INTELLIGENT WIRELESS TECHNOLOGY USAGE EFFECT IN CONTEXT OF PHYTOSANITARY TREATMENT SPRAYING

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ABSTRACT

In agriculture, pesticides and fertilizers are applied to prevent crop disease and increase plant productivity. As a result of the digitalization of agriculture, human labor is increasingly interacting with intelligent technology through robots to facilitate agricultural operations. The use of intelligent technology protects the natural ecosystem by reducing the major damage caused by the unconventional application of phytosanitary treatments resulting in a flexible, proportional spraying at precise angles, thus avoiding the generation of large amounts of chemicals. This paper presents a short review about the state of the art of wireless sensors networks and how together with robotics can be applied in different fields of agriculture through the prism of sprayers that include a detection system and a wireless controlled sprayer.

INTRODUCTION

Agriculture plays a vital role in the development of human civilization, which is why it is in continuous evolution and digitization.

Since the beginning of this decade, traditional agriculture has been transforming into a modern, also named as intelligent agriculture, which helps to improve crop management and the development of sustainable agriculture [10].

Modern agriculture also uses smart technology to apply plant protection treatments using wirelessly controlled crop sprinklers.

Spraying is intended to treat the aerial strains of plants during vegetation or during vegetative rest, using spray guns, portable appliances, motor vehicles, airplanes and helicopters. It has the advantages of greater effectiveness of treatments than in the case of dust and a lower consumption of active substance [17].

Intelligent agriculture involves many tools and technologies that are used to automate and monitor agricultural activities in real time. WSN has gained worldwide attention in recent years due to the progress in micro-electromechanical systems (MEMS), which facilitates the development of intelligent sensors [4,13].

Wireless sensor networks (WSNs) can be used in agriculture to provide farmers with a large amount of information. Precision Agriculture (AP) is a management strategy that uses information technology to improve quality and production. The use of wireless sensor technologies and management tools can lead to highly efficient organic farming. On the basis of the management of the PA, the same routine can be avoided with a crop, regardless of the location environment. From several perspectives, land management can improve the PA, including the provision of crop-appropriate nutrients and pesticide

waste for effective control of weeds, pests and diseases [8].

Given the excessive use of pesticides, the effect of the additive of environmental and food toxicity residues is an increasingly serious problem that has exceeded the natural degrading capacity of the environment. Thus, it caused groundwater and surface pollution, as well as the accumulation of toxins in food [20].

Therefore, the intelligent equipment technology of pesticide application, which was developed on the basis of agricultural mechanics, is an effective way to promote the health and sustainable development of agriculture, as well as reducing the harmful effects of pesticides on the environment and the human body [19].

This paper presents how the technology of digitization information is one of the key components of modern agriculture and having a significant role in achieving automatic surveillance and intelligent management of the production environment [9,11]. However, the complexity of agricultural land and crop growth have led to new challenges in monitoring and managing agricultural environments.

MATERIAL AND METHOD

New technologies and principles are available for modern agriculture to enable a much more efficient application of pesticides and fertilizers to prevent crop disease and increase plant productivity.

The responsibility of controlling and managing the growth of plants from the early stage to the mature harvesting stage involves the monitoring and identification of plant diseases, constant irrigation and controlled use of fertilizers and pesticides shown in Figure 1[14].

Intelligent technologies, including WSN technology, are applied to the development of modern agriculture. It can be widely used in three areas of agriculture, namely in irrigation management, fertilizer control and pest management.

For the determination of parameters such as temperature, relative humidity, solar radiation, precipitation, wind speed and direction, soil moisture and temperature, leaf moisture and soil pH, certain sensors with different interfaces have been implemented by various researchers and companies.

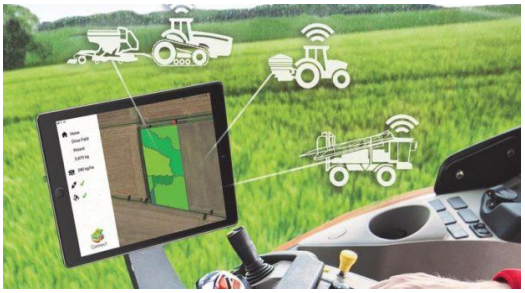

Fig.1. Precision farming technology [5]

The use of pesticides in agricultural production is necessary for soil sterilization, pest removal, prevention and eradication or control of hazards in agriculture, forestry, diseases, insects, weeds and other harmful organisms and intentional regulation of chemical plant growth.

Applying Wireless Network (WSN) technology is the main way to solve the problem of in-situ access. Additional information on crops perceived using wireless sensor networks reaches the agricultural environment through integrated sensors deployed in the agricultural land area, these sensors cooperating with each other to perceive and monitor soil and weather in real time.

In addition, this information will be transmitted to the diagnostic decision-making center by wireless communication with random self-organization over the network, which carries out remote

monitoring and management of the agricultural environment. Recently, WSN in the agricultural field on environmental information have been significantly developed and are used in agricultural irrigation, cultivation and fertilizer management [1,16].

The manual traditional operations of liquid pesticide spraying involve exposure to the toxic working environment, which harms the human body. Thus, spraying robots could effectively insulate pesticides in direct contact with plants without human exposure in the spraying process [12].

RESULTS AND DISCUSSIONS

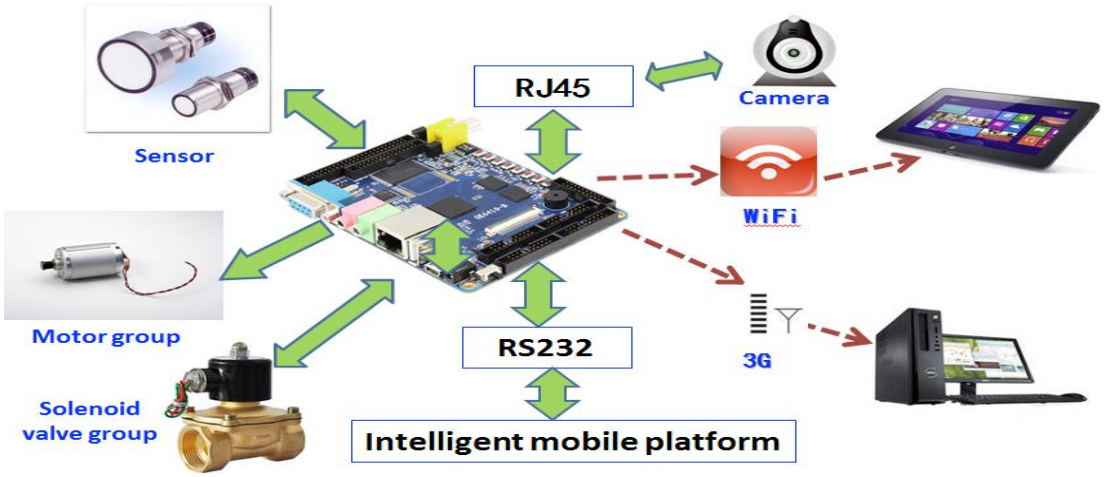

Fig.2. Structure of a wireless monitoring system architecture for the sprinkler equipment [21]

Wirelessly controlled sprinklers are usually composed of: a rotating pesticide selection unit, a real-time mixing unit, a multi-angle spray unit, a real-time image collection module that provides environmental information, a built-in control module, a wireless communication module (figure 3) and a smart mobile platform, with a principial example shown in Figure 2.

This type of machine is specially designed for hilly areas, greenhouses, orchards and other surfaces that do not allow access of large and medium-sized sprinklers [3]. An intelligent monitoring system was developed to improve the safety and intelligence of pesticide spraying machines. Focusing on the mechanical structure of the pesticide spraying machine, the ZigBee technology-based design project was proposed [6].

The monitoring node of the rotary pesticide selection unit, monitoring node of the real-time
preparation unit, monitoring node of the nozzle unit, Wi-Fi camera image collecting module, monitoring node of the intelligent mobile platform, and PDA controller were also designed.

The wireless communication of Wi-Fi technology enabled the robot to move in four directions as front, back, right and left. Commands can be transmitted to move robot into forward, reverse, stop, left, and right direction. The microcontroller in the proposed model enabled sundry functions in the field according to the commands received from phone.

The design of the wireless sensor node uses the modularizing design method, the architecture of the terrestrial WSN is shown in Figure 4, the underground WSN uses nRF905 wireless

chip instead of CC2430 RF chip, the structure of the entire nodes composed of sensor module, processor module, wireless communication module and energy supply module.[18]

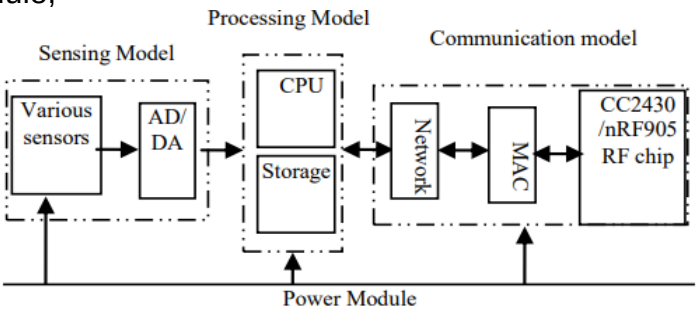

Fig.3. Wi-fi module [15] ***Fig.4. Architecture of wireless sensor network node* [18]**

The field of robotics is making real progress, gradually turning traditional agriculture into automated agriculture. The application of robotics in the field of machine design and the performance of tasks using agricultural vehicles has led to increased investment and research.

Continuous monitoring of the agricultural field is possible due to the automatic performance of these agricultural vehicles. The skills of agricultural vehicles can be classified as independent detection, action and steering to a particular target as well as mapping.

Vehicle navigation mode is called guidance, the extraction of environmental characteristics is called detection, and the execution of the assigned task is called action, and the mapping of the field with its characteristics is mapping. All four categories are interdependent.

One representative paper which presents a robotic vehicle used in agriculture to spray harmful pesticides is [17]. This robot involves the use of the PIC Micro controller to check the movement of the robot using navigation buttons and a receiver (Bluetooth mode). The mounted wireless camera follows the path taken by the robot.

This cost-effective robotic vehicle can improve productivity, safety in agricultural applications and meet work demand.

The farmer can control the pesticide sprinkler via the IoT (Internet of Things) app. The robot, as placed in the field, captures the image indicating the cause of the problem, thus providing the ability to monitor and view the cultures or path of the robot using the wireless camera.

The signal is received at the end of operation and viewed using the mobile device. Thus, the identification of the obstacle is very possible and simple, and the image of the obstacle is transmitted directly to the farmer.

Features:

- Compact and low cost;
- Possibility of displaying the number of parameters on the LCD screen;
- Fast operation because a chip embedded in RISC architecture is used;
- Covers 50 m away.

Applications:

- Used in farms and fields;
- Used in hardware industries and business units;
- Used for gardening;
- Used for the maintenance of public properties and parks.
- It can also be used in the automotive industry to spray paint.
- This Agribot can be a multifunctional device used in the current Covid-19 scenario to sanitize affected areas using Wi-Fi and Bluetooth without personal contact.

• Provides agricultural security, with human involvement minimized.

Fig.5. Agribot [2]

Another example of a robotic spraying system is provided in [7]. The spraying robot is endowed with an electric drive which allows for constant working speed performing very precise and repeatable phytosanitary substances application. The ramp of the spraying device can be customized in various different lengths and can be used horizontal or vertical. Because of the remote control, the operator doesn't come into contact with the toxic substances.

Fig.6. Spraying electric robot [7]

In [6] is presented a spraying robot designed for greenhouses. The tube/rail spraying robot uses the tubes of the heating/transport system to navigate between the beds. Also, the robot automatically moves from one row to another on the main path. The fully automatic robot works without human intervention.

The robot is also available in a semi-automatic version. The transport unit is moved by hand from one path to the next. Therefore, it needs an operator to guide the machine in the process. Both versions deliver the same high spraying quality, since the spraying units are identical.

Fig.7. Greenhouse spraying robot [6]

CONCLUSIONS

Wireless data communication technology and sensor networks has become one of the key areas in IOT application in modern agriculture.

The Internet of Things has a general influence in connecting devices and collecting statistics.

Such agricultural monitoring systems serve as a reliable and efficient system and corrective measures can be taken.

Wireless field monitoring reduces human effort and thus allows identification of the damage that causes crop problems.

Wireless field monitoring together with robotic intelligent pesticide spraying systems are an innovative alternative that successfully replace manual spraying, thereby reducing the operator's direct exposure to pesticide toxicity, improving crop productivity growth.

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