IOT IN AGRICULTURE: MIXED REALITY AND AI

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ABSTRACT

The farming sector remains one of the most important among different industries. People engaged in agribusiness are working 24 hours to increase crops yield and livestock growth. Despite the fact that their life became much easier for today, they still need some technical assistance to save costs and improve productivity at the same time. This is where mixed reality and artificial intelligence technologies come to the rescue. Their capabilities seem almost unlimited. And we will prove you it.

The agricultural sector is undergoing a technological revolution driven by the adoption of Internet of Things (IoT) devices. These interconnected sensors and actuators have transformed traditional farming practices by providing real-time data on various environmental parameters, crop conditions, and livestock health. This paper explores the applications, benefits, and challenges of IoT in agriculture, highlighting its potential to enhance efficiency and sustainability in food production.

Key areas of application include precision agriculture, where IoT sensors monitor soil moisture, temperature, and nutrient levels to optimize irrigation and fertilization practices. Additionally, IoT-enabled drones and satellite imagery facilitate crop monitoring, pest detection, and yield forecasting, enabling farmers to make data-driven decisions about planting, harvesting, and crop management.

In livestock farming, IoT devices such as wearables and RFID tags track animal health, behavior, and location, enabling early detection of diseases and improving overall animal welfare. Environmental monitoring is another critical application, with IoT sensors measuring air quality, weather conditions, and pollution levels to mitigate risks related to climate change and environmental degradation.

While IoT offers significant benefits in terms of increased productivity and resource efficiency, challenges such as data privacy, interoperability, and cybersecurity need to be addressed to realize its full potential in agriculture. Furthermore, the integration of IoT with other emerging technologies such as artificial intelligence (AI) and mixed reality (MR) presents exciting opportunities for further optimization and automation of farming practices.

Overall, the integration of IoT in agriculture holds promise for transforming the industry into a more sustainable and resilient system capable of meeting the growing demands for food production while minimizing environmental impact. Continued research, investment, and collaboration are essential to overcome challenges and unlock the full benefits of IoT in agriculture.

Keywords: *Smart farming, technologies, agribusiness, environment, Mixed Reality.*

INTRODUCTION

1. **Internet of Things (IoT)**: IoT involves connecting physical devices embedded with sensors, software, and other technologies to collect and exchange data over the internet. In agriculture, IoT devices can be deployed in various forms such as soil sensors, drones, weather stations, and crop monitoring systems. These devices gather real-time data on soil moisture, temperature, humidity, crop growth, and pest infestation, enabling farmers to make data-driven decisions about irrigation, fertilization, and pest control. IoT helps in optimizing resource usage, increasing crop yield, and reducing environmental impact.

2. **Mixed Reality (MR)**: Mixed reality combines elements of virtual reality (VR) and augmented reality (AR) to create immersive experiences that blend the physical and digital worlds. In agriculture, MR can be utilized for training purposes, allowing farmers to simulate various scenarios such as crop management techniques or equipment operation in a virtual environment. Additionally, MR can enhance the visualization of agricultural data by overlaying real-time sensor information onto the physical field, enabling farmers to better understand the status of their crops and make informed decisions.

WHAT IS MIXED REALITY?

Mixed Reality (MR) is a term gaining its popularity today. It defines a combination or union of two virtual environments where two worlds coincide together. Sometimes a mixed reality is called a crossbreed (hybrid) reality.

Let's discover some **mixed reality examples.** It makes it possible to simultaneously investigate a virtual environment and real world as a single whole. Using real environment and coordinates virtual objects can be placed in a real world. When a user approaches a certain object, it is enlarging, when moves away – it is shrinking. Owing to a virtual reality, users can explore an object from different angles and at any distance. Besides, a mixed reality allows users to affect virtual object and interact with them as if they were in the same place.

Mixed reality can turn your smart phone into an interactive handbook where the informational environment for places we are located in is building on. **How does MR technology affect farming**? 3D-mapping technology makes it possible to turn fields into the virtual environment where farmers can generate different scenarios of crop cultivation, even if they seem fantastic in real life. Special software combined with webcams in a virtual environment augment physical objects as well as integrates us into the virtual world.

Owing to unique capabilities and experience a hybrid reality has, developers start investigating different ways of efficient use of this technology in diversified areas. Present-day medicine, architecture, education, and **smart farming** are the most advantageous fields for the application of a hybrid reality technology.

3. **Artificial Intelligence (AI)**: AI algorithms can analyze the vast amount of data collected by IoT devices to provide actionable insights and predictions. In agriculture, AI can be used for crop disease detection, yield forecasting, weed identification, and crop recommendation systems. By leveraging machine learning techniques, AI models can learn from historical data to optimize farming practices and improve overall efficiency. Furthermore, AI-powered decision support systems can assist farmers in identifying patterns and trends in their data, helping them to mitigate risks and maximize productivity.

When combined, IoT, mixed reality, and AI technologies have the potential to revolutionize agriculture by enabling precision farming, reducing operational costs, and increasing sustainability. Farmers can harness the power of data-driven insights and immersive experiences to make informed decisions and adapt to changing environmental conditions, ultimately leading to improved crop yields and economic viability.

MACHINE LEARNING IN AGRICULTURE

Machine learning – a complex statistics application for search of consistent patterns in data and development of required forecasts – has eased the process of a task assignment. Developers do not have any longer to build special programs for their computers to solve one task or another. Instead of this, a computer is taught to find the problem by itself, without any assistance. A real breakthrough in the world of information technologies. And, considering technical capabilities of **AI, agriculture** field cannot be ignored.

History of machine learning has begun in the 1950s when computer scientists managed to teach a computer to play chess. Since then, together with computing capacity, the complexity of consistent patterns and forecasts computer is capable of drafting and detecting has been growing. As well as the complexity of problems computer can resolve today, and farming problems are also included in this list. Moreover, machine learning is a subdivision of **artificial intelligence (AI)**, so complex methods of smart intelligence are applied in ML technology.

How does ML work in **farming practices**? The algorithm gets a range of training data and then uses it for requests processing. For example, you can upload in the computer a few pictures with the description like 'A flower is depicted on the image' and 'There are no flowers at this image'. If you add new images to the database after this, it will start identifying pictures with flowers on its own.

The algorithm keeps on improving. Right and wrong results of image recognition are sent to the database, and software is becoming smarter with every processed image. In some sense, such process can be compared to building a muscle – the more you train, the stronger you get. The more images you have downloaded in the program, the more precise result it will produce.

Thus, AI and machine learning, in particular, can significantly change the agriculture and the whole **smart farming** field. How? The answer is waiting for you.

AUTOMATED FARMING: HOW IT WORKS

Farming is one of the most ancient human activities. Throughout history generations of people improved their skills in sowing, cultivating and harvesting crops. Such skills gave people a chance to feed themselves. Of course, agricultural tools have always been developed throughout history so today we use mechanical tools instead of their heavy manual counterparts. But computer and similar technologies always seemed to be

incompatible with a farming sector. And not so long ago people even didn't imagine how to combine them. However, everything has changed and there is a strong **impact of technology on agriculture** nowadays.

POPULATION GROWTH

The mission of a farming sector is to satisfy basic human needs in nutrition. Availability of agriculture has always been a critical factor in a population survival and growth. As modern cities are densely populated, people have to find new sophisticated means to harvest more crops at limited land sections. Implementation of agrochemicals, genetic manipulation and fertilizers on the one hand and information technologies and innovative farming equipment, on the other hand, will help humanity to avoid starvation. **Smart farming solution** can save the world if people apply them wisely.

Furthermore, scientists need to find the way to make crops flood and drought resistant in order to grow them in regions with uncertain climatic conditions.

Besides that, it is highly required to find the way to use less water for crops. In the light of all the above, it is impossible to avoid implementation of smart technologies since they can be advantageous and helpful for the whole world population.

TECHNOLOGIES USE CASES

Today **city farming** is gaining its popularity among the urban population. Dubbed vertical farming is one of the leading directions of city farming since it makes it possible to grow fruits and vegetables right indoors in the downtown of a big city. In other words, such harvest can be grown on walls and roofs of buildings. This tendency seems to be a solution to the problem of lack of nutrition. In addition, such technique allows growing crops 20% faster and uses 90% less water. Thus, this method can be applied as well even in a very dry region like Eastern Africa.

Second, **smart sensors** come to rescue today. They can monitor all plants' vitals send all necessary data in a real-time mode. Here where machine learning comes in. Algorithms check all information explore it to predict what pests can attack it. Also, **mixed reality applications** make it possible for farmers to monitor crops condition using special helmets with virtual and augmented reality.

As an example, we can take Plant.IO system. PVC pipes equipped with sensors, lights, cameras etc. are located around the perimeter of the field or greenhouse. All information is sent to the server where machine learning algorithm processes this information and analyzes the whole process. Such **mixed reality technology** as AR-glasses allow users to see the plant with augmented objects from any point of the world.

WHAT IS THE SENSE IN IT?

It may seem fantastic but the combination of a game with agriculture can really lead to a new level of a crop management and cattle breeding control. This level will be much more convenient and comfortable for farmers. Artificial intelligence together with mixed reality provides everybody with an opportunity to monitor and manage their fields from afar. Thus, previous hard work turns into a funny game due to a merger of **technology and farming**.

The integration of Internet of Things (IoT), mixed reality, and artificial intelligence (AI) in agriculture presents a transformative potential for the industry. Here's how each technology contributes:

IoT (Internet of Things) in agriculture refers to the use of connected devices and sensors to gather real-time data from farm environments, crops, livestock, and equipment. This data is then analyzed to optimize various aspects of agricultural operations, including crop management, resource usage, and livestock monitoring. Here are some key applications of IoT in agriculture:

1. **Precision Agriculture**: IoT sensors can monitor soil moisture, temperature, humidity, and nutrient levels, allowing farmers to precisely manage irrigation and fertilization. This leads to optimized resource usage, increased crop yields, and reduced environmental impact.

2. **Crop Monitoring and Management**: IoT devices such as drones and satellite imagery can capture data on crop health, growth stages, and pest infestations. This information helps farmers to detect problems early, apply targeted treatments, and make informed decisions about planting, harvesting, and crop rotation.

3. **Livestock Monitoring**: IoT-enabled wearables and sensors can track the health, behavior, and location of livestock animals. Farmers can remotely monitor parameters such as body temperature, activity levels, and feeding behavior, enabling early detection of diseases, optimizing feeding schedules, and improving overall animal welfare.

4. **Environmental Monitoring**: IoT sensors can measure environmental factors such as air quality, weather conditions, and pollution levels. This information allows farmers to mitigate risks related to extreme weather events, pollution, and climate change, ensuring the sustainability of agricultural practices.

5. **Supply Chain Optimization**: IoT technologies can track the movement and condition of agricultural products throughout the supply chain, from farm to market. This helps in minimizing spoilage, reducing food waste, and ensuring product quality and safety.

6. **Equipment Monitoring and Maintenance**: IoT sensors installed in farm machinery and equipment can monitor performance, fuel consumption, and maintenance needs in real-time. This enables proactive maintenance scheduling, minimizing downtime, and optimizing equipment efficiency.

Overall, IoT in agriculture offers significant benefits in terms of increased productivity, resource efficiency, and sustainability. By leveraging the power of connected devices and data analytics, farmers can make more informed decisions and adapt to changing environmental conditions, ultimately driving the modernization and optimization of agricultural practices.

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