Power Generation on Highways using Vertical Axis Wind Turbine and Solar Energy

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ABSTRACT

Renewable energy reliability has been the main agenda of country nowadays, where the internet of things (IoT) and Industry 4.0 are crucial research way with a lot of opportunities for improvement and challenging work. Data obtained from Internet of Things is converted into meaningful information to improve and monitor wind turbine and solar performance, driving wind energy cost down and reducing risk. However, the actual implementation in Internet of Things is a very challenging task because the wind turbine system level and component level need real-time control. So, this paper is dedicated to investigating wind resource assessment and lifetime estimation of wind power modules using IoT. To illustrate this issue, a model is built with sub-models of an aerodynamic rotor connected directly to a multi-pole variable speed permanent magnet synchronous generator (PMSG) with many various sensors for measurement of energy stored in battery are integrated with IoT. Actual work is constructed with ESP32 Microcontroller and Google Cloud service. IoT has proved to increase the reliability of measurement strategies, monitoring accuracy, and quality assurance.

Keywords: *vertical Axis wind turbine, solar panel, Internet of Things*

I. INTRODUCTION

The Internet is a gigantic intercontinental network of networks. The nodes that comprise each one of these networks were classically used to be computers. Now, with the advent of the Internet of things (IoT), things of the IoT encompass any physical entity on earth. Therefore, the Internet is no longer a massive network of computers; but rather the Internet now interconnects heterogenous devices with the required interoperability. This makes these devices (or things) accessible from anywhere on the planet. The user can enjoy the services of these things remotely. Moreover, the operation of these devices can now be controlled remotely via the Internet. It is expected that soon, IoT will be so pervasive to cover every aspect of the human's life including renewable energy generation and management.

The things in the IoT generate innumerable amounts of data. The nature of these data is in general unstructured data that need further processing painstakingly. Cloud services, provided by data centers, could be exploited to process such big data [1]. However, this imposes several challenges in case IoT, and cloud computing are coupled directly to each other. An exigency shows up to provide a seamless integration, and here comes the role of fog (aka edge) computing. The main purpose of the fog is to move the burden of dealing with vast amounts of data from the cloud to the edge of the IoT, near the end devices. In addition, fog computing is hoped to offer ameliorated security and privacy.

II. LITERATURE SURVEY

Adequate lighting in highways has been a prerequisite for the economic and social revolution in the developing countries because of their significant ratio (86%) in a comparative road accident study [4]. A research carried by New Zealand transport energy [5] revealed that the largest night-to-day crush ratio reductions attributable to road lighting on higher speed roads were 31%, 24% and 17% for motorways, divided highways and single carriage roads, respectively. Also, apart from the urban areas, many rural highways still need lighting to enable further safety for their users. However, the installment of lighting systems in the accident-prone stretches of remote highways is subjected to outrageous investment and maintenance cost. The cost of highway lighting services can be momentously impairing for a patchy budget. For example, 60% budget of European Commission was reported to be consumed only by their public lighting service [6]. Similarly, Australia spends more than $125 million for their approximately 2.3 million lighting lamps in public lighting services [7]. Furthermore, about 30%-60% of their total carbon emission can be attributed to the energy consumption of these lighting services. For example, the United States generated 67% of their total electricity produced by fossil fuels contributing millions of metric tons of greenhouse gases in the air [8].

III. PROPOSED ARCHITECTURE

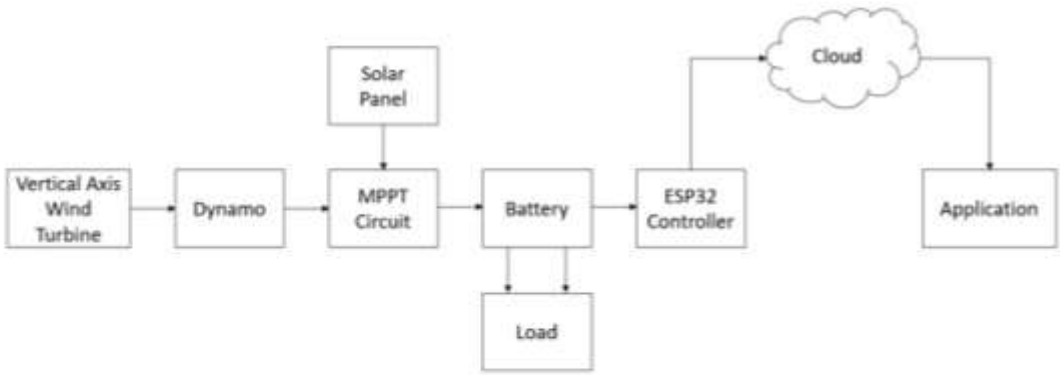

Figure 1 - System Architecture

When the vehicle passed on the highway it produces a considerable amount of air due to its speed. This air tangentially strikes on the blade of the vertical axis wind turbine, and it makes a rotation of the turbine in only one direction. The solar system is used to generate electrical energy and installed in a way that it diverts the vehicle air towards the turbine. The generator with the gear mechanism is connected to the shaft of the vertical axis wind turbine to generate electricity. The electrical output of vertical axis turbine and the solar system is stored in a battery. This stored energy which can be further used for charging electric vehicles, street lighting, toll gates, etc. ESP32 controller with voltage and current sensors, monitors energy generation, battery status and send on cloud.

IV. CONCLUSION

This paper has proposed an IoT-enabled hybrid energy driven system as an attempt to address the worldwide energy concern through a green energy solution. The novelty of this work is on combination of two renewable energy sources, namely solar and wind, which supplement each other under the supervision of IoT-driven controller. Under some scenarios, this small-scale eco-friendly concept has been shown to be suitable not only for rural highway applications, but also for urban or suburban highways. To evaluate the performance and validate the feasibility of the proposed system, we have performed a cost analysis and comparison study with a pure solar-based system. The proposed system has been shown to demand significantly less energy from the solar panel, reducing solar dependency for lighting up the highways. It is anticipated that this type of smart small-scale renewable energy solution for highway lighting can change the perspectives of relevant stakeholders and motivate researchers to develop better optimized versions.

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