Chapter 21
Development of a Solar-Powered Greenhouse Integrated With SMS and Web Notification Systems

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ABSTRACT

Energy for heating and cooling is among the biggest costs in greenhouse crop production. This has led to a rethink on energy-saving strategies, including the demand for solar energy as a viable renewable and sustainable choice for greenhouse farming. This chapter presents the development of a solar-powered system leveraging on internet of things and GSM technologies for sensing, controlling, and maintaining optimal climatic parameters inside a greenhouse. The proposed system is designed to automatically measure and monitor changes in temperature, humidity, soil moisture, and the light intensity. The strategy utilized in the design framework provides the user with the information of the measured parameters online and via SMS regardless of their geographical location. The chapter also incorporates a mechanism to self-regulate the climatic condition inside the greenhouse, suitable for the plant growth. Such a system can help improve the quantity and quality of crops grown in a greenhouse. Tests carried out on the system prove its effectiveness according to the design considerations.

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INTRODUCTION

A greenhouse is a structure covered mainly with transparent materials, such as plastic, glass and fiberglass, in which regulated environmental conditions suitable for plants growth is maintained (Hassanien, Li, & Dong Lin, 2016). The greenhouse industry is one of the fastest-growing sectors in the world (Panwar, Kaushik, & Kothari, 2011). The greenhouse provides a shelter for the crop away from the direct influence of natural weather conditions (Panwar et al., 2011). This allows for crop production in areas with unstable seasons or climatic conditions. The enclosure of the greenhouse allows for regulation of the crop environment to improve cultivation suitable for the plant needs. This leads to higher production, better quality, less use of pesticides and prolonged production (Panwar et al., 2011).

Energy for heating and cooling is among the biggest cost in greenhouse crop production. This has led to a rethink on energy-saving strategies, including the demand for solar energy as a sustainable choice for greenhouse farming (Hassanien et al., 2016). Factors such as increasing global population growth, high energy consumption, unpredictable weather patterns and poor water resource management, and the need to produce sufficient amount of food, is favouring greenhouse as viable means of supporting the agricultural sector (Hassanien et al., 2016; Sadik, 1991).

In South Africa as a case study, there are roughly 2 million smallholder or family unit farmers in contrast with 35 thousand business farmers. A number of these farmers depend predominately on the land to sustain their families with ideally some surplus to sell or exchange. However, the erratic climatic condition often experienced is hurting agriculture, for example, dry spells, floods, heatwaves or heavy winds, harm crops production in no small measure. It also increasingly render lower scale farmers helpless (Scott Ramsay & WWF South Africa, 2019). These extreme climate conditions likewise further disintegrate soils, which decrease the capacity of these zones for animals grazing and lessening harvests yields (Sadik, 1991). Ultimately impacts on food security for millions (Sadik, 1991). The idea of smart farming which includes the greenhouse industry is progressively been used to portray how innovation could be utilised to improve quality crops and increase the quantity of crop production (Nate Dorsey & Precisionag, 2017).

Plants need to be monitored regularly to survive these volatile extreme climatic conditions. Farmers with greenhouse environments are required to always be on-site to monitor plants. However, it is practically a challenge for a greenhouse farmer to be always present to monitor and control the conditions of the greenhouse to guarantee high-quality plants growth. More so, the situation is exacerbated by challenges related to the power supply, especially in developing countries. This paper, therefore, seeks to design and implement a solar-powered greenhouse system that leverages on the Internet of things (IoT) and GSM technologies and that remotely monitors greenhouse climate conditions. This system would replicate favourable climatic conditions inside a greenhouse (temperature, relative humidity, soil moisture and lightning) and provide regular updates about these parameters via the internet using GSM technology. Figure 1 depicts a typical greenhouse, which is auto controlled by sensors in real-time.

RELATED WORK

There are several works on greenhouse systems that have been developed under a broader smart farming or precision agriculture domain, leveraging on technologies such as IoT, cloud computing, sensors