IoT BASED AGRICULTURE MONITORING AND SMART FARMING USING DRONES

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Abstract:

Internet of things (IoT) system allows users to achieve deeper automation, analysis and integration within a system. It is an ecosystem of connected physical system objects that are accessible through the internet. IoT can connect devices embedded in various systems to the Internet when devices/objects can represent themselves digitally, they can be controlled from anywhere. The most important features of IoT include Artificial Intelligence connectivity, sensor, active engagement and small device use. One of the important applications of IOT is Smart Agriculture. Smart Agriculture reduces wastage of water, fertilizers and increases the crop yield. A smart phone empowers farmer to keep updated with the ongoing conditions of his agricultural land using IOT at any time and any part of the world. IOT technology can reduce the cost and enhance the productivity of traditional farming. This paper present the various technologies in drones used in agriculture. Smart drones have sensors within the Unmanned Aerial Vehicles (UAVs) feed into a network infrastructure where drones are connected to other devices via Internet technologies, which enables communication and thus, makes them smart.

Keyword: IoT in Agriculture, Application of IoT, Artificial Intelligence connectivity, sensor.

1. IoT in Agriculture: Rapid growth in population, high required resources and rapid changes in climate are a few hurdles to the farmers. Food and Agriculture Organization (FAO) estimated that in the year 2050 global food production needs to be increased 70 % to feed additional 2.3 billion people. Against the challenges such as extreme weather conditions, rising climate change and environmental impact resulting from intensive farming practice, the demand for more food has to met. One of the most trends in agriculture is using technology in order to make smarter decision, reduce costs and boost production[1]. But, complete automation in agriculture is not achieved due to various issues. Though it is implemented in the research level, it is not given to the farmers as a product to get benefitted from the resources. Hence, this paper deals about developing smart agriculture using IoT and given to the farmers.

2. The Rise of Drones in Agriculture: Agriculture drones are used in farming in order to increase crop production and monitor crop growth. Use of advanced sensors and digital imaging capabilities, farmers can use the drones to get a clear and richer picture of their fields. Information gathered from the drone is useful in improving crop yields and farm efficiency [2]. Autonomously controlled drones are characterized by pre-programmed flight plans or more complex dynamic automation systems, where humans are not involved in the actual operation. Drones can be remotely controlled either by one individual or by a group of people(shared control). In a shared control setup, when drones are controlled by swarms, the UAV is based on a modified commercial flight platform that is controlled by a ground control station. The flight platform is a software that can be either selected or developed and can involve a range of sensors, an advanced control system and autonomous flight features [3].

3. Applications of Drones:

Fig 1: Applications of Drones

3.1 Aerial Photography-Drones are now being used to capture footage that would otherwise require expensive helicopters and cranes. These autonomous flying devices are also used in real estate and sports photography. Furthermore, journalists are considering the use of drones for collecting footage and information in live broadcasts.

3.2 Shipping and Delivery-Major companies like Amazon, UPS, and DHL are in favour of drone delivery. Drones could save a lot of manpower and shift unnecessary road traffic to the sky. Besides, they can be used over smaller distances to deliver small packages, food, letters, medicines, beverages and the like.

3.3 Geographic Mapping-Available to amateurs and professionals, drones can acquire very high-resolution data and download imagery in difficult to reach locations like coastlines, mountaintops, and islands. They are also used to create 3D maps and contribute to crowd sourced mapping applications.

3.4 Disaster Management-Drones provide quick means, after a natural or man-made disaster, to gather information and navigate debris and rubble to look for injured victims. Its high definition cameras, sensors, and radars give rescue teams access to a higher field of view, saving the need to spend resources on manned helicopters

3.5 Precision Agriculture-Farmers and agriculturists are always looking for cheap and effective methods to regularly monitor their crops. The infrared sensors in drones can be tuned to detect crop health, enabling farmers to react and improve crop conditions locally, with inputs of fertilizer or insecticides. It also improves management and better yield of the crops. In the next few years, nearly 80% of the agricultural market will comprise of drones [4].

3.6 Search and Rescue-Presence of thermal sensors gives drones night vision and makes them a powerful tool for surveillance. Drones are able to discover the location of lost persons and unfortunate victims, especially in harsh conditions or challenging terrains. drone can drop supplies to unreachable locations in war torn or disaster stricken countries. For example, a drone can be utilized to lower a walkie-talkie, GPS locator, medicines, food supplies, clothes, and water to stranded victims before rescue crews can move them to some place else.

3.7 Weather Forecast-Drones are being developed to monitor dangerous and unpredictable weather. Since they are cheap and unmanned, drones can be sent into hurricanes and tornadoes, so that scientists and weather forecasters acquire new insights into their behaviour and trajectory. Its specialized sensors can be used to detail weather parameters, collect data, and prevent mishaps.

3.8 Wildlife Monitoring-Drones have served as a deterrent to poachers. They provide unprecedented protection to animals, like elephants, rhinos, and big cats, a favourite target for poachers. With its thermal cameras and sensors, drones have the ability to operate during the night. This enables them to monitor and research on wildlife without causing any disturbance and provides insight on their patterns, behaviour, and habitat.

3.9 Law Enforcement-Drones are also used for maintaining the law. They help with the surveillance of large crowds and ensure public safety. They assist in monitoring criminal and illegal activities. In fact, fire investigations, smugglers of migrants, and illegal transportation of drugs via coastlines, are monitored by the border patrol with the help of drones.

3.10 Entertainment- Drones are being developed to provide entertainment for players so that they can be used in fight clubs. Known as a cage match, two contenders and their drones are put up against each other. The destruction of any of the player's drones results in the other's win. Moreover, artificial drone intelligence is used in several ways to capture videos and photograph.

4. Agriculture Drone Sprayer

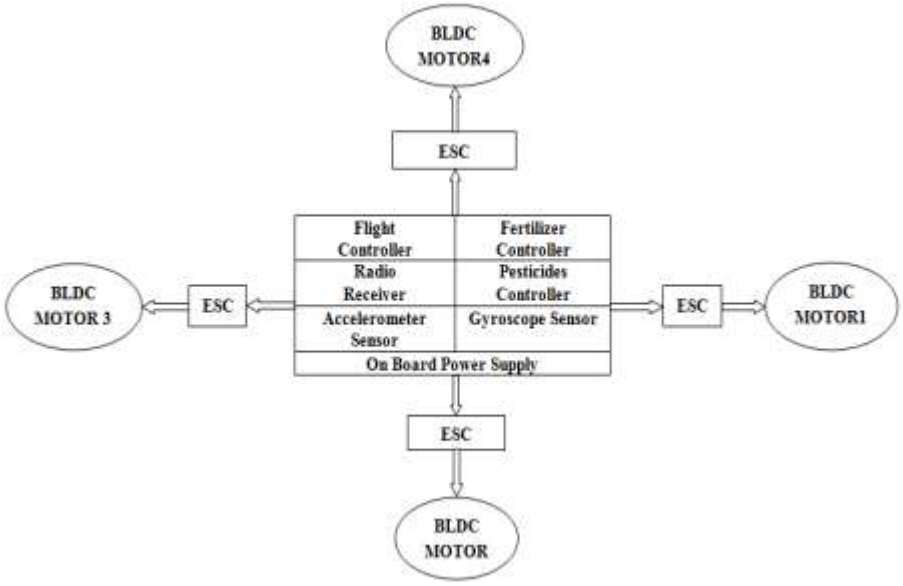

Fig 2: Block Diagram of the Agriculture Drone Sprayer

4.1 Functional Description of the Drone

BLDC: The brushless motors are multi-phased, normally 3 phases, so direct supply of DC power will not turn the motors on.BLDC electric motor also known as electronically commutated motors.

ESC: The ESC generating three high frequency signals with different but controllable phases continually to keep the motor turning. The ESC is also able to source a lot of current as the motors can draw a lot of power.

DC: 30PRM 12 v DC geared motors for robotics application. Very Easy to use and available in standard size. A power supply is an electronic device that supplies electric energy to an electrical load.

Accelerometer Sensor: The accelerometer measures acceleration and also force, so the downwards gravity will also be sensed. As the accelerometer has three axis sensors, we can work out the orientation of the device.

Gyroscope Sensor: A gyroscope measure angular velocity, in other words the rotational speed around the three axis. A gyroscope is a device that uses Earth's gravity to help determine orientation. Its design consists of a freely-rotating disk called a rotor, mounted onto a spinning axis in the center of a larger and more stable.

LIPO Battery: LiPo battery can be found in a single cell (3.7V) to in a pack of over 10 cells connected in series (37V). A popular choice of battery for a Quadcopter is the 3SP1 batteries which means three cells connected in series as one parallel connection [2].

5. Types of Drones

Depending upon the need or applications, the drones can have variable size and design. Drones can be classified according to the number of Propeller, according to Size, according to Range, and according to Equipment.

5.1 Rotor drones:

Fig 3. Rotor Drones

The most common construction in rotor type drone is to be multi rotor type designs that have many rotors for holding its position. The single rotor model contain single rotor inside. Another one will be a tail rotor that simply assists to provide control to the heading. In case if we have a mixture of hover possessing heavy loads but need a faster flight time with longer endurance then single rotor type helicopters can be best choice.[5]

5.2 Tricopter:

Fig 4: Tricopter

There are three different types of powerful motors inside a tricopter, three controllers, four gyros and only one servo. The motors are simply placed at every extreme end of three arms and each one of these is holding a location sensor. Whenever we need to lift your tricopter, it is essential to initiate a movement in throttle lever, the gyro sensor will immediately receive its signal and will pass is directly to controller that helps to control motor rotation. A tricopter is able to stay stabilized on its path as it is equipped with so many classic sensors and electronic stuff itself [5].

5.3 Quadcopter:

Fig 5: Quadcopter

When a multirotor is designed with four rotor blades then it becomes quadcopter. These devices are usually controlled by specially designed brushless type DC motors. Two of the motors use to move in clockwise direction whereas other two run in counter clockwise direction. It helps to decide a safe landing for quadcopter. The source of battery for such devices uses to be a lithium polymer battery.[6]

5.4 Hexacopter:

Fig 6: Hexacopter

Hexacopter will serve for many potential applications with its 6 motor mechanism where 3 work on clockwise direction and other three move in anti clock wise direction. Hence, these devices are able to gain higher lifting power as compared to quadcopters.

5.5 Octocopter:

Fig 7: Octocopter

Octo means eight; so octocopter, hence it serves with its powerful eight motors and that send power to 8 functional propellers. This craft naturally have much flying capabilities as compared to units discussed above and are also highly stable. We can avail a stable footage recording with octocopters at any altitude. These devices find application in the world of professional photography.[6]

6. Drones in Agriculture

New technological methods based on Unmanned Aerial Vehicles (UAV) leverage precision agriculture approach that includes crop monitoring which provide farmers real time data about the plant health and crop spraying chemicals over the field. The application of pesticides and fertilizers in agricultural areas is of very importance for crop yields. The aircrafts are becoming increasingly common in carrying out this task mainly because of its speed and effectiveness in the spraying operation. However, some factors may reduce the yield, or even cause damage (e.g. agriculture areas not covered in the spraying process, overlapping spraying of crop areas, applying pesticides on the outer edge of the crop). Particle Swarm Optimization (PSO) is used to reduce the amount of pesticide used and improve the quality of agricultural products as well as mitigate the risk of environmental damage. Recent technologies such as Cloud computing, wireless sensors, communication, networking technologies, embedded systems, Data Mining and Data Warehousing, NANO, Radio Frequency Identification using the standardized Internet routing protocol, IPv6 provide the farmers with new opportunities to use these technologies for holistic innovative approaches.

6.1 Water flow: An optimized irrigation system has become a necessity due to the lack of the exhausting resources like water, oil etc.,. Automatic irrigation of wireless sensor network and Internet technology can be used to improve irrigation water and to reduce cost of irrigation water. Use of Smart phones or wireless PDA can easily monitor the soil moisture content and control the irrigation. Irrigation using sprinklers is widely adopted in agriculture. When a rotating sprinkler malfunctions due to jamming, clogging or being worn out, may cause over watering in some small areas. To overcome the issue the camera based irrigation control system using drones can monitor the sprinklers using standard security cameras and control the sprinklers. The drip irrigation schedule system can saves the cost of water, price of yield, uniformity of the drip irrigation system, crop response to water.

6.2. Pesticide: Identification and monitoring of plant diseases, nutrient deficiency, controlled irrigation and controlled use of fertilizersand pesticides needs to be managed for crops from early stage to mature harvest stage. eAGROBOT (a prototype)is a ground based agricultural robot that overcomes the challenges existing in large and complex satellite based solutions and helpdesk form of solutions available as m-Services. Variable rate spraying control system can automatically change with the variation of duty factor at the fix frequency[7,8]. The characteristics of the flow control system provides development platform, fuzzy control, PID algorithm, PWM, temperature property, response speed for spraying. An optimal pest management strategy of the chemical control needs to be maintained the level below the economic threshold, which makes pesticide residuals and the total dose of the spraying pesticides least, and reduced pest populations. There are several ways for spraying pesticide together with their possible disadvantages such as crops may be crushed when using tractor, pesticide droplets may be perfused unevenly when it is applied by a person, or using aircrafts such as helicopter or plane for spraying may contaminate regions surrounding the target area. We can use Unmanned Aerial Vehicle (UAV), a drone, that is able to fly on and spray farmland autonomously.

6.3 Environmental Monitoring: Similar to emergency response applications, drones can reduce risks of human health in the field of environmental monitoring, because they fill the gap between manned aerial inspections and traditional fieldwork. This way, areas that are difficult to reach, such as contaminated places can be monitored by UAVs, not people in person. Habitat restoration, environmental assessments, monitoring and remediation can be improved by e.g .near-infrared sensors that give insights into details.

6.4 Mid Field Weed Identification: Using NDVI sensor data and post-flight image processing to create a weed map, farmers and their agronomists can easily differentiate areas of high-intensity weed proliferation from healthy crop areas growing right alongside them. Historically, many farmers haven't realized how pronounced their weed problem is until harvesting was performed.

6.5 Cattle Herd Monitoring: Many growers during periods of depressed commodity prices made the call to diversify their farms by adding cattle or swine operations. Drones are a solid option for monitoring herds from overhead, tracking the quantity and activity level of animals on one's fields. They are especially helpful for night-time monitoring due to a human's eye's inability to see in the dark.

6.6 Irrigation Equipment Monitoring: Managing multiple irrigation pivots is laborious, especially for large growers with many fields spread out across a region. Once crops like corn begin reaching certain heights, mid-season inspections of the nozzles and sprinklers on irrigation equipment that deliver the much-needed water really becomes a painstaking exercise. The drones will be much useful in monitoring the irrigation equipment monitoring.

7. Conclusion: The economy of our country is still depended on the agriculture. The implementation of drone will reduce the time and efficiency of the production which leads the higher production. At the same time the cost of the IoT implementation needs to be reduced. This will enable the small farmers to utilize the smart agriculture. The farmer needs to be educated or the agriculture studies could have separate subjects about the current development of IoT and the connected smart world. The fully customizable modular approach needs to be enabled in the agriculture software for adopt the vast area of the agriculture segments.

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