has been verified through digital compass to calibrated its accurateness of direction. The data is collected, analyzed and compared with other weather forecast website like Zoom Earth which is a live weather satellite, Public InfoBanjir, and Malaysian Meteorological Department. These are the most reliable source for weather guidance whether locally or globally for public who keen to know about regional weather status. This product is designed to withstand such blustery weather condition in a long run. Thus, having this personal weather station equipment at household is pretty convenient to monitor real-time weather.

ABSTRAK

Hari-hari ini, perubahan iklim yang tidak dapat diramalkan berlaku pada bila-bila masa dan di mana sahaja tanpa kesedaran kita yang boleh mempengaruhi kehidupan kita dengan teruk melalui bencana alam atau penyakit yang teruk. Di sinilah stesen cuaca yang dilengkapi dengan IoT berada di tempat di mana orang dapat memantau data cuaca masa nyata melalui peranti telefon pintar dalam sambungan WiFi. Sistem ini bertujuan untuk mengawasi kejadian kritikal di dunia fizikal, menghasilkan maklumat yang dapat dimuat ke awan di mana ia dapat diakses oleh aplikasi dan dari mana langkah berjaga-jaga awal dapat diambil. Projek ini menggunakan mikrokontroler 32-bit, bahagian deria anemometer, modul Wi-Fi ESP32 di mana data menghantar penghantaran ke perkhidmatan awan yang merupakan pelayan Blynk di mana ia diproses dan disimpan. Aplikasi yang merupakan Blynk IoT dapat menyambung ke peranti yang dimaksudkan untuk menunjukkan kepada pengguna data cuaca yang diselaraskan melalui telefon pintar. Oleh itu, arah angin dan anemometer 3 cawan telah dikalibrasi terhadap alat yang boleh dipercayai untuk memastikan ketepatannya sebelum memasang stesen cuaca di luar untuk tujuan analisis. Kelajuan angin stesen cuaca ini telah disahkan terhadap anemometer digital dan mempunyai peratusan kesalahan kurang dari 5%. Arah angin telah disahkan melalui kompas digital untuk menentukur ketepatan arahnya. Data dikumpulkan, dianalisis dan dibandingkan dengan laman web ramalan cuaca lain seperti Zoom Earth yang merupakan satelit cuaca langsung, Public InfoBanjir, dan Malaysian Meteorological Department. Ini adalah sumber yang paling dipercayai untuk panduan cuaca sama ada secara tempatan atau global untuk orang ramai yang ingin mengetahui mengenai status cuaca serantau. Produk ini direka untuk menahan keadaan cuaca yang tidak menyenangkan dalam jangka masa panjang. Oleh itu, mempunyai peralatan stesen cuaca peribadi ini di rumah tangga cukup mudah untuk memantau cuaca masa nyata.

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LIST OF SYMBOLS

°C	-	Degree Celcius
mm	-	Millimeter
Ω	-	Ohm
MPH	-	Miles Per Hour
Hz	-	Frequency
m/s	-	Meter Per Second
°	-	Degree
km/s	-	Kilometer Per Second
V	-	Voltage
%	-	Percentage

LIST OF ABBREVIATIONS

USB	-	Universal Serial Bus
Wi-Fi	-	Wireless Fidelity
IO	-	Input / Output
SSID	-	Service Set IDentifier
CPU	-	Central Processing Unit
PCB	-	Printed Circuit Board
I2C	-	Inter-integrated Circuit
HMI	-	Human Machine Interface
GPIO	-	General-purpose Input / Output
ADC	-	Analog to Digital Converter
PWM	-	pulse width modulation
NodeMCU	-	Node MicroController Unit
UART	-	Standard asynchronous serial communication.
Bit	-	Binary Digit
SPI	-	Master / slave communication
DAC	-	Digital to Analog Converter
IP	-	Ingress Protection
IoT	-	Internet of Things
IC	-	Integrated Circuit
VNC	-	Virtual Network Computing
EMC	-	Electromagnetic compatibility

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CHAPTER 1

INTRODUCTION

1.1 Background

People were completely reliant on sensory observations for any weather data until the 18th century. For example, people estimated the time of rain based on the number of clouds in the sky or understood the wind direction based on the movement of leaves. Weather stations have become quite popular nowadays as people can forecast everything regarding the weather quickly and accurately as possible so they can prepare for threatening weather conditions that can occur at any time. The weather station collects meteorological data regarding the current state of the weather in a particular region and makes forecasts regarding the weather conditions in a particular area like prediction about typhoon alarming from media to public as shown in Figure 1.1. Monitoring and alerting of the current weather conditions, including temperature, pressure, humidity, wind speed, wind direction, and the like as they occur in real time that keep on changing rapidly and unpredictably can helped to take initial precautionary.

Figure 1.1 News about typhoon alarming from Malaysian Meteorological Department

So, it is essential to keep a record of short-term weather updates in order to acquire accurate information regarding the state of the weather. In this case, the weather station plays an important mechanical method and having a personal weather station is necessary for household in modern day. Extensive data about the wind direction and speed for example is collected from weather stations across the world and made available online. Knowing the direction of the wind blowing is important since it provides information about storm systems that can expect soon. But with a quick glance, these simple instruments which is weather station that can be place at household can give first-hand knowledge of wind direction and wind speed. The use of weather stations that can observe the real-time of wind condition can helps to cope and can informed people well in advance about the prevailing weather condition with the Monsoon wind sign that might cause climate disaster in Malaysia such as flood or typhon. This project can measure real-time wind speed and direction at installed area using low-cost high precision calibrated anemometer for accurate measurement of parameter. This recorded data is then sent to the cloud platform for storage, processing, monitoring, notification, and prediction.

1.2 Problem Statement

Recent days, we can find out there are several of home weather station that can be purchased in the marketplace that can measure various of parameters such as rain fall, temperature, humidity, Barometric pressure, and wind parameter. However, there are still lack of invention for those weather station such as high cost to purchase, hard to setup and lack of connectivity range that can only be monitoring in short range area of installed weather station. Any method that is used to forecast the weather must adhere to the standards of accuracy and dependability. It also needs to make it simple to access all of the parameters that are being measured. Some people were preoccupied with domestic activities or office work and had no idea about the natural boundaries and weather variations beyond their home or office, especially those who travelled frequently. A location's weather conditions are determined by several factors, the like of wind speed and direction so stormy climate can be predicted. This equipment can provide an effective solution in these circumstances and dependable for monitoring the weather or climate conditions in a specific area using the Internet of Things (IoT) capability, which has the capacity to monitor and observe the wind condition anywhere from a remote area where does weather station is placed by utilizing the internet network. Keeping weather station able to withstand in its own place even in blustery conditions is also important circumstances as well to prevent electronics part from get fail or start to corrode.

1.3 Project Objective

The following is a list of the objectives that this study aims to achieve:

a) Design a based home weather station equipment that take precise readings of wind speed and direction in real time using active mechanical devices that physically interact with their surroundings.

b) To develop weather station that equip with IoT so it can be observe and monitor its data from smartphone within internet connectivity.

c) To develop portability usage, robust, weatherproof and reliable prototype based home weather station where its components implement in PCB board layout.

d) To analyze the real-time data from weather station.

1.4 Scope of Project

The information regarding the parameters that were measured is not helpful unless it is transmitted to the users promptly and correctly. Therefore, having a IoT based home weather station can help instantly provide alerts regarding abnormal changes in the weather on user through phone. Therefore, user can easily prevent any mishap or loss due to their forecasting and instant alerts. Also, user can share wind parameter data on various devices by connecting the weather station to a Wi-Fi network. The processing and transmission of measured data is a critical component of modern weather forecasting. The Internet of Things (IoT) is being implemented in this project so this project's application will involve monitoring the meteorological wind parameters. Thus, the scope of this study is as follow:

a) The design of the project is balanced for all these factors in terms of reliability, ease of use, accuracy, and cost.

b) The app interface provides user-friendly interface for monitoring weather parameter data.

c) The prototype is weatherproof and able to hold all of the components in place to measure precise weather parameters data.

d) The system required consistency of wind flows intensity at least to obtain best performance.

1.5 Report Structure and Organization

This thesis has five chapter that are outlined as follows:

Chapter 1 explained the background of weather station. Based on the problem statement that faced, few objectives are established as a guidance for further reference

In Chapter 2, literature study is conducted to provide knowledge while understanding of the other researches to reduce unresolved problems and prevent repetition of project occurs. The comparison between previous researches works are done to conclude the advantages and disadvantages of their methods.

In Chapter 3, methodology is formulated into four milestones that referred to the objectives for this project. The system architecture able to be designed based on the previous research studies by selecting the right methods and the components that included in this project. Testing and troubleshooting is evaluated based on the algorithm development in this system. Furthermore, data collection and analysis are analyzed to ensure this system achieved the objectives stated in this project. Finally, the prototype of the system is developed to fit all components.

Chapter 4 shows the results and analysis that should achieved by the system designed after the basic testing for the components. This result is used as a guidance for further works in second task of the final year project.

Lastly, Chapter 5 conclude all the efforts and works inside this project and a short summary for all the process that have been done in this project.