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Intelligent Green House Application Based Remote Monitoring for Precision Agricultural Strategies: A Survey

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ABSTRACT

Intelligent Green House (GH) Application has been deployed to improve the management of agriculture grow and hence monitoring the precision agriculture at various environments. This study attempts to introduce a brief survey on current and previous research area in an easy and compact manner. The objectives of this study are to characterize an overview of current and previous research, identify the clear research gaps. A number of agriculture monitoring systems have been deployed, particularly the growth of remote monitoring and control system of precision agriculture in GH application and services including environment, water distribution, climate condition, gas mitigation, temperature and humidity monitoring. Because of the limited solutions from the previous research, in addition that GH monitoring is not yet capable to manage the agriculture growth on fully control systems. This study explored how an agriculture growing based monitoring in GH has been applied for various environments. It also reviewed the GH characteristics considered in each system to define the research gap. The study gives a predictability of adopting agriculture in GH and possible shortcomings on transition techniques and its associated benefits. Furthermore, the remote monitoring strategies for each evolution technique were over viewed. The result shows an increasing interest in GH application in KSA based remote monitoring, mainly in common trend towards emerging designated GH and utilizing them in precision agricultural strategies.

Key words: Green house, wireless monitoring systems, green house characteristics, precision agricultural

INTRODUCTION

Agriculture is one of the important factors for sustainability and development of an economic growth of a country. In order to have successful agricultural practice it is required to create a balance between different parameters, such as types of seed, nature of soil, amount of water, type of fertilizer and pesticides and most importantly the environmental conditions. Saudi Arabia with its prevailing environmental conditions of agriculture demand is increasing

due to its increasing population along with severe threat on natural resources, requires an exploration and implementation of innovative agricultural technologies (SAMIRAD., 2005; FAO., 2009). The agriculture in the greenhouse is characterized by a high use of energy, Water-use efficiency in crop production and special environments (El-Obeidy, 2008). Sophisticated demands to enhance the productivity of greenhouse cultivation on the quality of the production process requiring precise control of climate, irrigation management, precision agriculture and fertilization. Most of the green

houses technologies in Saudi Arabia are applying the concepts of precision agriculture for high water-distribution accuracy of irrigation plant.

Why green house application: A greenhouse in Kingdom of Saudi Arabia is a building produced from glasses in which plants are grown in advance techniques to increase local production of fruits and vegetables as well as the implementation of current cultivation and irrigation system. The technology builds to enhance agriculture’s impact to the change of income sources and the growth of the production base. A review of existing research in agriculture and water regulate consumption to streamlining operations in the context of independent condition significantly (Al-Zahrani and Baig, 2011). The Division of agriculture in the KSA faces numerous impediments, the most well-known projection are lack of technical experienced, shortage of water, types of soil and marketing problems; pests and diseases and low prices for products (Al-Zeir, 2009; Shalaby *et al.*, 2010).

Related work: In the present era agriculture growth is considered to have a direct influence on the economic growth of any country, as on one hand agriculture provides basis for revenue by production of food and raw materials, while, on the other hand it generates employment opportunities at large scale. So, it can be stated that agricultural growth can be attributed as a major step in transformation of an economy from a conventional to an advanced economy.

The KSA, which covers 80% of the Arabian Peninsula is not considered to be ideal for farming due to its harsh climatic conditions together with barren regions (Royal Embassy of Saudi Arabia-USA., 2010b; Royal Embassy of Saudi Arabia-UK., 2010a). According to royal embassy in the first development plan a considerable attention has been focused on the development of infrastructure for sustainable agriculture in the kingdom (WHO., 2007). Traditionally rural population, which is mostly beduins (nomads), was forced to raise their livestock by practicing small scale agriculture in the rural

areas. However, in order to sustain agricultural growth and to improve living conditions of its inhabitants, in the Kingdom many programs have been initiated during last couple of years (Al-Shayaa *et al.*, 2012). At this stage efforts are being put on one hand to facilitate farmers to exercise sustainable agriculture and on the other hand promoting the concept of preservation of Kingdom’s natural resources.

Agriculture system comprises of a composite interaction between soil, seed, water, fertilizer and pesticides etc. Decline in crop yield can also been observed due to resource degradation that happens, when agricultural resources are exploited unscientifically to overcome the ever increasing demand of a country due to its growing population. Therefore optimization of resource utility is indispensable for sustainability of agriculture, which is only possible with better management and control of agriculture system. In addition, environmental conditions also play a vital role in a viable agriculture system. Also agricultural system is a complex task due to its inherent dependence on spatial and temporal variable parameters. For an example in some areas not even an increase, but decline in the yield of different crops has been observed, which might due to the fact that farmers in those areas still depend on the traditional way of farming (El-Obeidy, 2008). This may be due to use of conventional manual methods of data collections which are prone to irregularities due to erroneous data accusation of desired factors. These irregularities in measurement and data processing techniques directly influence environmental control which affects the crop yield. In Saudi Arabia 97% of water for agriculture comes from ground water reservoirs like fossils, deep aquifers as shown in Fig. 1c. As reported these reservoirs are getting depleted so fast that within 25 years they will not be available any more. For instance, since 1992 till 2006 the water withdrawal rate has increased by 40% of which 88 percent is used only for agriculture (Fig. 1a) and most (>90%) of this water is extracted from ground water resources (Fig. 1b) (AQUASTAT Survey, 2008). In addition to climatic conditions, it is reported that agricultural productivity is a

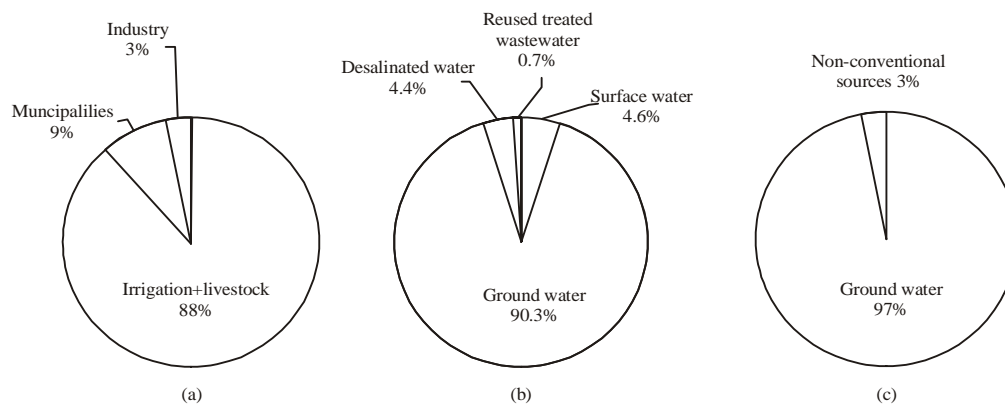


Fig. 1(a-c): Water withdrawal by (a) Sector (b) By source over total of 23666 km³ in 2006 and (c) Main source of irrigation water in 2000 (AQUASTAT Survey, 2008)

function of spatial degradation and temporal changes, which makes it a complex integrated system (Shah and Das, 2012). This calls for best possible use of the resources for managing and controlling agricultural system.

Emerging technologies during the last few years has added new level of sophistication to deal with the agriculture related issues and Challenges (Oxford Business Group, 2010). Precision agriculture is one of such revolutionary change, which is a new approach to increase the crop yield by managing resources in an appropriate way. The key to its success is real time data accusation of environment related field parameters like soil condition, water level, need for fertilizer and environmental parameters like humidity, temperature (Chavan and Karande, 2014). It is a system that can provide means for sustainable agriculture especially for the environments, which are not very hostile for agriculture.

In conventional approach measurements of agriculture’s environmental factors are done by individuals taking data manually at various times. On the other hand recent developments in automation and data logging techniques allow reduction of data lost and makes it possible unmanned data accusation from critical hazardous situations. These automated systems ensure fast response times, which ensure better quality control with additive advantage of reduction in labor cost (Luiz *et al.*, 2011). Along with this recent development in smart sensors and means to communicate between them to from a distributed network and concepts of remote sensing makes it possible to measure different parameters of interest remotely and in real time (Kim *et al.*, 2008; Haefke *et al.*, 2011). Therefore, latest findings of science and technology should be used in the field of agriculture in order to increase productivity, high yield and growth. Together with this, there is a need for a smart system, which ensures the security and full control on farming parameters in the field without the need of personal presence.

In Saudi Arabia irrigation techniques are used in agricultural sector, which can be divided into 3 main schemes large, medium and small scale based on the farm land areas as shown in Fig. 2b. Usually large scale farms are owned by governmental or private companies where as medium size farms are the property of private farms and small farms were existed prior to the agricultural development boom in 1970’s (AQUASTAT Survey, 2008).

Motivation and contributions: The aim of this study is to increase the productivity of greenhouse cultivation by applying the concepts of precision agriculture. Secondly engage urban community with agricultural activities while not disturbing their urban life especially greenhouse cultivation and small scale farming. So, in order to attract this community with the concept of precision agriculture it is necessary to develop a system, with which, urban farmer can monitor and control the different parameters of the precision agriculture system, while staying in their offices. It will also enable to make sure an efficient use of the resources of the Kingdom. For example, real time soil temperature and humidity data acquisition can guide on the amount of needed water in the future, thus, such an in time management of resources can improve the crop yield. The proposed system will make use of either smart phone application or internet to control different parameters remotely (Aziz *et al.*, 2010). This will engage the urban community with agriculture due to ease in handling their farm lands and it will also improve the productivity of the greenhouse by proper wireless, manual or automatic control (Mendez *et al.*, 2011). On the other hand data logging of these parameters over time and crop type will help to create a national level data bank for scientific research in different field of agriculture, like effect of environmental parameters on the crop yield, water management, fertilizer requirement and effect of seasons, etc. Lastly, the secondary objectives include human resource development and increasing the awareness regarding concepts of precision agriculture and its usage in greenhouse to local farmers and agriculture industry. It will also give an opportunity for graduating engineers and research associates from different fields to come along to solve problems in the field of agriculture (Alkolibi, 2002). Such engineers are greatly in demand in the agriculture industry. This project is an interdisciplinary venture between electrical, electronics, mechanical and agriculture departments and will keep the faculty in touch with problems faced by agriculture industry especially related to green house cultivation techniques.

Research gap: The existing study provided important perceptions into the applicability of agriculture grow monitoring methods to investigate the environmental condition

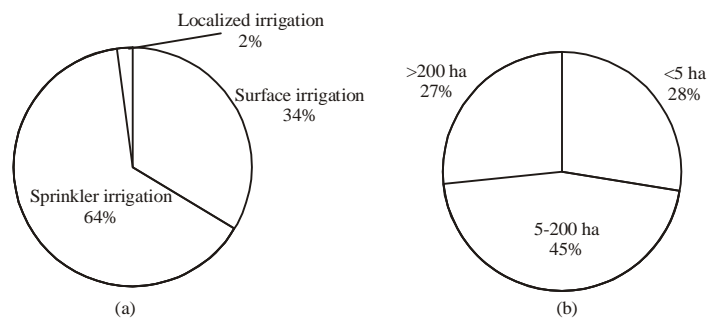


Fig. 2(a-b): (a) Irrigation techniques in 1992 and (b) Type of irrigation schemes (AQUASTAT Survey, 2008)

Table 1: Research limitation and probability of extension work

Limitation	Probability of work extension	Author
This study focused more on fundamental development of infrastructure for sustainable agriculture in the kingdom, which was forced to raise their livestock by practicing small scale agriculture in the rural areas.	Need extensive data collection produced by greenhouse application and the analysis will produce better prediction of agriculture production.	World Health Organization WHO. (2007)
This research has identified smart sensing platform using Zigbee based monitoring system for agricultural environmental parameters.	Since the case is critical, it may need to characterize the environmental impairment in the study area and the perfect design of greenhouse application.	Kim <i>et al.</i> (2008)
This exploration manage the best harmony between agrarian creation and the utilization of its assets, especially water without hurting nature needs to be kept up. As well, an abnormal state of arranging was given to bolster continuous applications and keep the framework fulfilled.	Need essential study for the environmental conditions that has become more challenging by considering the production quality factors.	Al-Shayaa <i>et al.</i> (2012)
This study reviewed most commonly used environmental monitoring platform using Zigbee based smart sensing technique, which incorporates to site specific in short range to predict the environmental problem in the greenhouse.	This study need to be generalized to apply in all agricultural products and validate the data in different greenhouse.	Haefke <i>et al.</i> (2011)
This study identified the key restricted of the color of images using Computational Methods on the data obtained by remote sensing.	The design of this system need to be considered the topographical and the environmental impairment as well.	Luiz <i>et al.</i> (2011)
This study presents Zigbee based wireless system to monitor Soil Moisture, Humidity and Temperature by considering the environmental impairment without full control over the water target.	Many users recommended this software but need to update the database for future revenues.	Chavan and Karande (2014)

and its affect in greenhouse locations (Al-Subaiee *et al.*, 2005). However, in spite of these increasing efforts and contribution, but still lack of new technology to fully control the agriculture environments process to make sensors and development of automatic monitoring GH building infrastructure. Table 1, addressed a systematic mapping on limitation of previous study and shows the probability of work extension for each contribution. Several strategies to further improvement technologies in agriculture grow monitoring were identified (Al-Hamzi, 1997). Moreover, counting the ability of agricultural growing observation in GH to sequester productivity of green agriculture crops are critical and need to enhance the productivity as means for moderating green house adoption for trading technology. This proposed technology has significant investments (private and public) in agriculture and diversify sources of national economy in Kingdom of Saudi Arabia. This proposed project is a blend of many strategic directions provided by KASCST, KSA, such as, irrigation scheduling technologies and Water-use efficiency techniques in crop production hydroponic techniques, production increase by enhancement of greenhouse technologies and best agricultural management practices to control the environment of precision agriculture technology. The proposed solution for the research gap is to design and implement a wireless control system via PLC/microprocessor to control different actuators for precision agriculture. Integrating supervisory software also proposed to manage sensed data of any agricultural practice in most climates and administrate the control unit using smart phone/internet user friendly environment to provide specific comparative values according to the detection and diagnosis.

Proposed solution: This system will be capable of data logging and processing for future management of resources. In

the second phase of the project productivity of a selected equipped green house will be compared over time with non-equipped green house for group of selected crops to create a database of crop productivity and effect of control variables to improve the PA application to green house crops in Saudi Arabia. The third phase comprises of providing training and public awareness of local farmers and community in the Qassim region about the PA technology and the use of remote monitoring and control to improve their agricultural products and enhance their livelihood.

The project will cater the range of low to high level of farmer’s income in the Kingdom by implementing PA techniques in a green house environment to enhance the productivity of green houses by remote monitoring and control at affordable price. The secondary objective of this study is to build up a system that can engage the urban community with the field of green house cultivation/agriculture with minimum effort as second profession or hobby. So, in conjunction with ongoing research in the field of greenhouse productivity measures and development of measurement and processing techniques, the first phase of the project will deal with remote monitoring of environmental parameters by using distributed sensors network either by using Global System for Mobile (GSM) SMS-based system or Zig-Bee based communication technique and a development of adaptive control system (Haefke *et al.*, 2011). This proposed system will also control irrigation system, pest control, nutrition control etc., with the use of wireless PLC/microcontroller based system.

As a part of the strategy, taking measurements and controlling parameters and managing a data base is one part and creating awareness through trainings and workshops is the other part. A two-pronged strategy is needed to achieve this objective. The technology transition strategy is shown in Fig. 3.

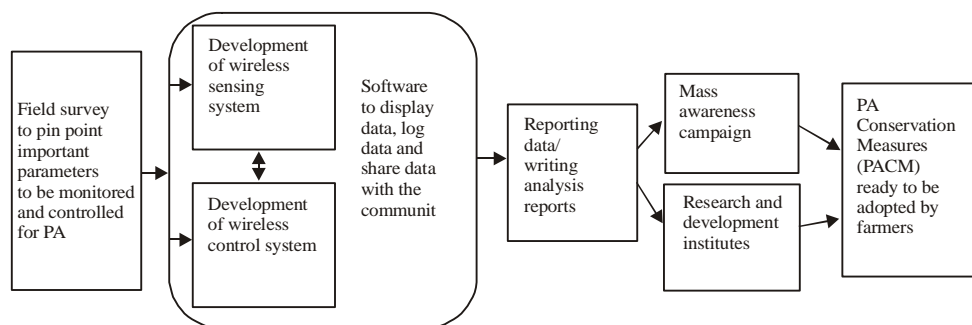


Fig. 3: Proposed framework

CONCLUSION

A total of 22 research projects were identified that met the enclosure criteria related to the proposed project. The detailed information was identified and enabling their full inclusion to define the gap analysis according to their limitation and the probability of work extension. This project is an interdisciplinary venture between electrical, electronics, mechanical and agriculture departments and will keep the faculty in touch with problems faced by agriculture industry especially related to green house cultivation techniques. According to the research gap there are a many factors and situations, which can affect agriculture and its outcomes and these are represented on the proposed framework. Building these factors into the process showed in the framework would simplify the interventions that improved nutrition, but this is not to downgrade the importance of research done in these areas.

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