Evolution in Electrical and Electronic Engineering Vol. 4 No. 1 (2023) 321-328

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Mini Invelox Wind Harvesting System with IoT Monitoring (MIWHS-IoT)

Mohamad Nabil Amiruddin Mohamad Isa[1], Aizan Ubin[1]*,

[1]Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussien Onn Malaysia, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2023.04.01.038
Received 15 January 2023; Accepted 12 April 2023; Available online 30 April 2023

Abstract: The mini Invelox wind harvesting with IoT monitoring (MIWHS-IoT) project aims to demonstrate the feasibility of using an Invelox system, a wind turbine that uses a series of funnels and ducts to increase wind speed, in combination with a boost converter circuit and IoT monitoring to improve the performance and efficiency of the system. The project includes the design and implementation of an Invelox system prototype, as well as the integration of sensors for monitoring wind speed and output voltage, and a boost converter circuit to step up the voltage. The sensor data is transmitted to a cloud-based platform for analysis and visualization using Blynk, an IoT platform for building IoT applications. The results of the project show that the Invelox system can generate a significant increase in output voltage and the IoT monitoring system provided valuable insights into the performance and efficiency of the system, and support for optimizing the system operation. The project provides a proof-of-concept for using an Invelox system in a small-scale wind harvesting application and can be used as a basis for further research and development in this field.

Keywords: Invelox System, Wind Turbine, Blynk, Iot

1. Introduction

Renewable energy has been recognized as having a significant potential to replace fossil-fuel based resource use. The development of numerous wind turbine research and implementation projects has been aided in part by this development. Due to the gradual maturity of wind power technology and continuous decline in the cost of wind power generation, wind turbines have been widely used in recent years [1]. The lack of wind speed in particular areas has proven to be the most difficult obstacle to the widespread application of wind energy harvesting systems. Implementation of wind energy harvesting system required a good maintenance system to maintain the system always in good condition as a fault in a wind turbine electrical system can have far-reaching consequences. Adoption of renewable energy including wind energy, required a significant amount of area. In order to tackles the disadvantages, Mini Invelox Wind Harvesting System with IoT Monitoring (MIWHS-IoT) is proposed. Invelox is a new

*Corresponding author: aubin@uthm.edu.my

concept for capturing wind from all directions and measured data confirmed that wind captures in 360. Turbine performance was enhanced from 300 to 3600 watt due to amplified wind speed and a higher power coefficient when turbine was mounted in the venturi section of Invelox [2]. The Internet of Things (IoT) is being used to implement wind turbines, which aids in the monitoring of the system. In order to maintain a reliable and costs-effective green energy wind turbines system, proper maintenance and monitoring system are compulsory. IoT technologies are mainly used in condition monitoring or the fault prediction of wind turbines. IoT is a system of irrelated computing devices having ability to transfer data over a network without requiring human interaction [3]. IoT makes it possible to collect the real time data required in order to monitor and improve the wind turbines.

The works embarks on the concept of a mini Invelox wind harvesting system, which could enhance and generate enough amount of electricity for low-power appliances. Invelox delivers answers to all the primary difficulties that have hampered the wind industry, including low turbine dependability, intermittency concerns, and negative environmental and radar effects [4]. IoT monitoring systems collect, analyze, and compute data from internet-connected sensors and other devices. These systems are suitable for wind turbine system as it frequently used for monitoring physical systems or processes, such as building systems, transportation systems, or manufacturing systems. Wind harvesting devices often incorporate sensors to measure wind speed, direction, and other characteristics, as well as control systems to optimize wind turbine performance.

2. Methodology

In this study, the Invelox concept is chosen as the type of wind turbine. Invelox is a concept that can enhance the wind's speed as it flows into the wind turbine. The Blynk platform is also employed as an IoT monitoring system for the wind speed and output voltage data from wind turbines. Table 1 shows the software and hardware used in implementing this project.

Table 1: Software and hardware used for MIWHS-IoT

SolidWorks	SolidWorks, (is used in the design of the 3D design of the Invelox wind harvesting system) an easy-to-use and intuitive CAD software for 2D and 3D modelling. The Invelox wind harvesting system is designed based on the parameters calculated for each section.
Proteus	Proteus software is being used in the design and simulation of the boost converter circuit which will be connected to step up the output voltage of the wind turbine motor.
Arduino IDE	The Arduino IDE is utilized as a platform to design the code for the connection of sensors and microcontroller, which is the Arduino Compactible DCCDuino as well as additional components such as the Blynk IOT Platform.
Blynk platform	The Blynk IoT platform displays and monitors sensor data from Arduino DCCDuino using a Wifi connection. Because the data is transmitted from Arduino DCCDuino to Blynk cloud via Wifi, a real time data monitoring of the system is possible.
Arduino DCCDuino Uno R3	The Arduino DCCDuino microcontroller is used to capture the sensor data as well as transmit and receive it to the Blynk platform.
ESP 8266-01	The ESP8266-01 serves as a wifi module in the Arduino DccDuino wireless internet communication with the Blynk platform.
Anemometer	An anemometer measures the wind speed from its surrounding.
Volatge sensor	A voltage sensor will be used to sense the voltage value boosted by the boost converter circuit.

12V DC generator motor	A 12V DC generator motor is used to convert wind kinetic energy into electric energy.

The flowchart of the project as shown in Figure 1 can be divided into three phases starting with the designing process of the Invelox wind harvesting system, constructing the boost converter circuit, designing the code for capturing the sensor data and transmitting the data to the Blynk platform. The project started with the parameter calculation and design process of the Invelox wind turbine part. The design must be able to enhance the wind speed that flows through the turbine. Following that, a boost generator circuit is designed to step up the voltage generated by the 12V motor generator. The voltage boost must be sufficient to light up a 12V DC lamp, which is the load of this project. Then, a voltage sensor and anemometer are installed to measure the wind speed and voltage generated by the boost converter circuit. Sensors are connected to Arduino DCCDuino microcontroller which then transmit the data to the Blynk platform. Blynk will function as a monitoring system for the MIWHS-IOT based on the wind speed and output voltage data.

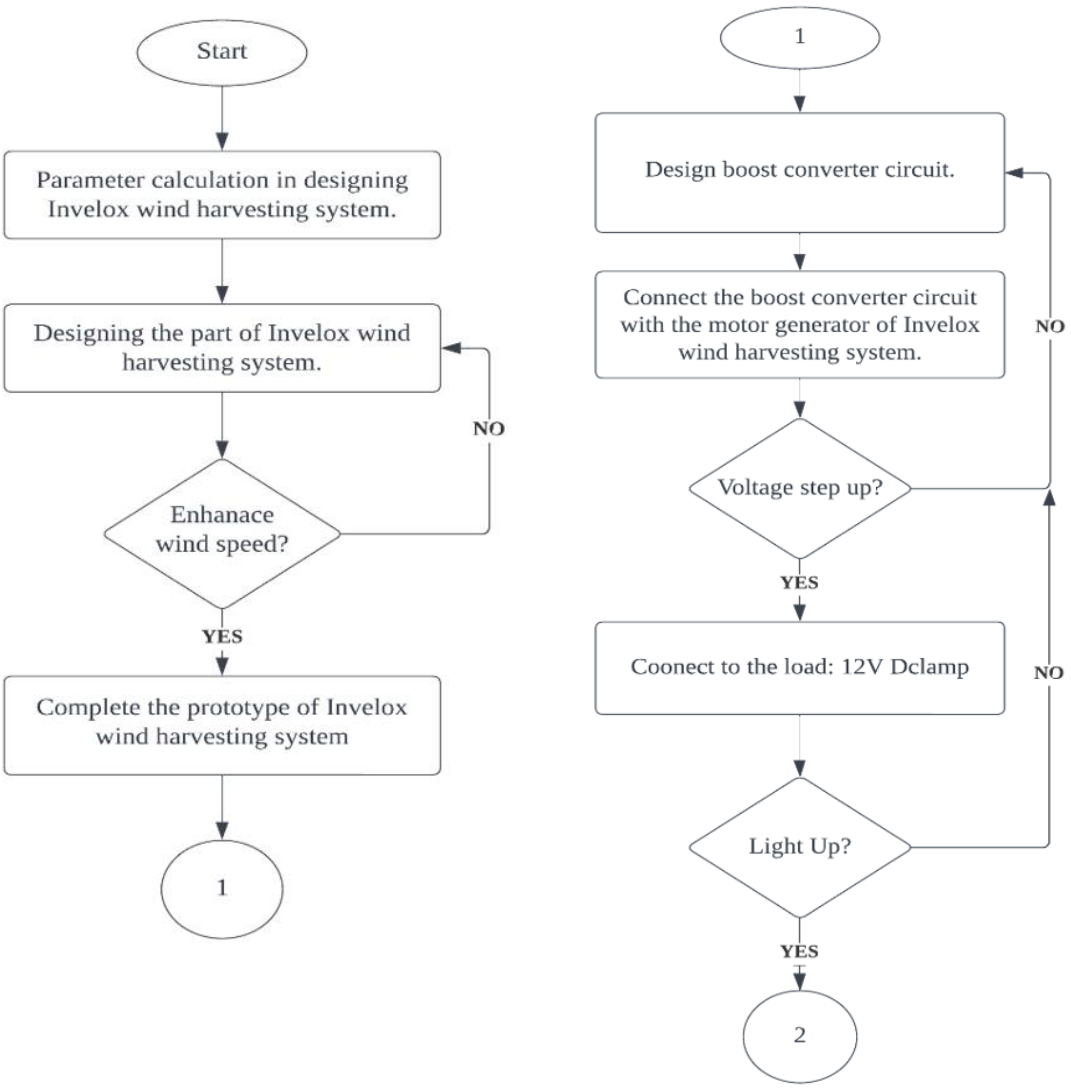

Figure 1: Flowchart of MIWHS-IoT

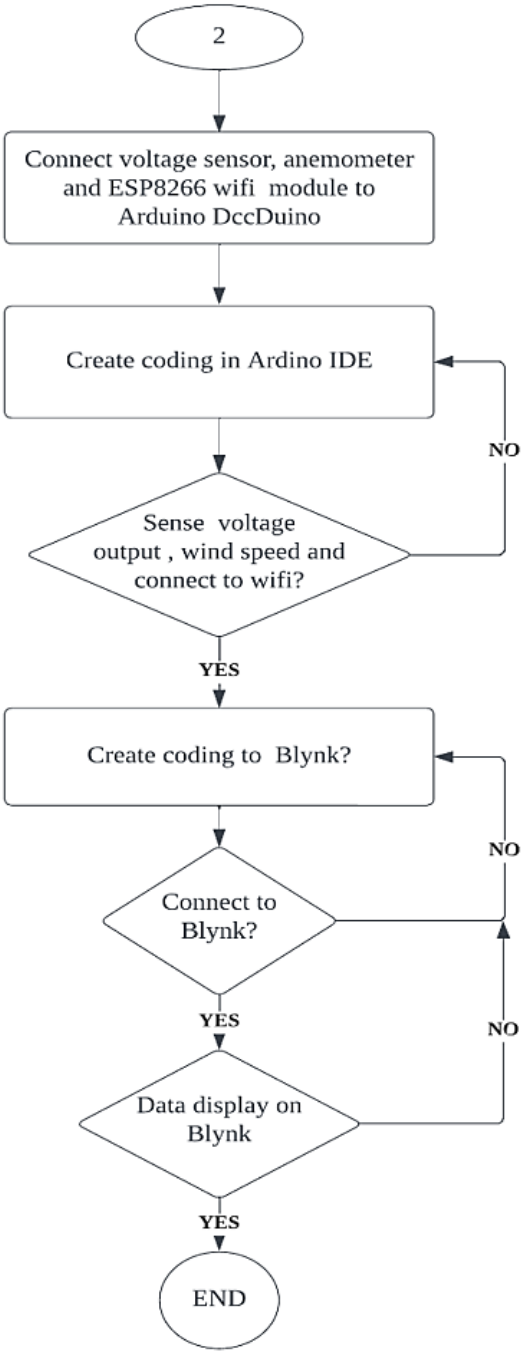

Figure 1: (continued)

Figure 2 shows the flow of the MIWHS-IOT project based on the block diagram. Wind will flow into the Invelox wind harvesting system and turn the blade at the turbine section. Motor generators then generate the voltage while boost converter is installed to step up the voltage generated. Anemometer and voltage sensor are used to sense the wind speed and voltage output on the boost converter. Both sensors and ESP8266 wifi module will then be connected to Arduino DCCDuino. In this project, the ESP 8266 will act as a wireless communication module with Blynk platform via wifi. This will allow Arduino DCCDuino to transmit sensors data to the Blynk platform for a real time data monitoring.

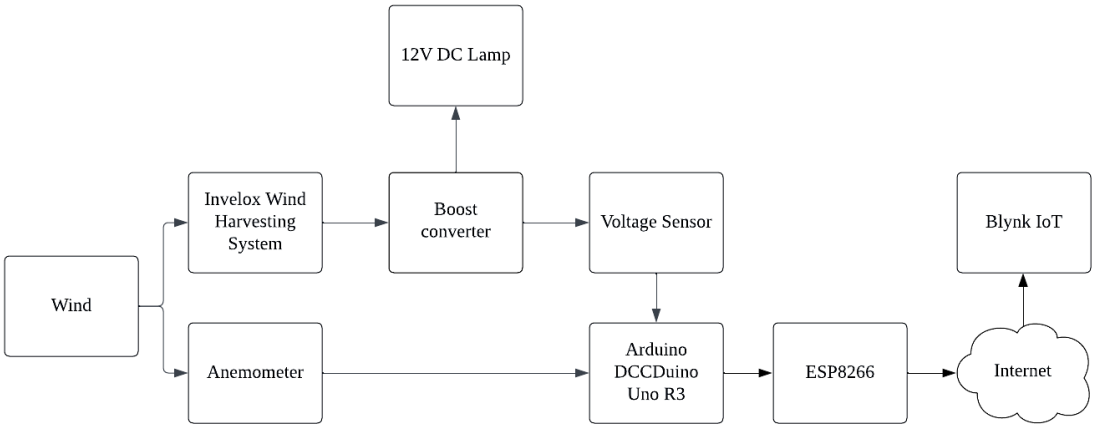

Figure 2: MIWHS-IoT block diagram

3. Results and Discussion

The results obtained throughout the implementation of the project are analyzed and explained in this section. The sensor data need must read using a serial monitor and displayed in the Blynk platform for both mobile and web dashboards. Wind speed and voltage output data are compared and analyzed based on their correlation. The sensors data also will be monitored in a real time data on the Blynk platform to see how it correlate. In theoretical, the output voltage should increase as the wind speed increases.

Figure 3 shows the full hardware connection of the project. Wind will flow into the turbine section of an Invelox wind turbine and turn the blade. The motor generator is connected with boost converter circuit to step up the voltage output of the motor generator, so it is sufficient to light up a 12V DC lamp. The correlation between output voltage and the wind speed will be discussed in the analysis part of the project. Once the data extraction process is completed successfully, all extracted data will be uploaded to the cloud server platform, Blynk. Blynk allows a real time data monitoring for the project. The source of data in this project is obtained by using a voltage sensor and an anemometer. Arduino DCCDuino Uno R3 is the main component for this project. Because Arduino DCCDuino lacks a built in wifi module, the ESP8266-01 wifi module is used to connect it to the internet. The Rx and Tx pin of the ESP8266-01 are connected to pins 4 and 5 of the Arduino. This will allow Arduino to transmit and receive the sensor data wirelessly over the internet with the Blynk platform. The prototype of MIWHS-IoT is shown in Figure 4.

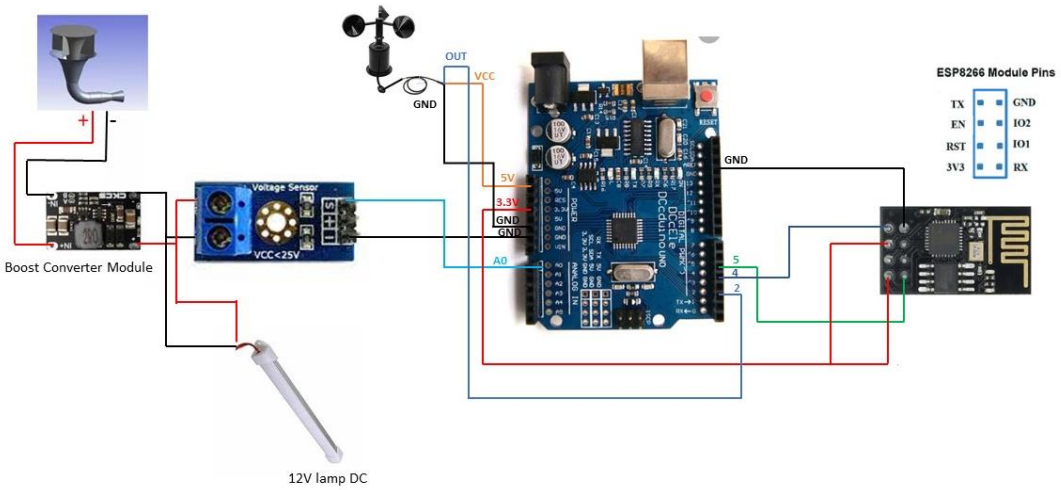

Figure 3: Hardware connection of MIWHS-IoT

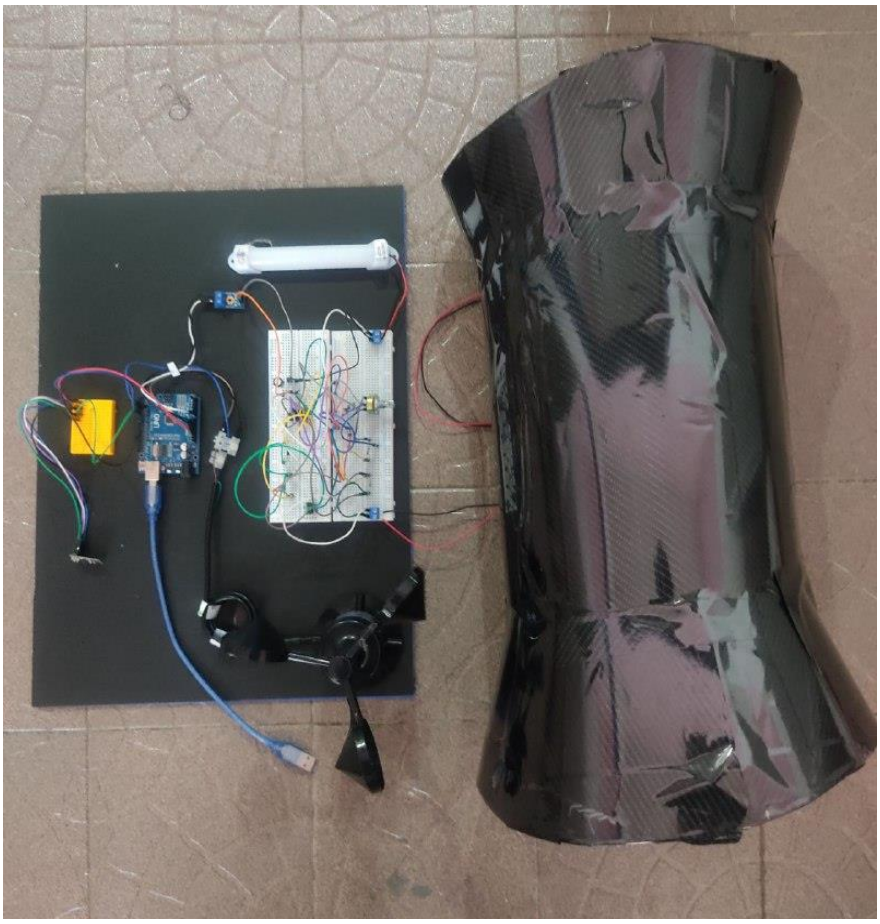

Figure 4: Complete prototype of MIWHS-IoT

The prototype testing of the MIWHS-IoT is conducted at Sungai Sembrong, Parit Raja. The testing is conduct using two method which with and without Invelox system. The wind speed and voltage output are recorded in Blynk platform. The output for prototype testing without Invelox system is shown in Figure 5 while the output for prototype testing with Invelox system is shown in Figure 6 for the duration of 1 hour. Based on the observation of the two Figure, the voltage generated by testing the prototype with Invelox system is slightly higher than prototype without Invelox with approximately the same wind speed in environment.

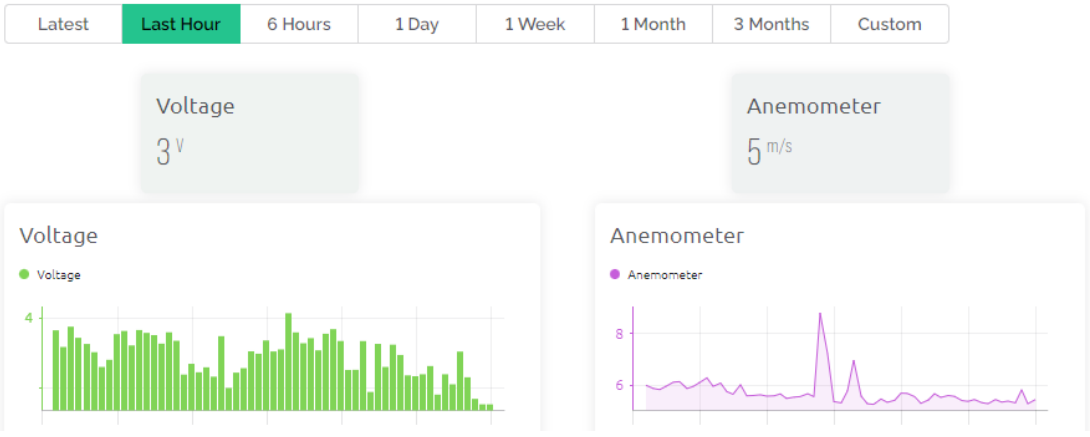

Figure 5: Prototype testing without Invelox system

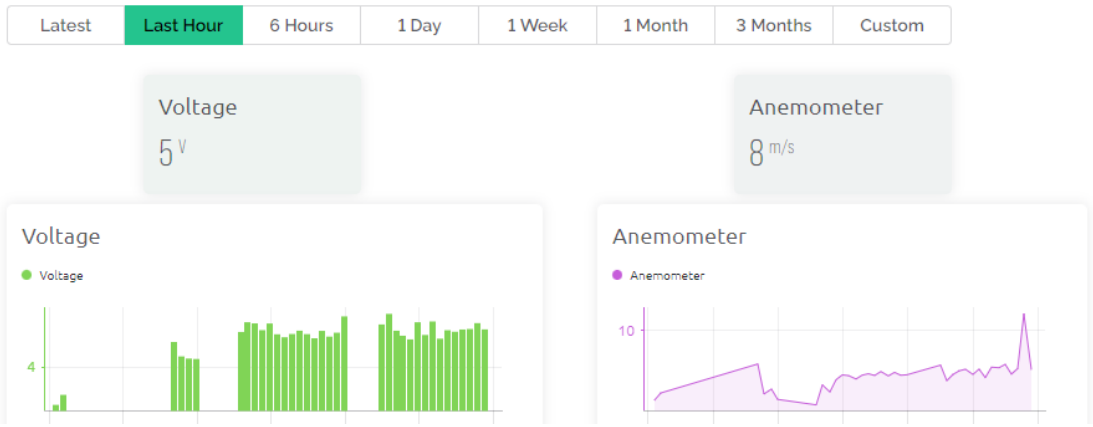

Figure 6: Prototype testing with Invelox system

Comparing the graph at Figure 5 and Figure 6, the results shows that the prototype with Invelox system generated a higher output voltage. The prototype with Invelox system recorded the minimum output voltage of 3V and maximum output voltage of 7V during testing. The prototype testing without Invelox system recorded minimum output voltage of 2V and maximum output voltage of 4V maximum during testing. The results proved that an Invelox system is a set of funnels that enhance the wind speed from the environment into the wind turbine which also increase the output voltage. The voltage generated by the Invelox wind turbine system also can be higher with a better design of Invelox as in this project the prototype is built involving convergence, divergence and venturi section without another two sections of Invelox which is nested funnel and bent section.

Based on Figure 5 and Figure 6, it showed that the wind speed sensed by anemometer during testing the prototype without Invelox system is between 6m/s to 9m/s while prototype testing with Invelox recorded the wind speed between 6m/s to 11m/s. The result shows that prototype testing with Invelox system produced higher output voltage as the wind speed flow through the turbines blades is enhance. This is because the turbine blades convert the kinetic energy of the wind into mechanical energy, which is then used to generate electricity. The higher the wind speed, the higher ouput voltage generated by wind turbine. The correlation between wind speed and voltage output in a wind turbine, such as an Invelox system, can have a significant impact on the performance and efficiency of the system. Invelox concept wind turbines such as MIWHS-IoT is practical in location with low intensity of wind as it can help to produce higher electricity.

4. Conclusion

In conclusion, the mini Invelox wind harvesting project with a boost converter circuit and IoT monitoring of anemometer and voltage sensor data can be a useful tool for understanding the performance and efficiency of the Invelox system. By monitoring the data from the anemometer and voltage sensor using the IoT, it is possible to gain a better understanding of the correlation between wind speed and voltage output. This can provide valuable insights into how the Invelox system is performing and can help optimize its operation

Acknowledgement

The authors would also like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, for its support.

References

[1] J. An, G. Chen, Z. Zou, Y. Sun, R. Liu, and L. Zheng, “An IoT-based traceability platform for wind turbines,” *Energies*, vol. 14, no. 9, pp. 1–17, 2021, doi: 10.3390/en14092676.

[2] G. A. Gohar *et al.*, "Design and comparative analysis of an INVELOX wind power generation system for multiple wind turbines through computational fluid dynamics," *Adv. Mech. Eng.*, vol. 11, no. 4, pp. 1–10, 2019, doi: 10.1177/1687814019831475.

[3] V. K. Singh, "IOT based Windmill Monitoring System," vol. 6, no. 13, pp. 1–4, 2018.

[4] D. Allaei and Y. Andreopoulos, "INVELOX: Description of a new concept in wind power and its performance evaluation," *Energy*, vol. 69, pp. 336–344, 2014, doi: 10.1016/j.energy.2014.03.021.