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A Graphical User Interface Based Application for Predicting Photovoltaic Power Output

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Abstract:

The photovoltaic or PV system is regarded as one of the most common forms of renewable energy for electricity generation. One of the disadvantages of the PV system, however, is that the consistency of the electrical power production of the PV panel is incompatible and very influenced by changing climate conditions. Therefore, it is important to predict the PV system's optimal power output. In this paper, a graphical user interface (GUI) based application that can help to predict PV electrical power output is developed. The results have shown that the GUI is able to show the daily electrical energy production of PV.

Keywords **—Photovoltaic, solar electricity, renewable energy, graphical user interface, MATLAB App Designer.**

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I. INTRODUCTION

As years go by, the green energy sector has produced billions of investments in the economy, with constant and steady growth, which begins to ensure a future of clean and sustainable energy. Renewable energy is often referred to as green energy, which can be described as electricity produced from natural sources which can be replenished. Wind, photovoltaic (PV), geothermal, biomass, and hydropower are among the most common renewable energies[1]–[3].Among of all type of renewable energies, PV is one of the most if not the most promising renewable energy for electricity generation [4]. This is because sunlight is received and limitless at most parts of the world. The generation of electricity from PV technologies is estimated to hit more than 900 MW[5], [6].

Although the PV system is one of the clean, environmentally sustainable, and endless sources of electricity, the PV system has a range of problems with the implementation of the PV system in Malaysia. Malaysia is situated in a tropical climate region where heavy rainfall and dry days occur daily every year[7]. This is due to the fact that PV is really dependent on the environmental values especially the Peak Sun Hours (PSH), temperature and solar radiation etc [8]. The PV panel can generate power only according to its ranking under the Standard Test Condition (STC). STC, includes among others two important characteristics which is the solar radiation must be $1kW/m^2$ and the PV temperature must be 25^oC [9], [10].

According to [9], there are a number of steps and equations involved in predicting the electrical output of a PV panel or PV array. PV array can be defined as a number of PV panel connected together whether in series or in parallel or even, in both configurations. Even though the predicting is suitable for small size of a PV system, it will be more difficult if the system expands or getting bigger. Hence, the research in this paper focuses on

developing a Graphical User Interface (GUI) based application for predicting the electrical output of the PV array. All the steps and methods are based on the information in [9].

II. METHODOLOGY

The GUI is developed by using an apps development tool called AppDesigner that is available in MATLAB.This tool is an immersive software platform for designing any application with GUI. It also provides a grid layout manager to coordinate the user interface, and automated reflow options to identify and respond to changes in screen size in the GUI [11].Fig. 1 shows the main interface of MATLAB App Designer.

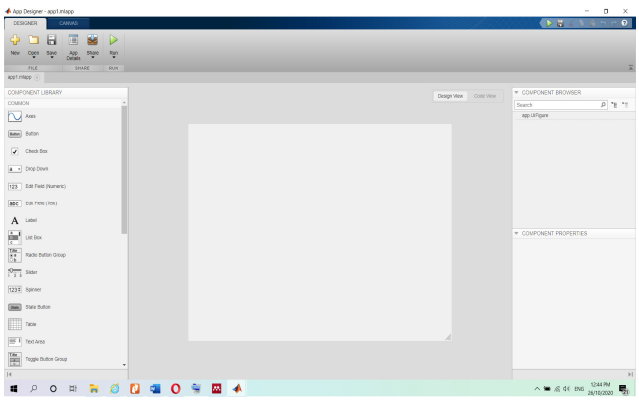

Fig. 1 Main Interface of MATLAB App Designer

The GUI will consist of two main windows. The firstwindow acts as the main menu as well as the introductory part.The other window consists of three tabs for day, month, and year. From this window, the user can go to other windows for day, month, and year. The Users just must key in the input values at the "Inputs" section which are the PV panel information, system information and environmental information. All the outputs generated at "Output Values" section will be shown when button is clicked. The outputs generated consist of PV Assured Power Output, Predicted Power Output, Net Array, Maximum AC Output and finally Daily Energy Production which is the PV array power generation. For the monthly tab, users must add the inputs to the table and add them to Annual Analysis to obtain the output values. Users may also refer to "User Info" for explanations and formulas related to this project. Furthermore, users may delete unwanted rows at its function shown.

III. RESULTS AND DISCUSSION

The diagram of the developed GUI is presented in this section. The GUI will open with a main menu window or also is the introductory window. Fig. 2 shows the design of the window. Here, the user can start just by simply clicking the start button.

Fig. 2 Main Menu Window

After clicking start, the user will see the second main window. This window consists of three tabs specifically for day, month, and year as shown in Fig. 3.

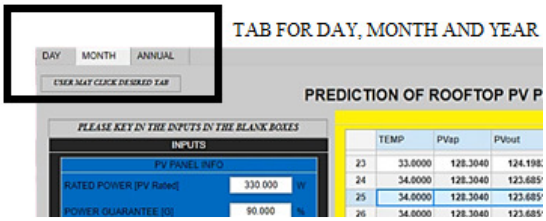

Fig. 3Tab for Day, Month and Year Prediction

Also, in this window, the user need to insert required parameters for the prediction purposes. Those parameters include the information of the PV panel, the information of the system and the environmental information. For the PV panel info, the user needs to insert the rating, output guarantee, quantity, and the temperature coefficient of the PV panel. These values can be obtained from the datasheet of the PV panel. For the system info, the user needs to provide the inverter's efficiency

(inverter is used to convert DC electricity to AC electricity), the wiring and the mismatch losses as well as the soiling derating factor. The soiling derating factor is important to take the shading of the PV panel due to dirt, cloud etc into the calculation or prediction process.Finally, for the environmental info, the user needs to insert the values of temperature, and peak sun hours of the current months. These data can be obtained from the meteorological websites or any trusted websites. Fig. 4 depicts the designed GUI for the user to insert all these values in window 2.From there, the results can be obtained in the result section as shown in Fig. 5. Similarly, the GUI also provides the same option for yearly prediction as depicted in Fig. 6.

Fig. 4Designed GUI Input Section

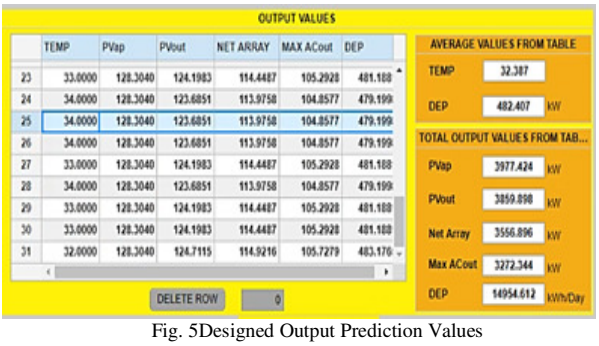

Fig. 5Designed Output Prediction Values

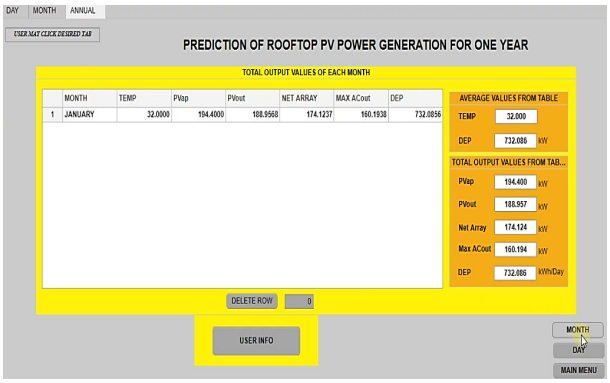

Fig. 6Designed Prediction Values for One Year

This result has shown that the developed GUI provides prediction functions forPV electrical power generation. Fig. 5 and Fig. 6 show the designed GUI for monthly and annually where all the generated outputs will be shown automatically. Every tab shows all procedures, explanations, and formulas of PVelectrical power generation. This information is simple and easy to understand. This will help to enhance users' understanding about this PV electrical power prediction.

IV. CONCLUSIONS

The resultshave shown that the designed GUI for predicting PV electrical power generation for three options. Those options are prediction by day, by months, or even for one long year. The determined outputs are based on information from the PV panel, device information and environmental information.All of this information can be insert systematically in the GUI designed area. This GUI is targeted for undergraduate students in the field of electrical engineering/engineering technology as well as fresh or junior engineers and technologists in the field of PV technology.

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