



# Research on Training Pilots of Agriculture and Forestry Protection Drone by MR Technology

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**Abstract.** With the rapid development of China's agricultural modernization, horticultural plant pest control and agricultural and forestry protection need to realize spraying through ground remote control or navigation flight control. However, whether UAV sprays toxic and harmful drugs or powders are not suitable for students' practical teaching, resulting in students' difficulty in understanding, lack of practical operation experience and unsatisfactory teaching effect. In order to solve the problems of lack of training equipment, relative lack of curriculum resources and single teaching means in the teaching of UAV application technology specialty, this paper studies the application of mixed reality technology (MR) in the teaching of UAV application technology specialty, and takes the teaching of UAV agricultural and forestry protection as the carrier to solve the pain points in teaching, Improve the application of information-based teaching ability in majors, and explore new ways to improve the quality of talent training. Create a new teaching and training experience with unprecedented authenticity, interest, security and convenience, significantly improve the effect and reduce the teaching cost.

**Keywords:** Aided-Teaching MR · UAV agriculture forestry protection · Pilots training

## 1 Introduction

China is a large agricultural country. With the rapid development of social economy, China's agricultural construction technology is becoming more and more advanced. In recent years, a variety of polluting and toxic agricultural products continue to enter the market, which has seriously affected people's life safety and social stability and development. In order to meet the requirements of social development, green and environmental protection planting technology should be used for agricultural production to provide people with safe and assured crops.

At present, an important trend of agricultural development is ecological agriculture, which is to give consideration to environmental protection in agricultural production, do not damage the environment, and realize the high yield of agricultural production on this basis. In order to meet people's requirements for crop products and ensure the ecology,

efficiency, safety, high quality and high yield of agricultural production, it is necessary to change the traditional agricultural production mode, use advanced scientific production technology and methods, use advanced management concepts to guide agricultural production and promote the development of agricultural production.

China's pesticide machinery research is relatively backward, the operation efficiency is low, the pesticide utilization rate is not high, there is a lack of efficient multi-functional pesticide machinery, the product quality of pesticide machinery is unstable, the overall performance is poor, the atomization quality is poor, and the drip phenomenon is serious. According to statistics, the highest effective utilization rate of pesticides in China is less than 30%, but the loss is as high as 60–70%. The efficiency of pesticides is low, which is harmful to the quality and safety of agricultural products, ecological environment and personal safety. Therefore, it is imperative to improve the spraying effect, operation quality and effective utilization rate of pesticides [1].

UAV is an unmanned aircraft operated by radio remote control equipment and self-contained program control device. As a new high-tech industry, it initially had a huge market demand in the military field. In recent years, with the development and progress of technology, the application of UAV has gradually extended from the military field to the civil field, and the application scope has been continuously widened. It is becoming more and more mature in the industries of consumption, plant protection, electric power, security, surveying and mapping and so on. UAV application is playing a more and more important role in national economy and social production and life [2].

In 2020, the civil UAV industry will continue to develop rapidly, with an output value of 60 billion yuan and an average annual growth rate of more than 40%. According to the prediction of the Ministry of human resources and social security, by 2025, considering the development law after the improvement of industrial maturity, the civil UAV industry will gradually mature from high-speed growth. According to the average annual growth rate of 25%, the output value of civil UAV will reach 180 billion yuan by 2025. Under the market demand of the UAV industry, the UAV driver profession came into being. The birth of a new profession made the UAV operation more professional, legal and standardized, and provided professional skills support for the rapid development of the industry [3].

As a new plant protection machine, agricultural and forestry protection UAV has the advantages of high operation efficiency, fast speed and less drift. In recent years, the development of plant protection UAVs has been strongly supported by the state and the government. Enterprises and scientific research institutes studying plant protection UAVs are gradually increasing. The developed plant protection UAVs are more and more accepted by the majority of farmers. At present, agricultural UAVs have occupied an important position in the field of aviation plant protection equipment.

Unmanned aerial vehicle (UAV) agricultural and forestry protection “– plant protection UAV spray operation as one of the main contents of the course is the working skill that must be mastered by UAV application technology students. However, the chemicals and powders sprayed by UAV are toxic and harmful to human body. Because students are not skilled in UAV operation, they are prone to poisoning accidents, so they are not suitable for students' practical training and teaching. It leads to students' difficulty in understanding, lack of practical operation experience and unsatisfactory teaching effect.

In order to enable students to experience the effect of real plant protection UAV spraying, intuitively understand the concept of droplet density and deposit volume, accurately evaluate the spray performance of UAV, and grasp the operational standard of plant protection UAV under the influence of ground effect. Huizhou engineering Career Academy has proposed a new digital system under the background of 3D simulation, multi-media and virtual reality technology. The main structure of the system is a teaching system based on mixed reality technology (MR), which involves the flight control, disassembly and maintenance, spraying diagnosis and other practical operations of plant protection UAV. Through the learning of mixed reality technology (MR) teaching system, students can accurately master the actual control technology of plant protection UAV, find and correct their errors in the flight control process of plant protection UAV, ensure the rationality of chemical spraying and the accuracy of control, and improve learning efficiency. Achieve the working ability that can be slowly obtained in five or six years of practice in a short time to meet the demand for technical talents in the plant protection UAV industry [4].

## 2 Mixed Reality Technology

Mixed reality technology is the latest technology of magic leap. It was first introduced by Intel at the 2016 idf16 developer conference in San Francisco. The virtual scene it creates can enter real life. For example, seeing a scene in the eye through a device can measure the scale and orientation of objects in real life, Its biggest feature is that the virtual world and the real world can interact [5].

At present, the main application fields of mixed reality technology include: medical treatment, military, aviation and games. However, the research and practice of mixed reality technology in the field of education are relatively few. Foreign educators Mullen, Baker and Brooks first proposed to develop virtual teaching products, software and environment based on mixed reality technology to assist teachers' teaching practice. Through the application of mixed reality technology, teachers can build education and teaching environments such as virtual classroom and virtual laboratory, develop new education and teaching methods such as virtual lesson preparation, virtual teaching and virtual examination, promote learner centered personalized learning and promote the transformation of teaching mode [6].

In foreign countries, mixed reality technology has some application attempts in the field of education. For example, pointmedia in Norway brought Microsoft's mixed reality technology hololens to the classroom to show cosmic galaxies and teach stem courses to help students understand the solar system. Canberra grammar school in Australia uses "3D periodic table application" to help students remember the boring chemical periodic table. It can not only learn the periodic table in the air, but also interact with a single element, combine multiple elements and see the effect after reaction. In addition, mixed reality technology is applied in biology, architecture, music and other disciplines.

At present, domestic higher vocational colleges have not carried out the teaching application research of mixed reality technology in UAV agricultural and forestry protection industry, but virtual reality technology has been applied in higher vocational colleges. With the maturity of virtual reality technology, people begin to realize the

application value of Virtual Reality Laboratory in the field of education. In addition to assisting scientific research in Colleges and universities, it also has many advantages in experimental teaching, such as high utilization rate, easy maintenance and so on. In recent years, many domestic universities have established some virtual laboratories according to their own scientific research and teaching needs. There are four kinds of Virtual Reality Laboratory and desktop Augmented Reality Laboratory in China: Virtual Reality Laboratory and Virtual Reality Laboratory.

According to the research status at home and abroad, mixed reality technology has broad application prospects in the field of education and training, especially in the training of practical technical skills in vocational colleges, it can give full play to its advantages of high interactive, immersive and experiential learning [7].

### **3 Related Educational Theories**

#### **3.1 Experiential Learning**

Experiential learning refers to recognizing knowledge or things through practice and experience, or enabling learners to fully participate in the learning process, so that learners can truly become the protagonist of the classroom. Traditional learning is external to students, but experiential learning, like any other experience in life, is internal and the income of personal participation in body, emotion and knowledge. Because of the whole-hearted participation, the learning efficiency, knowledge understanding and knowledge memory durability are greatly improved. The efficiency of experiential learning method is 3–5 times that of traditional learning method. Therefore, this immersive mixed reality holographic teaching mode can effectively improve students' understanding of UAV agricultural and forestry protection related knowledge points and mastery of control skills [8]. Experiential learning.

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#### **3.2 Constructivist Theory**

The The constructivist teaching model is summarized as follows: taking students as the center, teachers play the role of organizer, mentor and promoter in the whole teaching process, make use of learning environment elements such as situation, cooperation and conversation, give full play to students' initiative, enthusiasm and initiative, and

finally achieve the purpose of enabling students to effectively realize the construction of current knowledge. Mixed reality technology has the characteristics of virtual reality combination, real-time interaction and three-dimensional registration, which can improve the efficiency of students' meaning construction of knowledge and skills. The holographic teaching of MR technology follows the learning theory of constructivism, and the learning activities are reflective and innovative, so as to realize the reflection on the work content, working environment and personal actions in the vocational field, so as to promote the innovation of vocational learning. Through information means, we should transform the complex work reality into learners' controllable learning situation, learning content and communication mode, and provide technical support for learners' knowledge construction in the process of action. MR technology holographic teaching also provides a new way for career learning and career development, changes the traditional way of career learning, systematically designs the learning tasks of cross career and multi learning places supported by information technology, and realizes the transformation from cognitivism to contextualism [9].

### **3.3 Holographic Technology Improves Learning Efficiency**

Holography is complete information. With the continuous progress of holographic technology, its advantages are constantly highlighted and more widely used. Educational experts believe that the rational and effective integration of holography with education can change the way of intelligent learning, make learners change from learning from teachers to learning from resources, and make classroom teaching more vivid and active; At the same time, it also provides a more convenient and advanced equipment environment for smart classrooms and smart laboratories. Among them, mixed reality technology is the most effective technical means to build a holographic teaching system. By introducing real scene information into the virtual environment, an interactive feedback information loop is set up between the virtual world, the real world and users, so as to enhance the realism of user experience [10].

## **4 Construction of UAV Agricultural Forestry Protection Teaching Using MR Technology Project in Huizhou Engineering Vocational College**

Huizhou Engineering Vocational College is a municipal public higher vocational college approved to be established in 2017, formerly known as Huizhou agricultural school established in 1950 and Huizhou Industrial Science and technology school established in 1973. The college has nearly 60 years of school running history of secondary vocational education and has a rigorous and high-level teaching staff, including 99 associate professors and more than 100 doctors and masters. One won the title of national excellent educator, one won the title of national model teacher and famous teacher of "special support plan" in Guangdong Province, 10 won the title of chief teacher in Huizhou, 20 won the title of excellent teacher in Huizhou, and 10 won the title of rookie in Huizhou education. In recent years, the teachers of the college have undertaken and participated in more than 30 provincial and municipal scientific research topics, published more than

50 academic monographs, published more than 2000 papers in academic journals at home and abroad, including nearly 300 papers in core journals at home and abroad, and ranked among the top universities of the same kind in the province [11].

Huizhou Engineering Vocational College has good hardware facilities and advanced teaching and management facilities such as intelligent manufacturing, Haier Smart Home Internet of things training base, electronic integration, automatic control, industrial robot production training center, Ruijie network, new energy vehicle training base, cold chain logistics center and professional basic laboratories. During the 14th Five Year Plan period, the college focused on building and transforming the virtual reality experiment and training room into a productive and service-oriented base, integrating the functions of teaching, training, vocational skill appraisal and technology R & D.

The spraying agent of UAV is toxic and harmful to human body. Improper operation of student machine is easy to lead to poisoning accidents. It is not suitable for students' practical training and teaching, resulting in difficulties in students' understanding, lack of practical operation experience and unsatisfactory teaching effect. In order to solve the problems of insufficient training equipment, relative lack of curriculum resources and single teaching means in the current UAV agricultural and forestry protection teaching, Huizhou engineering vocational college studies the application of mixed reality technology (MR) in UAV professional teaching, and takes the teaching of UAV agricultural and forestry protection as the carrier to solve the pain points in teaching, Improve the application of information-based teaching ability in majors, and explore new ways to improve the quality of talent training.

At present, in order to solve the problem of insufficient teaching and training equipment, many domestic colleges and universities have built VR training rooms to make the equipment structure, principle and maintenance process into virtual three-dimensional animation. Students can use VR technology to conduct virtual operation of setting actions. Users can watch virtual images without the support of real equipment by wearing intelligent glasses. However, VR is a pure virtual digital picture, and its learning resources are relatively scarce. There is a large gap between virtual operation and real operation, so it is difficult to achieve the ideal learning effect. MR is a combination of digital reality and virtual digital picture, which belongs to the combination of virtual and reality, that is, Mr can let users see the reality that can not be seen by naked eyes through a camera. The new MR technology will be put into richer carriers. Relevant research work considers helmets, mirrors and transparent equipment as new carriers [12].

VR technology makes it more difficult for users to see the real world than Mr technology; In terms of delay, the current mainstream VR equipment only needs to limit the delay to less than 20 ms to obtain acceptable effect, but MR needs to reduce the delay to less than 10ms at least; In terms of interaction with the real world, VR only needs to know the user's own state to interact with the virtual world, while Mr also needs to know all kinds of information of the surrounding real world in order to make the virtual digital object interact with the real world dynamically. At present, mixed reality (MR) has not formed a unified technical standard, and major technology giants are still exploring. Compared with the "low threshold" of VR hardware equipment, the cost of MR head display equipment is higher, which also hinders the large-scale application in schools.

In the professional teaching of UAV related to agricultural and forestry protection, mixed reality technology is more suitable for the practical operation of UAV equipment cognition, disassembly and maintenance, flight control and spraying, especially for the demonstration of pesticide and powder spraying control, and the study of performance evaluation such as droplet density and deposition of UAV. On the premise of ensuring the safety of students, Quickly master the specifications, steps and results of spraying operation of plant protection UAV, so as to obtain intuitive onsite feedback that cannot be felt in the traditional teaching environment and deepen understanding and memory. At present, there is little research on the application of MR technology to the field of modern agriculture, and the same is true in the teaching of UAV agricultural and forestry protection. The construction is very urgent.

Mixed reality technology (MR) is a further development of virtual reality technology. By introducing real scene information into the virtual environment, it sets up an interactive feedback information loop between the virtual world, the real world and users, so as to enhance the realism of user experience. The application of mixed reality technology in the cultivation of UAV agricultural and forestry protection talents is more unique and forward-looking. The scientific fields involved mainly include mixed reality technology (MR), holographic technology, UAV application technology, horticultural plant pest control technology, Computer Science (flash, 3D Max), pedagogy, etc. When the traditional teaching methods and means are difficult to meet the teaching needs, the combination of virtual and reality displayed in the form of mixed reality will improve students' interest in learning, make them more clearly observe the composition, structure, flight control and spraying of agricultural and forestry protection UAV equipment, and improve learning efficiency, Reform the teaching methods and means of UAV agricultural and forestry protection.

Huizhou Engineering Vocational College combines the training objectives of the course with MR technology, formulates teaching standards, constructs teaching resources and teaching platform, and creates a complete and fine three-dimensional model of agriculture and forestry growth and case characteristics in UAV agricultural and forestry protection; Divide knowledge points according to the requirements of knowledge objectives and ability objectives in the curriculum system; In the process of teaching implementation, Mr technology is used to display and demonstrate the knowledge points in a virtual environment, so that students can simply, intuitively and conveniently learn the agricultural basic knowledge of UAV plant protection, diseases and pests, safety, maintenance, flight operation, function and maintenance of mainstream plant protection UAVs, Be able to study the working process of UAV spraying in an all-round way in MR environment, and reflect and improve teaching.

## 5 Construction Significance

The introduction of mixed reality technology (MR) into the training of UAV agricultural and forestry protection courses has changed the traditional laboratory training mode, broken through the time and space constraints of the learning process, helped to assist the development of teaching activities and improve the training effect. The development of the system integrates "theory, demonstration, training and feedback" and integrates

“teaching, learning and doing”, which can effectively cultivate the comprehensive application ability of users. At the same time, using virtual training instead of physical training teaching can solve the problems of equipment cost and difficult observation, which is of great value and significance to reduce cost and improve efficiency [13].

### **5.1 Theoretical Significant**

In the application research of UAV holographic teaching of agricultural and forestry protection course based on mixed reality technology, there is no relevant case in the research literature at home and abroad, which is novel. Subsequently, according to the growth process of crops, the high incidence period of diseases and pests and the picture characteristics of different diseases and pests, image samples can be collected respectively to make a virtual resource database. Through the storage and application of horticultural plant pest control and UAV agricultural and forestry protection knowledge and expert experience, simulate the thinking of experts through artificial intelligence methods, analyze faults, and obtain expert level diagnosis and maintenance level. Based on the history of UAV operation and analysis of UAV in agriculture and forestry protection industry, it provides the common solutions for UAV operation in agriculture and forestry protection industry. According to the current data information of UAV and the expert experience knowledge given by artificial intelligence, the management of agricultural remote visual diagnosis, control, early warning and treatment can be realized. So as to assist field technicians to make correct judgments on water, fertilizer, temperature, humidity, organic matter, diseases and pests in the plant growth stage, which can improve the efficiency and accuracy of UAV agricultural and forestry protection, and has certain theoretical research value in teaching application [14].

### **5.2 Practical Significant**

First, through the research of this subject, the principles, strategies and implementation ways of applying mixed reality technology to UAV agricultural and forestry protection course are summarized. Under the framework of talent training program, the teaching mode, teaching methods and means are reformed and innovated, which will effectively stimulate students' learning interest and improve students' professional skills, It has strong practical significance for students' personal growth and social needs.

Second, break the restrictions of space and time, save cost and improve teaching effect. Due to the limitations of UAV training courses related to agricultural and forestry protection, such as equipment, site, funds and safety, many experiments cannot be carried out. The use of mixed reality technology can completely break the restrictions of time and space. Students can do all kinds of experiments without leaving home. They can gain the same experience as real experiments without risk. On the premise of ensuring the teaching effect, the cost is greatly saved.

### **5.3 Popularizing Significant**

In The research results of this subject will play a good reference and reference role for other majors to apply mixed reality technology and reform teaching mode. The

correct way to implement vocational education is that in the vocational work situation, learners master knowledge and skills by participating in the professional activities of the community of practice. Therefore, the informatization of vocational education must also enable learners to subjectively construct their work intention, knowledge and skills in a real or virtual work environment, and put forward informatization solutions for work tasks, so that learners can cultivate professional ethics and professional identity while acquiring and mastering knowledge of the work process. Learners need real typical work tasks and work processes, complex action space, a certain degree of freedom and action authority. Therefore, the informationization of vocational education must be based on the characteristics and laws of vocational education, and use information technology to provide learners with a medium of interaction and exchange learning in different working situations.

To sum up, this study aims at promoting the organic connection of UAV education chain, talent chain, industrial chain and innovation chain, takes improving talent training quality as the core, closely focuses on the theme of professional construction and curriculum reform, focuses on student competition activities, research project application, scientific research achievement transformation, social and technical services, makes systematic planning, overall promotion and key breakthroughs, Realize the purpose of “professional guidance, peer assistance, exchange and discussion and common development” of the studio. Strive to form a UAV application technology teaching and research teacher team integrating “learning, production, research, training and training” after about three years of cultivation and construction, and give full play to the demonstration, guidance and radiation driving role of the studio in talent training innovation, professional construction optimization, curriculum reform practice, scientific research project application, achievement transformation and promotion, social and technical services, etc., Enhance the adaptability of UAV professional construction to industrial development, and further enhance the contribution of UAV professional personnel training to the economic and social development of the whole province and even the Great Bay area of Zhuhai, Hong Kong and Macao.

## 6 The Following Key Issues

Huizhou Engineering Vocational College is steadily promoting information-based teaching, including virtual reality (VR), augmented reality (AR), mixed reality (MR) and other projects. At present, the construction of UAV application technology training room has been completed and MR equipment has been purchased. MR equipment includes binocular Mr holographic smart glasses, binocular ar smart glasses, holographic teacher teaching platform Mr live, holographic courseware creation platform Mr studio, holographic enterprise school student interaction platform Mr world, etc. The basic holographic projection equipment, network equipment and basic supporting equipment of the training room shall be jointly constructed by the school enterprise cooperation unit and the school.

With the implementation of the project, the college will establish a virtual simulation training room for UAV agricultural and forestry protection, develop UAV agricultural and forestry protection holographic resources and resource management platform, meet the practical training of students majoring in UAV application technology, improve

teaching quality, improve students' interest in learning, and help the great leap forward development of the college. Huizhou Engineering Vocational College will solve the following key problems in the next step:

(1) Taking UAV spraying operation as the carrier, this paper explores the application of mixed reality in UAV agriculture, forestry, plant protection and prevention industry. Taking the three-dimensional agricultural and forestry model resources with rich growth and case characteristics in the course of UAV agricultural and forestry protection as the spraying operation object of UAV, this paper explores the implementation ways and main contents of applying mixed reality technology to the relevant courses of UAV agricultural and forestry protection industry. This paper summarizes the organic integration strategies and evaluation methods of mixed reality technology and higher vocational courses, so as to provide reference for other majors to carry out the curriculum teaching mode reform based on mixed reality technology.

(2) Relying on the holographic teaching mode, realize the work process oriented learning

Work process orientation is realized in the application of mixed reality (MR) holographic teaching. Information technology and modern agricultural production mode put forward higher requirements for the key professional ability of agricultural technicians, which can only be obtained in the process of work. Mixed reality (MR) holographic teaching can promote this "vocational learning in the process of work". Take learners as the center, help learners understand learning objects, follow the principles of work process orientation and action orientation, and cultivate students' professional action ability, including professional ability, method ability, social ability and personal ability. Mixed reality (MR) holographic teaching can also promote learners' joint participation, help learners complete comprehensive work tasks in specific work areas, work environments and working conditions, and integrate learning into the work process.

(3) Relying on holographic teaching platform to improve teaching effect

A complete holographic teaching platform based on mixed reality technology is studied and developed, and applied to the teaching practice of UAV agricultural and forestry protection course. Under the holographic teaching mode, establish a complete and fine three-dimensional model of agricultural and forestry growth and case characteristics, and build a learning system from the agricultural basic knowledge, diseases and pests, safety and maintenance of UAV plant protection to the flight operation, function use and maintenance of mainstream plant protection UAVs, so as to realize the integration, dynamic and realistic expression of knowledge. The interaction of students' classroom participation has been increased to 100%, the average skill level has been improved by more than 80%, and the teaching effect has been significantly improved compared with the traditional model; According to the talent training goal of UAV application technology specialty, students can skillfully master the practical skills related to UAV agricultural and forestry protection course through mixed reality technology.

## 7 Conclusion

Based on the course of UAV agricultural and forestry protection, this paper studies and uses mixed reality technology to solve the pain points of traditional teaching mode, in order to improve the training quality of UAV application technology professionals. It is proposed to construct a new teaching mode of UAV agricultural and forestry protection by means of mixed reality technology, which better fills the gap in the application of agricultural and forestry mixed reality technology in domestic vocational colleges. It is expected to greatly improve the teaching effect and better cultivate students' practical operation skills. The core content of the teaching mode is: student-centered, teachers use the holographic teaching mode to immerse students in learning the professional course content, and focus on solving the problems existing in the current UAV agricultural and forestry protection course, such as the lack of training equipment, the teaching mode does not adapt to industrial development, the operation capacity is prone to poisoning and other safety accidents.

From the perspective of systematicness, professionalism and practicality, combined with relevant educational theories, this paper explores the application of mixed reality technology in UAV agricultural and forestry protection course, and explores the construction strategy, main content and implementation way of the application of mixed reality technology in a specific course. So as to effectively improve the training quality of students majoring in UAV application technology, and provide reference for other majors to carry out the curriculum teaching mode reform based on mixed reality technology.

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## References

1. Bu, X.: Analysis of the status quo and industrial development of UAV agricultural plant protection. *New Agriculture* **14**, 85–86 (2021)
2. Zhang, Z.: Plant protection drones become the “new favorite” in the field. *Xing’an Daily*, (003) (20 July 2021)
3. Ying, J., Yang, Y., Lin, Z., Ying, Y., Zhou, N., Wang, H.: Several thoughts on the promotion of plant protection UAV flying defense technology in Xianju county. *Bulletin of Agricultural Science and Technology* **07**, 8–11 (2021)
4. Ma, C., Yuan, Y., Xu, Y., Tan, L., Yuan, Y.: CFD-based flow field numerical simulation and cooling characteristics analysis of agricultural plant protection drones. *J. Shaanxi Univ. Sci. Technol.* **39**(04), 136–141 +181 (2021)
5. Chen, S., et al.: Influence of lateral wind on droplet drift of plane fan nozzle of aerial plant protection UAV. *J. South China Agric. Univ.* **42**(04), 89–98 (2021)
6. Lu, X.: Dongying city, cultivate rural craftsmen and help rural revitalization. *Shandong Human Resources and Social Security* **07**, 48–49 (2021)
7. Zhang, J.: The unified defense rule starts to defend Xiaozhan rice. *China Agric. Mater.* **26**, 15 (2021)
8. Sun, J., Kang, Z.: “Flying prevention” of rice diseases and insect pests is imperative. *Ningbo Daily* (A06) (13 July 2021)

9. Yao, Y.: The role of agricultural plant protection drones on the development of modern agriculture. *New Agric.* **13**, 61–62 (2021)
10. Sun, Z., Lan, Y.: Development status and promotion of Heilongjiang plant protection drones. *China Collective Economy* **22**, 161–162 (2021)
11. Zhang, S.: Plant protection drones to prevent and control crop diseases and insect pests. *Agricultural Development and Equipment* **06**, 139–140 (2021)
12. Lei, J.: Analysis of the advantages and disadvantages of plant protection UAVs in practical applications. *Agricultural Staff* **12**, 81–82 (2021)
13. Wei, S.: Research on the application of plant protection drones in the control of rice diseases, pests and weeds. *Nongjia Staff* **12**, 85–86 (2021)
14. Song, B., Dong, Y.: Xiuzhou District promotes the large-scale application of plant protection drones. *Quality and Supervision of Agricultural Machinery* **06**, 10 (2021)