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Increasing Productivity in Agriculture Through Integrated Smart Architecture of Irrigation Systems with LORA Technology

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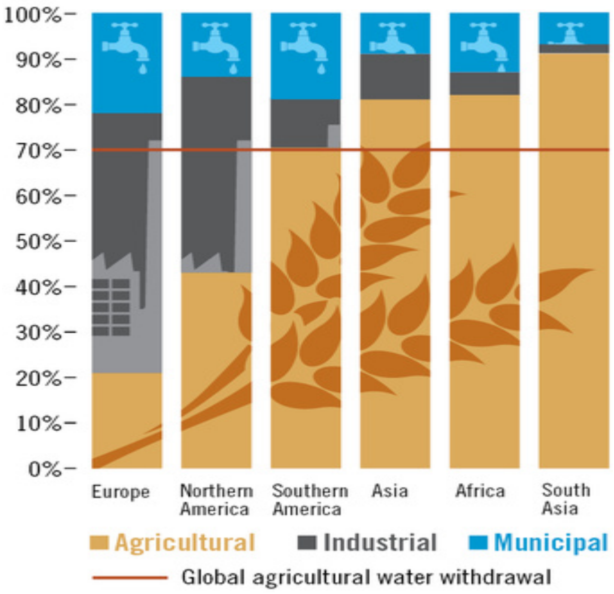
Recently, remote monitoring systems have been evolving to respond to the needs in the agriculture sector, which is an essential pillar in the modern concept of a smart community. We propose a smart system to monitor plants' current activities and conditions, as a smart agriculture system based on the widely spreading available technologies, namely, LoRa and Laravel. Statistics show that the database system performance for big data are risk factors for high data rates to decrease. Preventive measures should be applied to provide a real-time agriculture monitoring system, to save plants' life productivity at an acceptable time. The overall aim of this research is to provide an effective model system that will track, trace, and monitor temperature, pH and humidity readings in order to provide efficient agriculture services in time for IGH PoliPD (Intelligent Green House PoliPD). In this paper, we focus on the auto irrigation system in contribution to save water and reduce workers. By using sensors, the data will be captured and compared with a predefined threshold. This paper demonstrates the possibility of building a complete end-to-end smart agriculture monitoring system by using wide ranges of available sensors for more vital plant parameters to connect activities with farmer. The results of real-world farming measurement shows significant reduction in the use of man power and water usage which contribute to increased productivity.

Key words: *Automation in agriculture, LoRA technology, auto irrigation.*

Introduction

Agriculture is by far the largest consumer of the Earth's available freshwater: 70% of "blue water" withdrawals from watercourses and groundwater are for agricultural usage, which is three times more than 50 years ago. By 2050, the global water demand of agriculture is estimated to increase by a further 19% due to the irrigational needs. Approximately 40% of the world's food is currently being cultivated in the artificial irrigated areas, especially in the densely populated regions of South East Asia. The main factor for the increasement yields was the huge investments in additional irrigation systems between the 1960s and 1980s (Aquastat, 2016). It is disputed whether further expansion of irrigation as well as additional water withdrawals from rivers and groundwater will be possible in the future, how this can take place, and whether it makes sense. Agriculture already competes with peoples' everyday use and environmental needs, particularly in the areas where irrigation is essential, thus threatening to literally dry up the ecosystems. In addition, in the coming years, climate change will bring about enormous and partly unpredictable changes in the availability of water. Figure 1 show the water demand in the agriculture sector in the world.

Figure 1. Competition for a scarce resource, Aquastat (2016)



Due to this, embedded to the technology of Wireless Sensor Network and LoRA technology were used in this research to overcome this problem. WSN is one of the most rapidly evolving R&D fields in microelectronics. Their application and marketing potentials are increasing day by day. According to Frost & Sullivan, the expected market size will be approximately US$ 2 Billion by 2012 at a compound annual growth of 4.19%. (Jiber et al., 2011). WSN has been deployed for a broad variety of application and has increased to be implemented in technology for the agricultural atmosphere. WSN can reduce effort and time required for monitoring a particular environment.

Management of farms or greenhouses is a hard work for the farmers. The farmer that owns a large farm does not have enough time and is too busy to monitor each plant's status and health. This means that the farmer is manually monitoring and controlling the plants. Using the labor force for the whole farm is a difficult job and will cost the farmer large amounts of money to hire labors.

In addition, the manual or traditional irrigation system will cause wastage of water resources. Most of the farmers are contributed to the lack of monitoring and manual irrigation system at farm level (Rosegrant, et.al.2009). This type of irrigation is normally based on the time scheduled without considering the needs of the plant towards water and the status of the soil moisture. Furthermore, when it comes to the rainy season, the soil is already wet, and this system will also water the plants as scheduled (Kalaivani,2011; Rahman & Castelli 2013). This type of irrigation and fertilization will not only waste water and cost but also will create worst effect to the plant growth.

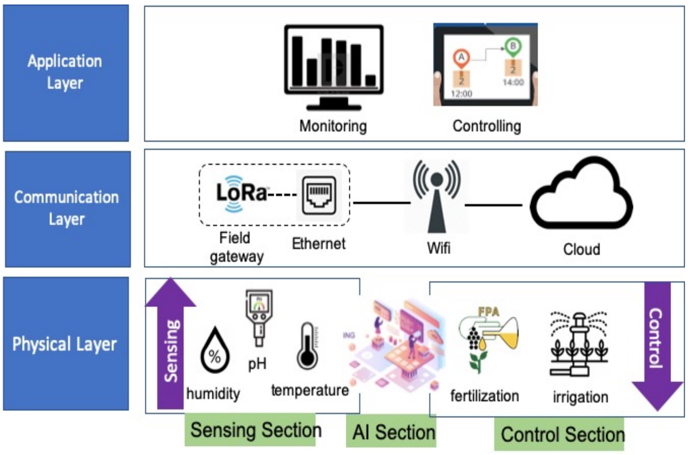
Manual monitoring and management of the farm can create many problems during the rainy season such as irrigation and fertilization and shortage of labor. Farmers will have sleepless nights because they must go to the farm at night and monitor their plants which is tiring work. The difficulties in measuring and monitoring the water usage and inefficient irrigation systems due to human control are the main factors in this situation.

In accordance with this information, this research designed and developed an automated IGH that consists of the main part which are irrigation, fertilization and aquaponic system known as IGH PoliPD with real time remote monitoring and control system to the crops in the farm. The architecture of this propose system consists of the embedded LoRA Technology on the WSN platform and sensor technology. This paper will present the overall architecture system and the result of man power and water saving after 6 months of the real-world field test.

Methodology

The IoT technology provides a more efficient approach to manage irrigation. Figure 2 illustrates the proposed IGH PoliPD System Model that encapsulates 3 layer which are the physical layer, communication layer and application layer. The physical layer includes the sensing section, AI section and control section. In the sensing section, the main objective is to produce valuable data sensing field variables and all of these data will be sent to the communication layer through the LoRa gateway. The control section and AI section receive information from the communication layer. The AI section is controlled by the programming code to give out information to the control section so that further actions can be done. As an example, when the humidity data is received by the AI section, the control program will adjust the action to be taken that will be performed by the control section. Another example would be activating the sprinkler to ensure the soil humidity is as needed according to the type of crop. In the communication layer, all the collected data from physical layer will be sent to the cloud storage through Wi-Fi. Finally, the application layer will display the data and allow the user to handle, control and predict activity.

Figure 2. Proposed Architecture of IGH PoliPD System Model

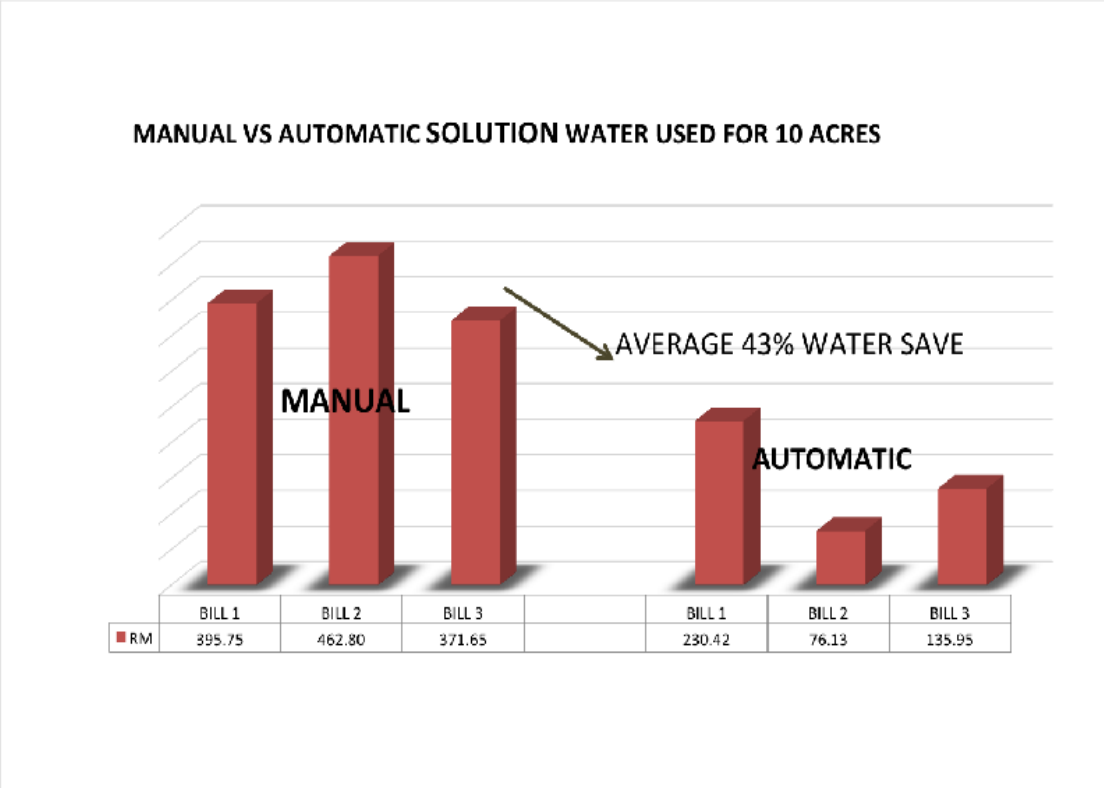


The proposed IGH PoliPD system model will provide an effective irrigation system. The soil condition can be monitored in real time through sensors and LoRa network. With enough sensor data, the system can assist in analysing the current irrigation situation and make appropriate decisions on when and where to release water as well as how much water should be used. This would help to control the amount usage of water and affect the operating cost. It is important to note that different types of crops require different soil moisture, temperature, and humidity condition. Therefore, with support from the AI, this system will set the value according to crops condition, monitor the motor pump and sprinkler and also keep the land condition in track.

Result and Discussion

The developed WSN in farms consist of wireless sensor node throughout the farm. Each sensor node integrates with the LoRA components and sensor to read the parameter of the soil. The sensor node will collect environmental parameters of the soil moisture, fertilizer level and ph value at each farm. The data collected by each individual sensor node will be sent wirelessly to the web-based monitoring system at the base station through the LoRA network. The gateways and nodes work together to form a mesh network. The gateway maintains a list of nodes (by serial number) that have been authorized for network access. This part highlights the results of recent analysis on the IGH PoliPD performance which includes the platforms for hardware, network and software as embedded in smart architecture for automation in agriculture. Figure 3 shows the result of data collection result of water saving when the IGH Poli PD was implemented in a 10 acre farm.

Figure 3. Result



The result of thediscussion is based on the analysis of measurement and evaluation conducted in real environment. The capabilities and reliability of the systems regardless of the sensors or IGH PoliPD system are very dependent on the architectural design of all integrated and embedded system components. This shows that the embedded architecture designs between hardware are practical and fulfil the required applications as suggested. It also shows that the embedded design does offer more advantages in the proposed systems when using the WSN and monitoring and using the control system application. Figure 4 shows the result of 80% reduce in labor cost and 50% productivity obtained after 6 months of pilot test in 10 acred Rossel farm.

Figure 4. Result

Conclusion

The capabilities and reliability of the systems, regardless of the sensor nodes or complete solution of IGH PoliPD, are very dependent on the architectural design of all integrated and intelligent integrated system components. This shows that the integrated architecture designs between hardware are practical and fulfil the required applications as suggested. It also shows that the integrated system design does offer more advantages in the proposed systems when using the LoRA network application.

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