Unlocking the potentials of IoT, 5G and AI for Food Production – a short review

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In recent years, we have witnessed amazing advancements in agricultural processes, from micro-farming to large-scale farming, while global food consumption continues to climb. By using the Internet of Things, Artificial Intelligence, and fast network connectivity (5G) for monitoring, managing, and analysing agricultural data and processes for an information-driven agricultural management system, smart farming will continue to lead the way to the required increase in food production.

The Internet of Things (IoT) provides a solid foundation for innovative agriculture solutions by using sensors to collect real-time agricultural data for analytics. When AI algorithms are applied to agricultural data, farmers can perform real-time descriptive, diagnostic, or predictive analytics to make sense of the data and farming automation.

IoT has aided in developing agricultural robots that can do various tasks that would otherwise require humans. The IoT devices and cloud services connected to the 5G network enable flexible and efficient smart farming solutions and the automated operation of numerous unmanned IoT devices, resulting in secure, dependable, environmentally friendly, and energy-efficient operations with low latency and high-speed broadband networks.

The installation of 5G networks is often done for proximity coverage, non-battery powered systems, and short-range access. As a result, other networking technologies like LoRaWAN, Ingenu, Sigfox, and NB-IoT are adopted for large-scale farming solutions and long-distance data transfer. Long-distance data transport is dominated by LoRaWAN so far. While 5G offers high network capacity, high spectral efficiency, and seamless connectivity between end devices, sensor devices are integrated with these LoRa-equipped transceivers to collect data and deliver it to gateways. These gateways then transport the data to the core 5G network. With 5G network Farmers can acquire real-time data from drones, such as high-definition video streams, as well as other crucial sensory data and telemetry, faster and more fluidly than with previous-generation mobile networks thanks to the 5G network. Because they make long-term investments, farmers are under pressure to select the most appropriate technology for their operations [1]. Concerning soil health, for instance, a farmer's investment considerations may include the deployment of sensors or smart farming technologies with an optimal network architecture that addresses the need to scale from thousands to millions of nodes, densely or sparsely populated IoT devices distribution, fixed or mobile operations depending on the geographical locations of the farms.

Nutrient monitoring in the soil can become difficult on a large field; manually taking samples around the area and testing them is labour-intensive. As a solution, IoT sensors are deployed into the ground to monitor the state of soil around the area in real-time for accurate information-gathering of soil’s qualities [2]. These sensors are deployed in-ground and connected to applications to receive real-time data on the soil, which can subsequently allow the implementation of AI algorithms that could map the sensors

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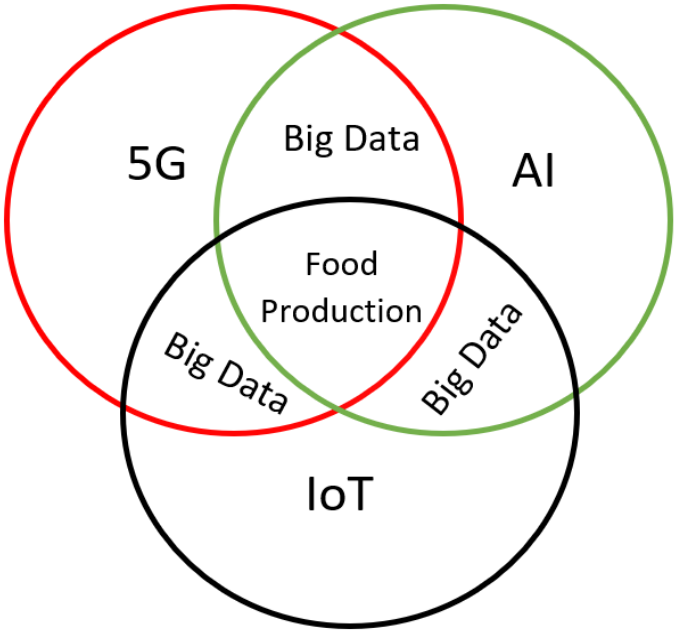
around the field and display visual maps and charts on the data collected or react to the occurrence of a certain event. To ensure plant fertility, the chemical composition of fertilizers and soil, such as the amounts of phosphorus, nitrogen, and potassium, is calculated using IoT-based devices. Farmers can apply the ideal amount of fertiliser to their crops without sacrificing the fertility of the soil by using sensor data on nutrient and weather levels [3].

Farmers often use single-based sensors that are vertically submerged into the ground to record the level of Soil moisture which can vary across the depth of the ground, but in a well-optimized system, these vertical sensors collect data at different points of its length. The soil moisture sensor helps to quickly detect soil water content and soil nutrients and convert them into a precise velum to display on a smartphone or programmable Board with an LCD screen. A suitable sensor layout around the field can create a sophisticated irrigation system, making sure the levels of moisture are recorded all around the field throughout the season, thus improving crop yield and reducing water waste. However, since different variables affect the soil around the area, the soil moisture or nutrient may not be completely uniform. Thus, the more sensors are deployed, the more accurate the data is provided about the soil.

With the ability to connect billions of the Internet of Things (IoT) devices, 5G networks will be able to create big data that will require the use of artificial intelligence to analyse.



Farmers are using more innovative livestock monitoring to boost productivity, improve livestock health, minimise waste, and save costs as they combat rising land costs and concerns about food hygiene caused by animal diseases. Implementing a data-driven agricultural system that makes use of technologies like the Internet of Things, 5G, and artificial intelligence to improve cattle health is imminent.

Sensors are being used to keep an eye on livestock from a distance, track where cattle are, and so on. For example, more and more farmers use health sensors every day, such as heart rate sensors, body temperature sensors, Glucometers (which measure the amount of glucose in the blood), and Sphygmomanometers (which measure blood pressure) to monitor animal health. [4] With the IoT sensor's readings and the animal's GPS data, predictions on the health state of the herd are being made in real-time [5].

Other applications of IoT in livestock include using sensors to learn how animals eat before, during, and after milking so that farmers can predict milk production or using motion sensors to measure cows' stress levels to find out if it affects how much milk they make. Another IoT application uses a heat detection sensor to track when the cows are in heat so that the cow's feed, mating schedule, and overall health can be adjusted in advance.

Further, AI and IoT sensors are being used to identify how much energy animals are getting in [6]. This is important for understanding and even predicting diseases like trace element deficiencies, lameness, and calving issues in animals. Anoestrus in animals, for example, can be caused by a number of factors, including postpartum illness and, more significantly, an inadequate energy intake that cannot support the needs of nursing. These solutions greatly aid the precision agricultural field as they smartly inform growers and farmers what crops or animals need particular attention at the correct time, saving money in the long run.

Conclusion

5G networks will be able to connect billions of IoT devices, producing big data, necessitating the deployment of artificial intelligence to make sense of it. 5G is a key part of the future Agricultural ecosystem's ability to support, grow, and drive innovation. Unlocking the potential of technologies like Artificial Intelligence (AI), the Internet of Things, and 5G could help develop new ideas for smart agriculture for global food production.

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