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IoT-Based Framework for Smart Agriculture

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ABSTRACT

Agriculture plays an important role in the making and development of a country. In India, agriculture is the primary source of living for more than about 60% of its population. The agriculture-related issues always hinder the development of a country. The enhancement of traditional agriculture methods and its modernization towards smart agriculture is the only solution for agriculture problems. Hence, by considering this issue, a framework is presented for smart agriculture using sensor network and IoT. The key features of this system are the deployment of smart sensors for the collection of data, cloud-based analysis, and decision based on monitoring for spraying and weeding. The smart farming approach provides valuable collection of data, high precision control, and automated monitoring approach. The proposed system presents smart agriculture monitoring system that collects and monitors the soil moisture, environmental temperature, and humidity. The measured soil moisture, temperature, and humidity are stored in ThingSpeak cloud for analysis.

KEYWORDS

Internet of Things (IoT), Precision Agriculture, Productivity, ThingSpeak Cloud Platform, Wireless Sensor Networks (WSNs)

1. INTRODUCTION

Precision agriculture is a method in which farmers optimize inputs such as water and fertilizer for the enhancement of productivity, quality and yield (Srbinovska et al., 2015). The term precision agriculture also encourages for minimizing pests and diseases through specially target application of precise amount of pesticides. Smart agriculture or precision agriculture is an integrated farm management framework which constitutes a holistic management approach aiming to optimize the yield per unit of farming land. Increasing the quantity and quality of agricultural products while utilizing less inputs such as fertilizers, water, pesticides, energy, etc., results in cost reduction with positive environmental impact (Mekala and Viswanathan, 2017). Therefore, rather than applying the same amount of fertilizers over the entire agricultural field or applying fertilizers to specially target area helps in overall cost reduction. The smart agriculture solution measures the variation in field conditions and adapts the fertilization or feed strategy accordingly (TongKe, 2013). Farmers as the principal stakeholders usually make complex decisions without proper information and execute the

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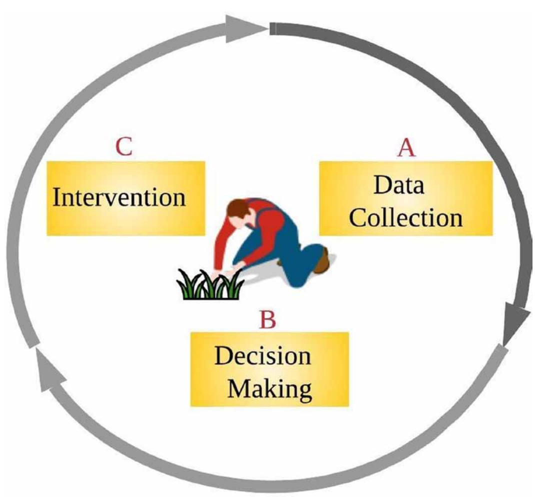
demanding field operations. Therefore, smart agriculture solutions are best designed considering farmers at the center of the process. The solutions of smart agriculture complements and transforms the skills and experiences gained naturally through the generations (Chhetri et al., 2017). The smart solution can complement the farmer's capabilities in three main processes. The three sub-processes are presented in Figure 1. The sub-processes are data collection, decision making, and intervention. The data collection is a part where remote sensing and sensor networks are utilized. In the decision making part, expert systems and machine learning can be exploited. The third part is an intervention where intelligent machinery and robotic agents can be utilized for field operations. The complete typical process cycle includes data collection for measuring such as soil moisture, temperature, PH, humidity, or multi-spectral images. The data collection process is followed by the data analysis which produces a description for the pesticides, irrigation, fertilizers, and harvest. The last component of the process is an automated intervention which executes the description maps on the field area using variable rate technology machinery. This cycle can monitors the possible areas of concern like soil, vegetation, or the environment. In addition to this farmer, related sub-processes smart agriculture can be designed to provide extra benefits. The benefits for external functions such as soil and environment monitoring, traceability of food, and specific bookkeeping facilitating national planning (Mekala and Viswanathan, 2017). The recent survey presents the decreasing level of waters and drying up of major water resources such as rivers and tanks, presents efficient utilization of water resources (Veena et al., 2018). The technological evolution of WSNs and IoT made it possible to monitor the environment and agricultural fields for gaining the production (Khanna and Kaur, 2019).

These technologies are in different levels of maturity and adoption across all over the world. Therefore, more than often technology introduction to different communities needs to be planned and driven by the relevant authorities. The blind technology or solutions should account for the wide diversity of agriculture for the following characteristics particularly farm size, farming types, farming practices, level of yield, and employment (Patil and Kale, 2016). These are the major challenges in the technology of smart agriculture. The technology and their solutions should be customized and adapted accordingly. In general, the factors that affect technology adoption in agriculture are yield gap, farm size, and the learning required for the integration of new technologies with the existing practices (Elijah el al., 2018). On the other hand, smart agriculture solutions affect farming economics through multiple channels. Hence solution design should evaluate farming economics in different levels of analysis. The smart agriculture solution can reduce operational costs by optimizing the user inputs.

Figure 1. Sub-processes of Smart Agriculture



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