TECHNOLOGY ARCHITECTURE

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Abstract

Smart Farming is a development that emphasizes on the use of modern technologies in the cyber-physical field management cycle. Technologies such as the Internet of Things (IoT) and Cloud Computing have accelerated the digital transformation of the conventional agricultural practices promising increased production rate and product quality. The adoption of smart farming though is hampered because of the lack of models providing guidance to practitioners regarding the necessary components that constitute IoT based monitoring systems. To guide the process of designing and implementing Smart farming monitoring systems , in this paper we propose a generic reference architecture model, taking also into consideration a very important non-functional requirement, the energy consumption restriction. Moreover, we present and discuss the technologies that incorporate the four layers of the architecture model that are the Sensor Layer, the Network Layer, the Service Layer and the Application Layer. A discussion is also conducted upon the challenges that smart farming monitoring systems face.

I. INTRODUCTION

Nowadays, the digital transformation of the agricultural sector is considered a priority in order to face the numerous challenges presented in the fields. Environmental monitoring and remote controlling in agriculture is rapidly growing to-wards developing more productive and competitive agricultural systems and tools. Precision Agriculture and Smart Farming can lead to this direction. These two terms refer to the integration of advanced technologies into existing agricultural practices so as to achieve fine-grid crops management. Smart farming systems can provide to farmers meaningful real- time environmental data from the cultivation fields aiming to boost competitiveness and profit. Almost every aspect of the agricultural field can benefit from these kind of technological advances ranging from planting and irrigation processes to plant protection and harvesting methods. Most of the current and forthcoming agricultural technologies under Precision Agriculture fall into the following three categories that are expected to become the pillars in each Smart Farm:

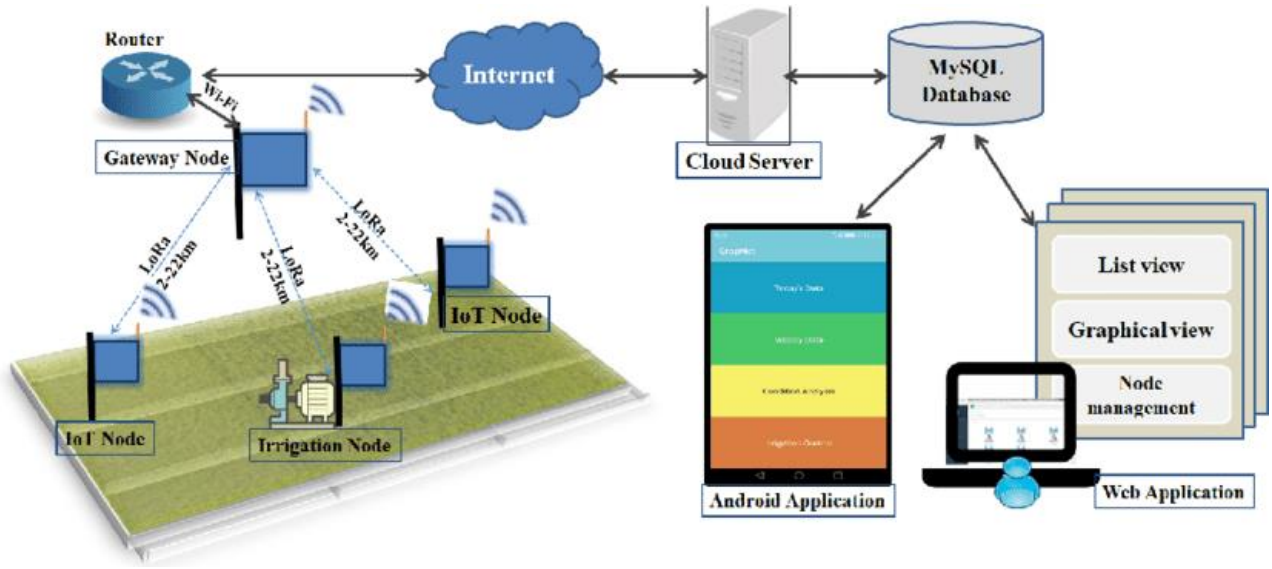
•The Internet of Things (IoT) is a large communication network involving a vast number of distributed devices around the network, so as to recognize and notify users instantly about real-time events. These devices, having basic computational skills, are called smart objects. Smart objects are characterized by a unique identifier, i.e., a name tag for device description and an address for communication. In most cases IoT devices have constrained resources in terms of power, processing, memory and bandwidth

•The Unmanned Aerial Vehicles (UAV) are flying vehicles that do not have a pilot on their spindle, but make flights either autonomously or by means of remote control. Unmanned aircrafts that can be used for remote sensing are part of Unmanned Aerial Systems (UASs), which include all necessary devices and procedures to operate an UAV, while managing the kind of data it collects.

•Sensors are measuring devices that convert an external stimulus, input signal, into an appropriately measurable output signal. A sensor is a device that will convert a macroscopic size (light, power, pressure, etc.) to an electrically measurable size, and

then, after processing this electrical signal, it will convert it into a standardized signal with certain characteristics. Exposure to a particular analyzer or change in environmental conditions alters one or more of the sensor properties in a measurable manner, either directly or indirectly.

The adoption of smart farming though is hampered because of the lack of models providing guidance to practitioners regarding the necessary components that constitute IoT based monitoring systems. The contribution of this paper lies upon the presentation of a simple reference architecture model for a smart farming monitoring system. This architecture model engages novel IoT technologies [1] and Wirelesse Sensor Networks (WSNs) capabilities so as to provide a sufficient view of precision agriculture. What is more, the proposed architecture enables a combination of modern remote sensing techniques such as UAV tracking, Global Positioning System (GPS) for location detection, Geographic Information Systems (GIS), real-time monitoring with different types of sensors and intelligent input control systems. These technologies have already been tested in various agricultural fields in different countries for the cultivation of rice, wheat, tomatoes, vegetables, potatoes, ornamental flowers, chilly, cacao, pepper, corn, olives, apples, lemons, grape and others. By incorporating new technologies into agricultural production growers will be able to manage their crops at a different and more advanced kind of level in detail that was not possible a few years ago.The rest of the paper is organized as follows. In Section II, the proposed smart farming monitoring system architecture is introduced. In Section III, the sensor layer is presented, followed by the network layer and its suitable protocols and technologies in Section IV. Section V refers to the provided services of the proposed monitoring system, while Section VI focuses on IoT agricultural applications. Section VII presents energy saving technologies that be implemented in cooperation with networking technologies of the system. Existing challenges are mentioned and discussed in Section VIII. Finally, Section XI concludes this study.



- IBM cloud Server (for using storage).
- IOT device (for using node MCU, sensors to monitor the plants).
- Mobile application (Control the IOT device).
- IBM Watson IOT Platform (connect the mobile application & IOT device).
- Red Node
- MIT App Inverter (for using block code to develop application).