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IoT-based Precision Agriculture Platform: A Review

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Abstract: Technological advancements such as the Internet of Things (IoT) and Artificial Intelligence (AI) are helping to boost the global agricultural sector as it is expected to grow by around seventy percent in the next two decades. There are sensor-based systems in place to keep track of the plants and the surrounding environment. This technology allows farmers to watch and control farm operations from afar, but it has a few limitations. For farmers, these technologies are prohibitively expensive and demand a high level of technological competence. Besides, Climate change has a significant impact on crops because increased temperatures and changes in precipitation patterns increase the likelihood of disease outbreaks, resulting in crop losses and potentially irreversible plant destruction. Because of recent advancements in IoT and Cloud Computing, new applications built on highly innovative and scalable service platforms are now being developed. The use of Internet of Things (IoT) solutions has enormous promise for improving the quality and safety of agricultural products. Precision farming's telemonitoring system relies heavily on Internet of Things (IoT) platforms; therefore, this article quickly reviews the most common IoT platforms used in precision agriculture, highlighting both their key benefits and drawbacks.

I. INTRODUCTION

When it comes to the Internet of Things, it's characterized as an integral aspect of the future Internet, which ensures that "things" with identities can communicate with each other, according to the Cluster of European Research Projects report. Many various applications of the Internet of Things (IoT) will be developed in the future, such as smart cities and agriculture as well as energy and environmental protection. In addition to targeting conventional, large farms, IoT-based smart farming applications could be used as new levers to boost other growing or common trends in agriculture, such as organic farming and family farming (complex or small spaces, particular cattle and/or cultures, preservation of particular or high-quality varieties, etc.). They could also be used to improve highly transparent farming. To achieve precision agriculture, sensors, control systems, robotics, autonomous vehicles (AVs), automated hardware and variable rate technologies are all essential components. Wireless sensor networks can be used in precision agriculture, agricultural production process management, greenhouse monitoring, plant growth optimization, farmland monitoring, and crop protection to deter animal invasions, among other applications. Aerial photography technologies such as drones have enabled farmers to receive richer sensor data from their fields in the recent past because of their emergence. Drones can assist farmers in mapping their fields, monitoring crop canopy remotely, and checking for anomalies, according to the National Agriculture Statistics Service. It is possible that over time, all of this information can be used to identify good farming techniques and provide suggestions based on previous crop cycles, leading to higher yields, reduced inputs, and less environmental impact.

Using Thingsboard, Cadavid et al. present an extension for device administration, telemetry data collection, processing and visualization. A cloud-based Smart Farming platform with sensing devices, decision support systems, and remote-controlled actuators and devices, such as drones, is the goal of the writers. Farm, Land Lot, and Crop are included as enhancements to the baseline data model. MongoDB, GridFS, and REDIS are also included as complementary database engines. As a result, a third-party platform can be interacted with via an API. The proposed architecture was evaluated by simulating the detection of Phytophthora infestans fungus as a potato problem. Twenty-five sensors in five different crops were simulated using the Smith Period prediction model and 25 sensors in five different crops were employed.

Using low-cost, long-range technology (TVWS), the authors offer a low-cost IoT architecture for agriculture that supports high bandwidth sensors. Soil sensors, drones and machine learning algorithms work together in the Farm Beats platform to gather data about specific farms that can then be analyzed. Farmbeats system is made up of the following components: sensor/drone system, solar-powered, weather-aware IoT Base Station and IoT Gateway, and a cloud component. The FarmBeats system has the advantage of implementing a web service while still allowing for offline operation. Deploying innovative summarizing tools for sensor data and drone films are also made possible by accessing data acquired from several types of sensors.

IoT-enabled Smart Agriculture Private Platform [15] has been developed. Telemetry, intelligent systems, wireless communications, and cloud computing should all be part of the solution that's being presented. Sensor nodes should be able to be added, removed, identified, and modified on the platform. Aside from that, it should be able to collect and calibrate raw data, as well. Communication protocols and APIs make it easy to acquire and import data.

II. FUNDAMENTAL ASPECTS

A. IoT Infrastructure

IoT infrastructure consists of sensors, a microcontroller and communication devices, among other things. This layer's primary function is to collect data from sensors and send it to the server. LM393, DHT11, etc. sensors are utilized to monitor the soil characteristics in this study. This data streaming architecture is comprised of NodeMCU and associated devices for each node that has WiFi capability to connect with them. These nodes are chosen because of their increased scalability and ease of setup.

B. Data Processing

Here, data from different nodes and users are saved centrally. A database is used to store the sensor and processed data in this layer, which is composed of the sensor data and processed data. This database will be used by the frontend layer to populate the dashboard. When the Processing Layer does batch processing in order to give predictive analytics, this data will be employed. Two principal services will be in charge of data processing in this case.

C. Data Streaming

Unreliable data gathering networks are necessary for real-time analytics to be performed in real-time. The streaming platform is used to achieve the above requirements. Software for stream-processing that is available under the GNU General Public License (GPL). Higher throughput, reliability, and replication qualities are its main advantages. Nodes send data to this layer, which is responsible for collecting it.

The introduction of the Messaging protocol and a connector allows the streaming layer to be significantly more scalable. In contrast to HTTP, Messaging protocol is data-centric. As a request-response protocol for client-server computing, HTTP isn't necessarily well suited to use on smartphones and other mobile devices. Messaging protocol's lightweight and publish/subscribe paradigm, which makes it ideal for resource-constrained devices and helps save power, are two of its biggest advantages.

D. Business Logic and Data Query

An application programming interface would be used to query the databases and Kubernetes clusters for efficiency & optimal load balancing would be used in case of scaling. Services/APIs are used to provide real-time data to the Frontend, which is then accessible to the end-user through the Business Logic layer. Also, this layer would handle the user's authentication and registration on the platform, as well as managing your site nodes and adding or deleting a site. To arrange and manage efficiently microservices, the application of orchestration services is made.

E. Frontend

To monitor the site's stats conveniently, the frontend layer includes a web and mobile application. As well as receiving frequent reports about the sites, both applications allow users to download documents. Authentication and other functions are handled by an API gateway. Clients and backend services use it as an API administration tool to manage API requests. The reverse proxy gateway accepts all API calls, aggregates the numerous services required to fulfil them, and returns appropriate results. Exposing APIs and deploying them via API gateways is a smart practice. Users authentication, rate limitation, and analytics are just a few of the common duties handled by API gateways.

III. LITERATURE REVIEW

Thingsboard, a scalable platform for managing devices and collecting, analyzing, and displaying telemetry data, is proposed by Cadavid et al. [12]. A smart Farming platform that is cloud-based and incorporates sensing devices, decision support systems, and remotely controlled actuators and devices like drones is being developed by the authors as part of a MaaS (Monitoring as a Service) initiative. The work contributes to the default data model by adding concepts like Farm, Land Lot, and Crop as extensions. Additionally, it incorporates third-party database engines like MongoDB, GridFS, and REDIS into its architecture. Additionally, an API is provided to facilitate interaction with third-party services. To validate the design, a computer simulation was used to simulate the detection of the potato pest, Phytophthora infestans. The Smith Period prediction model was utilized, and simulations were run on 25 sensors spread over five different crops [15].

Vashisht et al. studied a low-cost IoT platform for agriculture that makes use of TVWS to connect high-bandwidth sensors (low-cost, long-range technology). To collect and analyze data on specific farms, the Farm- Beats platform uses low-cost sensors in soil and drones, as well as machine learning algorithms and farmer experience (information regarding when, where and what to plant in order to obtain cost reductions and higher yields).

There are several components to the FarmBeats system, including sensors and drones, and IoT Base Station that is weather-sensitive and solar-powered, and an IoT Gateway that provides both Cloud and offline service availability. For the FarmBeats system, the advantage is that the gateway implements a web service while still allowing for offline use. Additionally, having access to sensor data allows for the development of new summarization algorithms for sensor data as well as drone video [16].

Popovic et al. developed a smart agriculture IoT platform using a private IoT platform. There should be a combination of telemetry, intelligent systems, wireless communications, and cloud computing in the proposed approach. A sensor node management platform should allow for the addition, removal, identification, and modification of sensor nodes as needed. Raw data should be able to be collected and calibrated as well. Communication protocols and APIs make it easy to acquire and import data [17].

Citrus soil humidity and nutrients will be monitored via a method developed by Zhang et al. The proposed solution's other purpose is to reduce pollution from chemical fertilizers and the accompanying costs of physical labour. Farmers will be guided in adapting the fertigation system by a decision support system. The IoT Platform (Figure 1) is divided into four sections: the perception layer, the network layer, the middleware layer, and the application layer. As an example of a perception layer device, consider a portable nutraceutical soil nucleic acid detector, which includes soil and humidity sensors. The short-range transmission component of the Network layer is represented by a ZigBee protocol-based wireless sensor network. To connect to the public network and convert protocols, an Internet of Things Gateway is used as the brain of a wireless sensor network. The Middleware layer manages services, stores data, and makes decisions, while the Application layer includes a sensor network management system, an analysis and querying system based on WEB-GIS, and a fertigation decision support system [18].

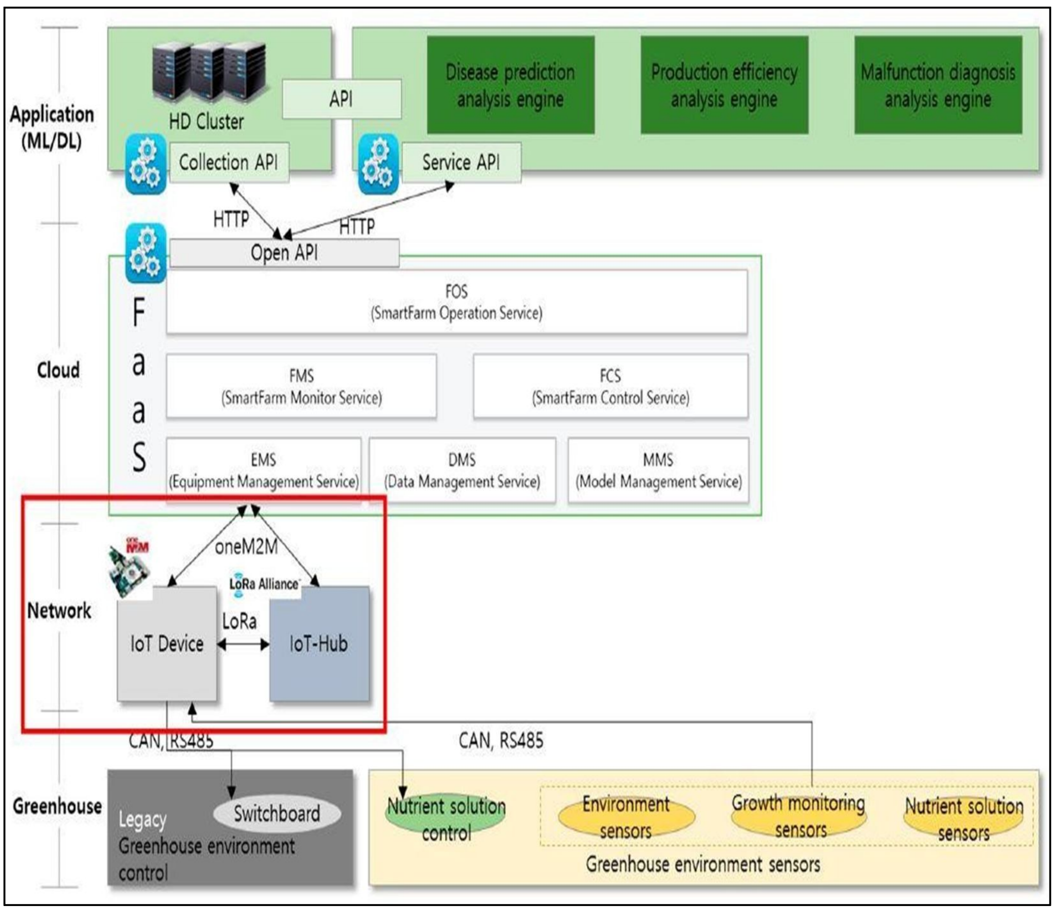

Figure 1 Zhang et al. precision's agricultural platform

The platform developed by Ferrández-Pastor et al. is based on a 5-layer design shown in Figure 2 and is intended for irrigation control. Fog and Thing layers will be discussed in detail among these five levels. Sensors for soil, relative humidity, electrical conductivity and pH are all included in the Thing layer for greenhouse monitoring. Sensors are also included in the Thing layer for monitoring the environment outside the greenhouse. The Thing layer also includes sensors for water temperature and electrical conductivity and pH. The system also contains water valves and pumps [19].

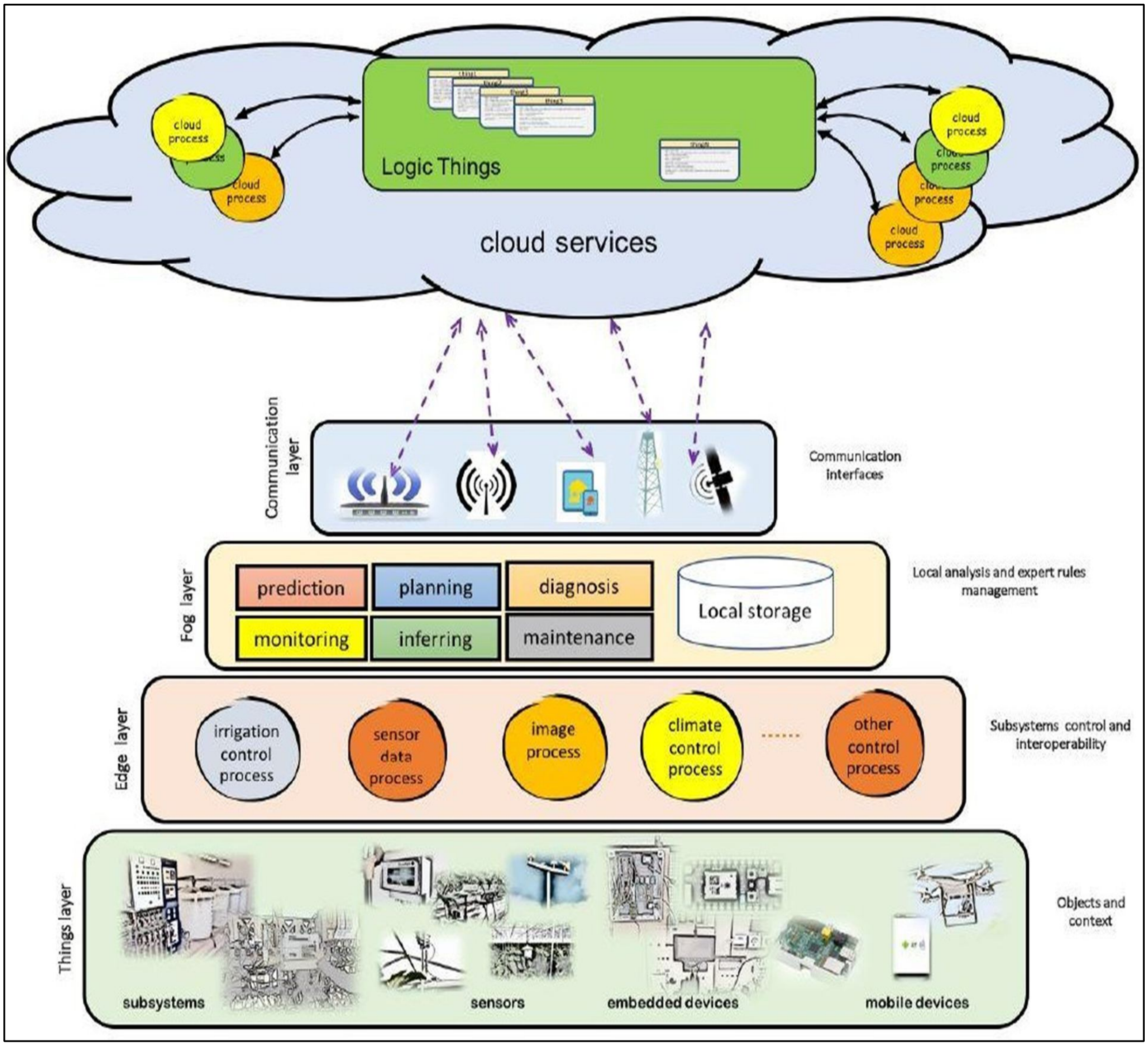

Figure 2 The 5-layer IoT Precision Agriculture platform developed by Ferrández-Pastor et al.

The edge layer may be in charge of data filtering, climate prediction computing, and categorization services. The fog layer, as an extension of the Cloud, helps with the real-time application by minimizing system latency and activating actuators without the need for information to initially arriving in Cloud [19].

IV. CONCLUSION

The introduction of the Internet of Things platform aided in the analysis of all the data from many domains. Aggrotech's use of the Internet of Things (IoT) has many advantages over traditional methods of crop monitoring such as eyeballing yield, weather conditions, and pollution levels. In light of climate change, the use of IoT in agriculture represents a significant advance. Precision agriculture platforms allow farmers to minimize production costs while increasing sales since they can combat disease by using the appropriate treatment type and amount at the appropriate time, avoiding the use of pesticides or other hazardous treatments and resulting in healthy crops. The use of IoT platforms will also reduce the consumption of water by watering the crops only when necessary and with a suitable amount of water. Therefore, farmers can select from a wide range of platforms that will improve their labour based on their Internet connection, location, crop kind, and other factors. The goal of the paper was to conduct a comparative analysis of the most widely used agriculture platforms, focusing on a variety of factors such as knowledge base, monitoring modules, and overall efficacy. These platforms serve the purpose of bringing users (farmers) and professional providers together. Farmers who use smart agriculture will get instruction when they need it and will have a better crop when the season is over.

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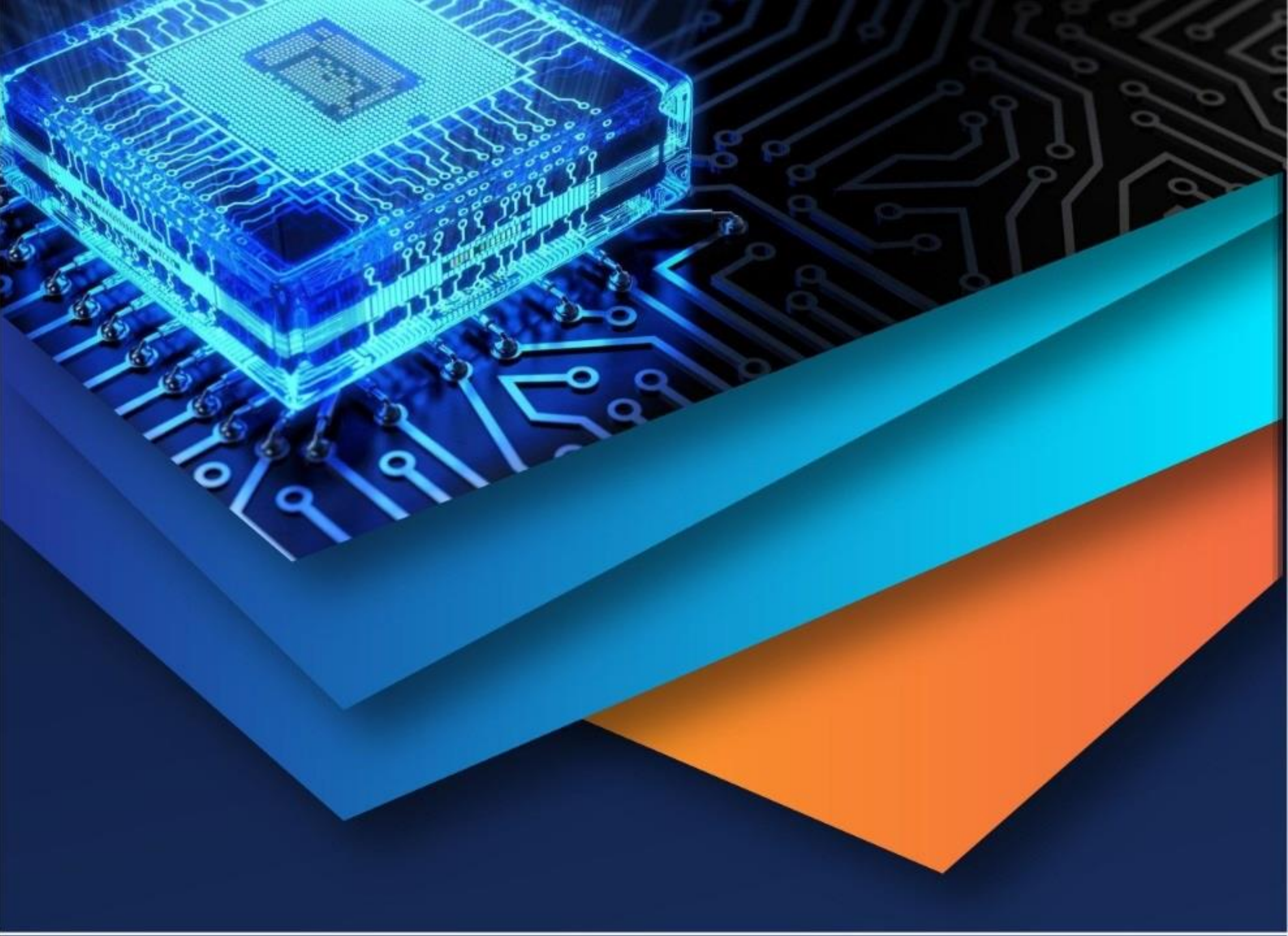

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