A REVIEW ON: AN EVALUATION OF IOT BASED REMOTE SENSING SYSTEM DESIGN AND DEVELOPMENT IN AGRICULTURAL SECTOR

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ABSTRACT

Modern sensors are widely used in a wide range of applications such as robotics, navigation, automation, remote sensing, underwater imaging, and so on. In recent years, sensors with advanced techniques such as artificial intelligence (AI) have played an important role in remote sensing and smart agriculture. The AI-enabled sensors function as smart sensors, and the Internet of Things (IoT) has resulted in highly valuable tools in the area of agriculture by making many kinds of sensor-based equipment and gadgets accessible. In this work, we focused on an in-depth examination of improvements in smart sensors and IoT, which are utilised in remote sensing and agricultural applications such as assessing weather conditions and soil quality; crop monitoring; the use of robots for harvesting and weeding; and the usage of drones. The emphasis has been placed on specific types of sensors and sensor technologies by presenting a comprehensive study, review, comparison, and recommendation for IoT advancements that will aid researchers, agriculturists, remote sensing scientists, and policymakers in their research and implementations.

Keyword : - ***sensors; smart sensors; AI; IoT; remote sensing; agriculture applications***

1. INTRODUCTION

Sensors are widely employed in a variety of applications ranging from bodily parameter assessment to autonomous driving. Furthermore, sensors play an important part in completing detection- and vision-related activities in all current applications of science, engineering, and technology where computer vision is dominant. The Internet of Things (IoT) is an intriguing growing topic that utilizes smart sensors, since it deals with wireless networks and sensors deployed to detect data in real time and produce particular results of interest via appropriate processing. Sensors and artificial intelligence (AI) are the most crucial features of IoT-based devices that make them smart and intelligent. Indeed, because of the role of AI, the sensors act as smart sensors and find an efficient use for a variety of applications, such as general environmental monitoring monitoring a certain number of environmental factors; weather forecasting satellite imaging and its use; remote sensing based applications hazard event monitoring such as landslide detection self-driving cars; healthcare, and so on. In this latter area, the use of smart gadgets in hospitals and diagnostic centres for assessing and monitoring different health problems of afflicted patients, both remotely and physically, has lately expanded significantly. Practically, no sector of study or research can function intelligently without the use of current sensors. The widespread use and demand for sensors, as well as the use of IoT in remote sensing, environmental and human health monitoring, make the applications smarter. Agriculture applications have also included the use of many kinds of sensors in the recent decade for monitoring and managing various environmental factors such as temperature, humidity, soil quality, pollution, air quality, water contamination, radiation, and so on.

1.1 Smart Sensors and IoT for Agriculture Application

With proper crop quality evaluation, crop categorization, and soil moisture monitoring, modern agriculture using sophisticated technology such as AI and smart sensors may deliver greater yields. Smart sensors are employed in agriculture by integrating sophisticated sensors, advanced AI approaches, soil health monitoring systems, animal-husbandry applications, and crop yield analyses. Smart sensors play a critical role in agricultural and pharmaceutical industries, where not only productivity but also long-term growth are attained.

Fig 1: Smart sensors for agriculture applications.

(Source: Research Gate)

1.2 IoT which is used in the agriculture sector

Farmers, agricultural cooperatives, local, national, and international authorities must meet multiple objectives, including conducting economically viable activities, ensuring agricultural production to feed a growing population, and reducing or even reversing negative environmental impacts by minimizing resource depletion and contributing to climate mitigation. Because remote sensing provides a nondestructive method of monitoring vegetation in both space and time, it looks to be an unavoidable instrument in attaining these objectives. It can help to identify new varieties that are better suited to challenging environments monitor agricultural land use, forecast within-season crop production, optimize short-term production, and provide ecosystem services related to soil or water resources, as well as animal or plant biodiversity. These numerous applications are connected to distinct stakeholder needs that entail multiple geographical scales and different temporal scales ranging from real time to decades, with varying degrees of precision and a priori crop status information This has a direct impact on the data collecting options for remote sensing-based solutions (e.g., proximate sensing, UAV, satellite, sensor) and methodologies (e.g. empirically or physically based). In this part, we discuss current research advancements that enable us to increase application capabilities in remote sensing for the aforementioned thematic, as a supplement to analysis, which was confined to large-scale operational monitoring systems.

1.3 Benefits of IOT in Agriculture

There are various benefits and advantages to use IoT in agricultural sector some of the benefits are as follows:

- **Efficiency of input:** It will improve the efficiency of inputs of agriculture like Soil, Water, Fertilizers, Pesticides, etc.
- **Cost reduction**: It will reduce the cost of production.
- **Profitability**: It will increase the profitability of farmers.
- **Sustainability**: Improves sustainability.
- **Food safety**: It will help to accomplish the Food Safety Mission.
- **Environment protection**: It plays important role in the environment protection

2. LITERATURE REVIEW

2.1 M. Weiss et.al (2017) Conducted study on, "Remote sensing for agricultural applications: a meta-review "Agriculture provides humanity with food, fibers, fuel, and raw materials that are paramount for human livelihood. Today, this role must be satisfied within a context of environmental sustainability and climate change, combined with an unprecedented and still-expanding human population size, while maintaining the viability of agricultural activities to ensure both subsistence and livelihoods. Remote sensing has the capacity to assist the adaptive evolution of agricultural practices in order to face this major challenge, by providing repetitive information on crop status

throughout the season at different scales and for different actors. We start this review by making an overview of the current remote sensing techniques relevant for the agricultural context. We present the agronomical variables and plant traits that can be estimated by remote sensing, and we describe the empirical and deterministic appro aches to retrieve them. A second part of this review illustrates recent research developments that permit to strengthen applicative capabilities in remote sensing according to specific requirements for different types of stakeholders.

2.2 Nikesh Gondchawar.et.al (2016) Conducted study on, "IoT based Smart Agriculture" Agriculture plays vital role in the development of agricultural country. In India about 70% of population depends upon farming and one third of the nation's capital comes from farming. Issues concerning agriculture have been always hindering the development of the country. The only solution to this problem is smart agriculture by modernizing the current traditional methods of agriculture. Hence the project aims at making agriculture smart using automation and IoT technologies. The highlighting features of this project includes smart GPS based remote controlled robot to perform tasks like weeding, spraying, moisture sensing, bird and animal scaring, keeping vigilance, etc. Secondly it includes smart irrigation with smart control and intelligent decision making based on accurate real time field data. Thirdly, smart warehouse management which includes temperature maintenance, humidity maintenance and theft detection in the warehouse.

2.3Mohamed EsmailKarar et.al (2020) Conducted study on, "A Pilot Study of Smart Agricultural Irrigation using Unmanned Aerial Vehicles and IoT-Based Cloud System"This article introduces a new mobile-based application of modern information and communication technology in agriculture based on Internet of Things (IoT), embedded systems and an unmanned aerial vehicle (UAV). The proposed agricultural monitoring system was designed and implemented using Arduino microcontroller boards, Wi-Fi modules, water pumps and electronic environmental sensors, namely temperature, humidity and soil moisture. The role of UAV in this study is to collect these environmental data from different regions of the farm. Then, the quantity of water irrigation is automatically computed for each region in the cloud. Moreover, the developed system can monitor the farm conditions including the water requirements remotely on Android mobile application to guide the farmers.

2.4George Adamides(2020) Conducted study on, "A Review of Climate-Smart Agriculture Applications in Cyprus"Climate-smart agriculture is an approach for developing agricultural strategies to modernize agricultural systems using digital techniques, aiming for sustainable agriculture and ensuring food security under climate change. This article provides a systematic literature review of smart agriculture technologies towards climate-smart agriculture in Cyprus, including robotics, Internet of Things, and remote sensing. The paper starts with a review of climate-smart agriculture, presenting its importance in terms of optimizing agricultural production processes in order to address the interlinked challenges of food security and climate change. An extensive literature review of works published in the areas of robotics, Internet of Things, and remote sensing is undertaken, with particular attention paid to works carried out in relation to agriculture in Cyprus.

2.5Xiang Feng et.al (2019) Conducted study on, "Study of Wireless Communication Technologies on Internet of Things for Precision Agriculture"Precision agriculture is a suitable solution to these challenges such as shortage of food, deterioration of soil properties and water scarcity. The developments of modern information technologies and wireless communication technologies are the foundations for the realization of precision agriculture. This paper attempts to fnd suitable, feasible and practical wireless communication technologies for precision agriculture by analyzing the agricultural application scenarios and experimental tests. Three kinds of Wireless Sensor Networks (WSN) architecture, which is based on narrowband internet of things (NB-IoT), Long Range (LoRa) and ZigBee wireless communication technologies respectively, are presented for precision agriculture applications. The feasibility of three WSN architectures is verifed by corresponding tests. By measuring the normal communication time, the power consumption of three wireless communication technologies is compared.

2.6Muhammad ShoaibFarooq, et.al (2020) Conducted study on, "Role of IoT Technology in Agriculture: A Systematic Literature Review"The growing demand for food in terms of quality and quantity has increased the need for industrialization and intensification in the agriculture field. Internet of Things (IoT) is a highly promising technology that is offering many innovative solutions to modernize the agriculture sector. Research institutions and scientific groups are continuously working to deliver solutions and products using IoT to address different domains of agriculture. This paper presents a systematic literature review (SLR) by conducting a survey of IoT technologies and their current utilization in different application domains of the agriculture sector. The underlying SLR has been compiled by reviewing research articles published in well-reputed venues between 2006 and 2019. A total of 67 papers were carefully selected through a systematic process and classified accordingly. The primary objective of this

systematic study is the collection of all relevant research on IoT agricultural applications, sensors/devices, communication protocols, and network types. Furthermore, it also discusses the main issues and challenges that are being investigated in the field of agriculture. Moreover, an IoT agriculture framework has been presented that contextualizes the representation of a wide range of current solutions in the field of agriculture.

2.7 Sharma Sachin, et.al (2019), Conducted study on, "Nuts and Bolts of ETL in Data Warehouse"Data transformation from text files to database files, relational database management systems, and distributed database management systems in recent past has emerged a vast field of data warehouse. Currently data analytics is the most appealing field for the data scientists and challenges are very big as data volume is very huge. Not only data volume is high but the speed at which data is growing annually is exponentially. Data analytics has become a tool to grow the business by forecasting, business intelligence and decision support systems. In a simplified way, data is organized in the form of database, collective databases makes the data warehouse and the technologies like business intelligence, decision support system, and data analytics make use of data warehouse for their purpose.

2.8 AnnaTriantafyllou, et.al (2019) Conducted study on, "Precision Agriculture: A Remote Sensing Monitoring System Architecture"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 seven layers of the architecture model that are the Sensor Layer, the Link Layer, the Encapsulation Layer, the Middleware Layer, the Configuration Layer, the Management Layer and the Application Layer.

2.9Rajendra P,et.al (2020) Conducted study on, "Applications of Remote Sensing in Precision Agriculture: A Review"Agriculture provides for the most basic needs of humankind: food and fiber. The introduction of new farming techniques in the past century (e.g., during the Green Revolution) has helped agriculture keep pace with growing demands for food and other agricultural products. However, further increases in food demand, a growing population, and rising income levels are likely to put additional strain on natural resources. With growing recognition of the negative impacts of agriculture on the environment, new techniques and approaches should be able tomeet future food demands whilemaintaining or reducing the environmental footprint of agriculture. Emerging technologies, such as geospatial technologies, Internet of Things (IoT), Big Data analysis, and artificial intelligence (AI), could be utilized to make informed management decisions aimed to increase crop production. Precision agriculture (PA) entails the application of a suite of such technologies to optimize agricultural inputs to increase agricultural production and reduce input losses. Use of remote sensing technologies for PA has increased rapidly during the past few decades.

2.10Silvia LiberataUllo, et.al (2021) Conducted study on, "Advances in IoT and Smart Sensors for Remote Sensing and Agriculture Applications"Modern sensors find their wide usage in a variety of applications such as robotics, navigation, automation, remote sensing, underwater imaging, etc. and in recent years the sensors with advanced techniques such as the artificial intelligence (AI) play a significant role in the field of remote sensing and smart agriculture. The AI enabled sensors work as smart sensors and additionally the advent of the Internet of Things (IoT) has resulted into very useful tools in the field of agriculture by making available different types of sensor-based equipment and devices. In this paper, we have focused on an extensive study of the advances in smart sensors and IoT, employed in remote sensing and agriculture applications such as the assessment of weather conditions and soil quality; the crop monitoring; the use of robots for harvesting and weeding; the employment of drones. The emphasis has been given to specific types of sensors and sensor technologies by presenting an extensive study, review, comparison and recommendation for advancements in IoT that would help researchers, agriculturists, remote sensing scientists and policy makers in their research and implementations.

3. METHODOLOGY

A systematic literature review is selected as the research methodology for this paper. The goal of this research is to investigate and provide a review of existing IoT-based agricultural monitoring applications, sensors/devices, and

communication protocols. We have followed the methodology proposed by to make research impartial in the context of information selection and results in representations

4. CONCLUSION

This paper provides a critical evaluation of current research and studies in the subject of IoT and sensors used for Remote Sensing applications, as well as in agriculture. The literature and a critical analysis of work in several domains of smart sensors and IoT in terms of their usage, features, and limits have been carefully researched and presented. The review-based suggestions and discussion have been produced, in addition to an impact analysis of the quantity of research done in recent years in the field of study. For effective Remote Sensing applications and their implementation, an IoT framework and a strong collection of sensors are needed. Despite the fact that there are many sensors for diverse purposes, the sensors for remote sensing that result in unique and robust remote sensing-based agricultural monitoring and control are very restricted. Furthermore, statistics and their application in diverse publications are seldom employed in research, so future study might try statistical analysis and performance assessment of IoT and sensors for the listed applications. In the future, specific study on robustness, sensor selection, environmental conditions, and the design of appropriate IoT and smart sensors will be required.

References

1. *Version of Record: https://www.sciencedirect.com/science/article/pii/S0034425719304213* . (n.d.). 1–69.
2. Karar, M. E., Alotaibi, F., Al Rasheed, A., &Reyad, O. (2021). A pilot study of smart agricultural irrigation using unmanned aerial vehicles and IoT-based cloud system. *Information Sciences Letters*, *10*(1), 131–140. https://doi.org/10.18576/isl/100115
3. Kishore Kumar, K. (2021). IoT-based smart agriculture. *Handbook of Research on Innovations and Applications of AI, IoT, and Cognitive Technologies*, *5*(6), 63–77. https://doi.org/10.4018/978-1-7998-6870-5.ch004
4. Adamides, G. (2020). A review of climate-smart agriculture applications in Cyprus. *Atmosphere*, *11*(9). https://doi.org/10.3390/ATMOS11090898
5. Feng, X., Yan, F., & Liu, X. (2019). Study of Wireless Communication Technologies on Internet of Things for Precision Agriculture. *Wireless Personal Communications*, *108*(3), 1785–1802. https://doi.org/10.1007/s11277-019-06496-7
6. Farooq, M. S., Riaz, S., Abid, A., Umer, T., &Zikria, Y. Bin. (2020). Role of iot technology in agriculture: A systematic literature review. *Electronics (Switzerland)*, *9*(2). https://doi.org/10.3390/electronics9020319
7. Patel, H., & Patel, B. (2019). Stemmatizer—Stemmer-based Lemmatizer for Gujarati Text. In *Advances in Intelligent Systems and Computing* (Vol. 841). https://doi.org/10.1007/978-981-13-2285-3_78
8. Triantafyllou, A., Sarigiannidis, P., & Bibi, S. (2019). Precision agriculture: A remote sensing monitoring system architecture. *Information (Switzerland)*, *10*(11). https://doi.org/10.3390/info10110348
9. Boursianis, A. D., Papadopoulou, M. S., Diamantoulakis, P., Liopa-Tsakalidi, A., Barouchas, P., Salahas, G., Karagiannidis, G., Wan, S., &Goudos, S. K. (2022). Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in smart farming: A comprehensive review. *Internet of Things (Netherlands)*, 100187. https://doi.org/10.1016/j.iot.2020.100187
10. Sishodia, R. P., Ray, R. L., & Singh, S. K. (2020). Applications of remote sensing in precision agriculture: A review. *Remote Sensing*, *12*(19), 1–31. https://doi.org/10.3390/rs12193136
11. Ullo, S. L., & Sinha, G. R. (2021). Advances in IoT and Smart Sensors for Remote Sensing and Agriculture Applications. *Remote Sensing*, *13*(13). https://doi.org/10.3390/rs13132585