IoT in Rural Development : Opportunities and Challenges

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Abstract: *In this Digital era filled with technological advancements, the Internet of Things (IOT) has found its many applications in the numerous sectors of our daily life. The World Wide Web (WWW), being a vast network for the computer systems, IOT a "younger brother" of WWW, inter-connects the multiple smart devices, taking a huge step forward in the automation sector. Even though having abundant possibilities of applications of IOT, it finds its use majorly concentrated in urban areas. Despite having a market for IOT, its presence is observed very little in the countryside. The primary cause being the exceedingly different kinds of challenges as compared to its developed counterpart. The underlying issues such as transportation, irrigation, healthcare, education, and others; can be resolved by solutions specific to targeting these problems. These challenges faced by the rural sector are profound in nature and omnipresent, irrespective of the geographical aspect. The objective of this paper is to give a piece of brief information about the Opportunities and Challenges for IOT in the untapped market, i.e., the Rural Sector. The IOT can not only provide a viable solution to the problems, but it can also provide much needed technological advancement due in the field of agriculture.*

Keywords: **Agriculture, Rural Development, Internet of Things (IOT)**

1. INTRODUCTION

The bare essence of IOT is that the sensor devices can talk to the supervisory device(s) by utilizing the internet as a communication medium. The primary benefit being the system would be capable of providing much-needed feedback promptly to carry out preventive/corrective actions pertaining to a task. The extension of this system is the supervisory device, autonomously, or with the input from a person who would perform the required action all by itself. Thus, completing the task much efficiently and precisely with some or no human intervention. The agricultural sector having the vastly stretched-out farmlands, with a sparse workforce to utilize and, being sensitive to the various environmental and geological factors, is already forming up to be a textbook challenge, which resulted in the development of the Internet of Things(IOT).

2. RELATED WORKS

Numerous researchers addressed the use of IoT in agriculture to improve the different agricultural processes. Joe-Air Jiang in their paper proposed and novel approach to solving precision agriculture (PA) issues. Wireless sensor networks (WSNs) and IoT might be great tools to monitor environmental parameters and plant growth in agricultural applications because these two technologies can provide high-resolution spatiotemporal sensing data extracted from real-world physical/analog signals.[1]

Xiaojing and Yuanguai in their paper, emphasize mostly on the use of cloud-enabled systems, in order to show the relationship between the cloud and IoT from the viewpoint of agricultural data and its use cases. They argue that intelligent agriculture is one of the applications of the Internet of Things (IoT), which has an extensive application and a bright future.[2]

ZigBee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. As a brand-new information acquisition and the processing technology, the ZigBee has seeped gradually into the agricultural environmental monitoring domain. The ZigBee technologies allow the identification of pests in the crops, drought or increased moisture. Having such information at a real-time interval, automated actuation devices can be used to control irrigation, fertilization and pest control in order to offset the adverse conditions. This technology can be applied for wireless applications in agriculture. The ZigBee nodes can obtain the temperature, humidity and illumination information in real time, and then transfer to a remote monitoring center.[3][4]

Gipsa Alex, Benitta Varghese, Jezna G Jose, AlbyMol Abraham proposed work on modern healthcare IOT platform with an intelligent medicine box along with sensors for health monitoring and diagnosis of the disease. In their proposed work an intelligent home-based medicine box with wireless connectivity with an android application (Health-IOT) is developed that helps patients and doctors to be in more close communication. They proposed a work that has an intelligent medicine box that gives alerts for patients to take their medicine at the night-time. The box is wirelessly connected to the internet to make timely updates about medicines which will be notified in the android application within the patient's smartphone. Their system automatically gives alarm so that the patient takes the right medicine at the right time.[5]

A. Arun Rajaa, R. Naveedhab, G. Niranjanadevic, and V. Roobini proposed in their paper that a security alert system which records a video when a motion is detected and uploads it to the external server and notifies the user via text message is reported. Their application can be used to view the remote activities and notifications can be received whenever the motion is detected. Internet of Things basically deals with transferring of useable data without involving human interferences. In their proposed work they used the Raspberry Pi camera module is used for detecting and capturing the motion. Raspberry Pi (Model B+), a credit card-sized computer is used for processing the captured video.[6]

Haesung Lee, Kwangyoung Kim and Joonhee Kwon proposed in their research work that a new interconnection technique for efficient information sharing in IOT environment considering social network. They present a method and algorithm which is based on not only the analysis of the human's social network but also the consideration of the device's sociality. Then they describe some scenarios and implement original system using the scenarios. Some experiments are conducted. From the experimental evaluation, they verified that their proposed technique is helpful in the efficient interaction between devices without any intervention of humans.[7]

Andreas Kamilaris, Feng Gao, Francesc X. Prenafeta-Boldu' and Muhammad Intizar Ali in their paper propose Agri-IoT, a semantic framework for IoT based smart farming applications, which supports reasoning over various heterogeneous sensor data streams in real-time. AgriIoT can integrate multiple cross-domain data streams, providing a complete semantic processing pipeline, offering a common framework for smart farming applications. Agri-IoT supports large-scale data analytics and event detection, ensuring seamless interoperability among sensors, services, processes, operations, farmers and other relevant actors, including online information sources and linked open datasets and streams available on the Web.[8]

3. APPLICATION OF IOT

A. IOT in Irrigation

Farming, the backbone for multiple countries like India, is very crucial for the economy. One of the necessities of a human being to survive; food, which is the result of the same process. Food being this important, it is crucial that the quality of it must be maintained. In the extensive process, starting from the seed to the final crop of farming, a great deal of care and attention is demanded. The Internet of Things can find its application in a multitude number of factors that contribute to the health of the crop. The IOT based monitoring system can take the weather characteristics, insect damage, soil moisture, and many such factors into account to provide the optimum solution.

The smart farm, as demonstrated by Minwoo Ryu, Jaeseok Yun, Ting Miao, Il-Yeup Ahn, Sung-Chan Choi, Jaeho Kim in their paper is a farm embedded with IoT systems, could be called a connected farm, which can support a wide range of devices from diverse agricultural device manufacturers. Also, connected farms could provide more intelligent agricultural services based on shared expert knowledge. For example, people having even little experience on farming could grow plants or crops for profits. Infectious disease prevention could also be another benefit of developing the connected farms by detecting influenza virus in a specific pig farm, and proactively isolating that one from others.[9]

B. IOT in Healthcare

Rural Healthcare is also one of the sectors which could utilize the superior solutions of IOT over the conventional healthcare that has to offer. Having chronic problems like low average lifespan, malnourishment among children in conjunction with very few resources to diagnose and cure uncommon diseases results in many avoidable deceased cases. IOT based system can provide the information via a comprehensive analysis of the person's ailment to find its frequency of occurrence, the recovery rate, the age group and gender in which it majorly affects, and many such more. In addition to this, it is a pivoting advantage that the accomplishment of the prior mentioned is possible to do remotely. This advantage would open the doors to world-class care for even the most secluded area and, at the same time reducing, the overall cost.

C. IOT in Education

The literacy rate is abysmal in the villages, the primary root cause being the less amount of priority given by people residing there to the education. The IOT based learning system can enable a student to have equal opportunity and resources for studies as its urban counterpart. With new interactive learning via augmented reality (AR), a student will be able to gain much from an enhanced learning environment. In addition to it, digital materials that are not only limited to text and images but also include videos and other forms of interactive content could be easily accessible from anywhere, at any time.

Ammar Khaleel, Salman Yussof, in their paper, discusses the underlying issue of student security very well. Up until now, most of the schools take attendance via roll call. This method proves to be highly insecure as the presence of a student on campus is recorded for only a singular instance of time. More real-time status of a student's whereabouts would be particularly beneficial during school trips as well as everyday classes.[10]

D. IOT in Surveillance

The crop on the farm is very susceptible to the slightest changes in the environment. Apart from the natural condition, it would be affected by other external factors as well. One such being the grazing animals, if any of those wanders into a field of crops, it can very easily ruin a significant portion of the farm. Not to mention the result of a whole herd roaming in the fields would be catastrophic. Like them, the crops are also in danger from the birds on the field. The conventional way to prevent such incidents is the installation of a scarecrow. However, failing to provide proper security from the dangers, this system of a scarecrow is outdated. The novel approach to that would be the IOT based fence monitoring system. Not only would it sense if there is any trespassing in the farm, but it would also alert the farmer via text message when the farm border has been breached. Such a solution, in real-time, would be very beneficial for the farmers and others.

4. PRIMARY CHALLENGES IN THE FIELD

A. Technological Stagnation.

The denizens of rural areas are seldom as familiar with the current technology as their urban counterparts. These are least affected by the latest advancements due to Industrialization and Globalization. It is prevailing in many villages wherein the "basic necessity" of the Digital World, electricity, is not available round the clock. The majority of the IOT devices which are available today are power on AC grid power. The continuous supply of the grid supply is essential as, for many IOT devices, it is a prerequisite as they are operating 24/7. Even the devices functioning on battery should preferably be kept in online charging mode. The remote location of their application makes it impractical if frequent replacement or charging is needed.

B. Public Awareness

Having a minimal connection to the outside world, the villages of India fails to benefit from expansion in the technical fields. The primary problem having a partially isolated ecosystem that is apparent in Rural areas is the unawareness that something like the IOT system even exists. A targeted marketing scheme must be employed as it would be needed to educate the people about the IOT based products and their broad domain of application. It would only be achievable with a significant investment, as a mammoth of a task of an introduction of a whole new concept to a relative orthodox audience, along with other things.

C. Low Literacy

It is well known that in the underdeveloped societies of India, as opposed to the investment and opportunity for growth, learning and education are viewed as a liability and waste of time. This type of thinking is particularly tricky to target, as the uneducated mind remains conservative. An additional challenge is the knowledge relevant to the current technology is absent, making it that much harder to implement any system pertaining to it. The installation of and maintenance of IOT systems would require some skillset, which through its respective training, can be imparted. However, it would take a tremendous amount of work to train the technicians to a level that they could perform autonomously.

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5. CONCLUSION

This paper has identified the potential applications for IOT based system in the Rural Sector. Due to the lack of access to current technological advancement caused due to very poor networking with its urban counterpart, the IOT market is majorly untouched. These domains include irrigations, healthcare, education surveillance, and water. This study weighs out the potential pros and cons as per the current situation, providing some shrewd insights into the present scenario. There is enormous potential for the IOT in the Rural Areas implementation of them would lead to a better overall life for farmers, along with the improved quality of crops. Along with that, the limitation which hinders the implementation of IOT in current time is discussed extensively. The integration of IOT in Rural life is in the near future, provided that some bare minimum development is done to cause poverty alleviation and upgrade the standards of people.

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