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Robust FPV Drone Vision by Artificial Intelligence Technology

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Abstract

Ground station remote control of drones is the key for advancing this technology into commercial use. For example, reliable ground control is required when human intervention is needed. Manual flights were also required to collect various data sets for training the deep-control system. This axiom applies even more to drones, where there is no easy way to capture the best possible navigational footage. In this case, enhancing the ground control capabilities of drones through precise control devices. To enhance the ground control experience and thus the quality of the footage, we suggest robust remoting-system to a full-immersive experience, providing the operator with a clear vision, and first-person perspective (FPV) view through a Head-Mounted -Display (HMD). We do practical tests by having users (n=10) try to fly the drone in the suggested area. Flight tests have shown that users operating our system can successfully fully position perception, and land using the HMD headset. This only affects mesoscopic vision. The immersive experience gives a more accurate and realistic rhythm during the process of controlling the drone, which achieves an enjoyable flying experience. Our method provides higher accuracy of flight perception, leading to higher accuracy, which translates into fine flight data for training comprehensive drone control policies. The system depends on developing the ability to see the drone by using artificial intelligence techniques that stimulate the capabilities of virtual reality in enhancing the vision of users. This was evident through the tests conducted on the ten people as samples, whose results were approved during this approach.

Keywords: Drone, Virtual Reality, HMD, FPV, Fully immersive

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تقوية رؤية الطائرات بدون طيار FPV خلال تكنولوجيا الذكاء الاصطناعي

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المستخلص

يعد التحكم عن بعد في المحطة الأرضية للطائرات بدون طيار مفتاحًا لتطوير هذه التكنولوجيا في الاستخدام التجاري. على سبيل المثال ، يلزم وجود تحكم أرضي موثوق عند الحاجة إلى تدخل بشري. كانت الرحلات الجوية اليدوية مطلوبة أيضًا لجمع مجموعات بيانات مختلفة لتدريب نظام التحكم العميق. تنطبق هذه البديهية بشكل أكبر على الطائرات بدون طيار ، حيث لا توجد طريقة سهلة لالتقاط أفضل لقطات ملاحية ممكنة. في هذه الحالة ، فإن تحسين التحكم الأرضي وتطوير أنظمة الطائرات بدون طيار الدقيقة هما وجهان متماثلان. لتعزيز تجربة التحكم الأرضي وبالتالي جودة اللقطات ، نقترح ترقية نظام التشغيل عن بعد الموجود على اللوحة إلى إعداد غامر بالكامل ، مما يوفر للمشغل رؤية مجسمة ومنظور الشخص الأول (FPVمن خلال سماعة مثبتة على سماعة الرأس الواقع الافتراضي (VR).نحن نختبرها من خلال جعل المستخدمين (ن = 10) يطيرون بطائرتنا بدون طيار في الميدان. أظهرت اختبارات الطيران أن المستخدمين الذين يشغلون نظامنا يمكنهم بنجاح تحديد موضع الإدراك بالكامل والهبوط باستخدام سماعة الرأس .HMDهذا يؤثر فقط على الرؤية الوسيطة. يقبل إعداد الاستريو الغامر لدينا إدراكًا أكثر دقة وعمقًا ، والذي له آثار خالصة على أفضل تشغيل عن بُعد وملاحة بدون طيار. توفر

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معلومات البحث
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طريقتنا دقة أعلى في إدراك الطيران ، مما يؤدي إلى دقة أعلى وأفضل عملية عن بُعد ، والتي تُترجم إلى بيانات طيران دقيقة لتدريب سياسات شاملة للتحكم في الطائرات بدون طيار. يعتمد النظام على تطوير القدرة على رؤية الطائرة بدون طيار باستخدام تقنيات الذكاء الاصطناعي التي تحفز قدرات الواقع الافتراضي في تعزيز رؤية المستخدمين. وقد تجلى ذلك من خلال الاختبارات التي أجريت على العشرة أشخاص كعينات ، والتي تمت الموافقة على نتائجها خلال هذا النهج.

الكلمات المفتاحية : طائرة بدون طيار ، واقع افتراضي ، HMD ، FPV ، الانغماس الكلي

1. Introduction

The rapid technical development of remote control systems for drones, in itself represents a great challenge in simulating driving these unmanned vehicles independently and experiencedly, especially for amateurs and other users. This is a realistic scenario that coincides with the growing need for drones in capturing scenes and documenting events. [1]. Drones fly at more speeds and can be dangerous tasks that may cause big problems. Therefore, the transfer of ground control must be of high-speed. The remote operation has implications not only important for the navigation of drones, but also for the development of autonomous systems, as captured recording frames can be used to train new pilots. Therefore, it is possible to find a mechanism that represents an actual combination between the human control of the controller of the drones and those drones in the drone's area to achieve an integrated scene between the user on the one hand and the flying machine on the other hand [2].

Drones were the most important consumer product of 2016. The past year has seen a real hardware revolution and software used in the manufacturing process and Control of the drone. This makes it easier for these devices the ability to move, the ability to fly safer, the ability to shoot video Professional quality HD footage and photos. In a recent study [3], it was clearly observed that UAVs is about to completely change human life and industry. The most important aspect is that it can be used effectively Monitoring in places that humans cannot reach. It arrives by reducing the cost of UAVs, and the cost of avionics systems is low Make a prototype [4]. It also makes the structure light and strong.

Current technologies for controlling drones can be from a first-person perspective (FPV) or a third-person (TPV). TPV-type operations create control issues because it is difficult for the operator to guess the drone's direction and they may do so. They are not being able to do eye level contact at a low distance (>150 m). Moreover, given effective of human anthropomorphism, limited to 24 meters, estimating the location of the drone is difficult for the controller to determine in relation to nearby sites or objects in order to avoid hitting obstacles and objects that impede the path of the unmanned vehicle [4]. In this case, on the ground the farther you are from the plane, the more difficult it is to control it. Some drone setups couple head tracking with the camera's mechanical controls 3 to create a coherent somatosensory experience [5]. However, camera delays inherent in mechanical systems which can cause massive simulated diseases. We propose a head movement control system that has the ability to track the drone's navigation and rotation by using an added camera. These items suffer from severe delay and unstable motion s, although similar approaches may be applicable to other robotic scenarios without navigation. In general, the incubation period of stirring can be overcome by digitizing a wide range of video content filmed with a wide-angle camera. The practice was implemented by using only one display screen in a commercial drone.

For ground flight and autonomous control in both cases, the robots need a better understanding of what that means FPV controllers and solutions offer the best methods and methods to obtain an advanced experience in controlling the operator independently of the remote control [6]. Therefore, we propose a full-immersive stereo remote control system for UAVs that can provide high-quality FVP controller optimized, and better collect videos for future training in independent and semi-independent of control strategies. Our system uses a specially designed coil to mount a wide-vision stereo camera to a commercial-Hexacopter drone (DJI F550) [7].

The camera broadcast all HD video frames are captured to a ground remote is connected to an HMD headset. Supply the stereo vision in remote operating senses, we hypothesized that stereo view would also have a significant effect on the specific state of control in FPV state [8]. Standard tests were conducted for the system we are working on users (n = 10) to fly our drone in the test region. Furthermore, conducted of two experiments, with a more significant number of participants by using pre-recorded flight and walking videos to compare an existing commercial FPV solution for monocular drones with immersive stereo setups. We measured trial quality, the ability to estimate distance, and simulated disease [9]. In this paper, we present this device and demonstrate a new model which can improve the control experience.

2. Related Work

Because drones, whether establishment , rely networking and other technologies to bridge the space between a user's "presence" and their own, they are often considered informational technology. Because the lack of pilots is largely based on these arguments, which are just trivial facts; rather, it is a well-established, coordinated, carefully modified, and enduring intermediary relationship between remote technical infrastructures. Control, remote sensing, embodied sensory perception, and human user behavior. The difference in this configuration is that the drone operates at a distance without direct contact through touch and vision. This configuration is based on a modern matrix, its cognition, and its behavior of operate a spatial relations outside of its physiological domain.

Drones are “vision machines” [10], allowing us to see things we cannot see the non-intermediate range of the human vision. Trevor- Paglin present a “drone vision” in a 2010 video installation [11], which is a concept central to academic discussions of the “visual politics” of drones [12]. Among the many scholars who have drawn on Paglin’s idea of “drone seeing” to cognitive and practices of army drone imagery, Roger-Stahl explained in a 2013 paper titled drones do indeed see the problem (Stal 2013)[13]. Single-camera drones need to rely on the fuselage Single depth appreciation and accumulation of ego movement SLAM/Visual Distance Measurement. Unfortunately, these systems cannot be Individual visual cues and those based on IMUs with gyroscopes and accelerometers [14] or special calibration procedures for global volume estimates. Inaccuracy contributes to size estimation for errors in calculating the parking of the car. Adding a depth predication requires accurate location information for all tires, this presents a challenge for monochromatic SLAM systems. The performance of the automatic control of drones to be controlled remotely is affected by technical limitations to a large extent, especially by the sensors that are controlled through the head. The delay caused by the tracking process is affected by the accuracy factors provided by the camera installed in the front of the drone [15].

3. Method

Our test system in this approach consists of a Hexacopter drone (DJI F550) [16], Equipped with a wide lens to achieve the best capture of the scene to be photographed, as shown in Figure 1.

Where this plane was used for its ability to bear the weight of the stereoscopic camera without tilt or vibration, thus ensuring high-quality video non-blurry. The stereoscopic camera provides us with a separate vision (left and right), one from the right lens and the other from the lens on the left. Thus, the two images are combined by using Oculus Quest 2 VR head-mounted-display [16] , to obtain a high-definition (HD) vision.

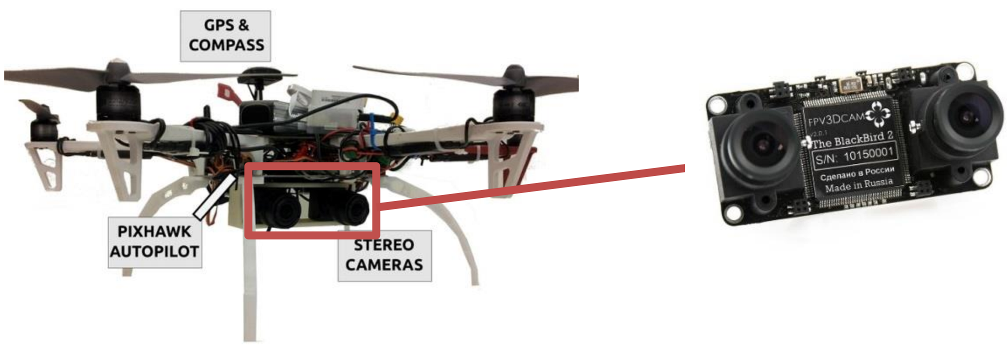

FIGURE 1 | DJI Drone (Left) being modified by the addition of the stereo camera (Right)

On the other hand, where the user is located in the ground station, as shown in Figure 2. Which consists of the FPV controller, receives a video signal from the drone and connects to rtmp server [17] by using a high-speed workstation computer used to send a stereoscopic signal to HMD Oculus Quest 2. We test pixels based on the user's current head position and use pre-computed UV coordinates to render correct left and right eye widths. We prepare these UV coordinate systems by projection the vertices of the two virtual fields in the fisheye frame use the intrinsic camera parameters as calculated in Equation 1, and then interpolate UV rays between adjacent peaks.

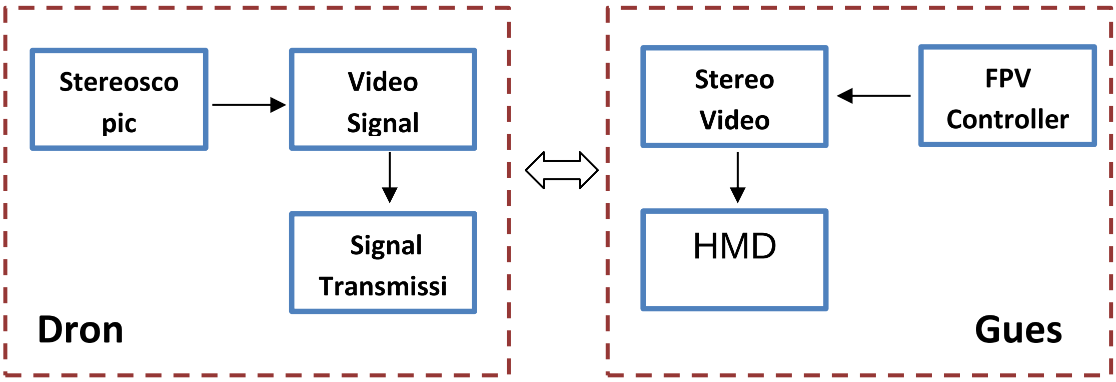

FIGURE 2 | System Pipeline

Users (n=10) asked to fly a drone; also HD video stream signal streaming to the controller from the live scene which was recorded in the same region, as shown in Figure 3.

$$a = \frac{x}{z}, b = \frac{y}{z}$$
$$r^2 = a^2 + b^2$$
$$\theta = atan(r).$$

Fisheye distortion: **Equ.1**

$$\theta_d = \theta\left(1 + k_1\theta^2 + k_2\theta^4 + k_3\theta^6 + k_4\theta^8\right)$$
$$x' = \left(\frac{\theta_d}{r}\right)a,\ y' = \left(\frac{\theta_d}{r}\right)b.$$

To test our drone FPV setup, we asked ten users (all male, mean age = 40.17, SD = 4.05) to fly our drone in the clearing. Participants flew in them for about 10 minutes Virtual reality helmet. All participants had the same reduction in exposure time Differences in modeling disease. It is also well known this navigation speed affects simulator motion sickness and max At 10 m/s and steady faster speeds. In our case, participants were able to a range of 0-8m/s. In real-time, users can Choose speed, but reduce variance all done Experiment in the same open space and receive the same instructions on where to go and how to takeoff the drone .

FIGURE 3 | controller monitor a drone via our first person view system.

4. Result

Participants (n=10) of the live-streamed test were able to launch the drone at velocity below 10 m/s, , although four of them reported said the general tendency to suffer from motion sickness, of which only three people played 3D games.

Users report flying and out-of-body sensations [18]. In addition, the participants showed a large tolerance to latency, as the system had a latency of 455 ± 40 m/s, you won't notice the delay, which was apparent to observers. Turn-on by an action-binding mechanism by which the perceived flying duration of an intended action and its sensory consequences can influence the awareness of the action by reducing the real delay [19]. The system was accepted to reach a top speed of 10 m/s without incident. Although the UAV is able to propel faster, latency and the perception of motion constraints on the latency become critical at speeds above 10 m/s, the velocity of UAV can land and an accidental crash may occur.

These speeds are limited which are compared to the 20 m/s advertised by the drone manufacturer, this speed is only at its maximum without a load, and our camera unit with batteries weighs over 3.5 kg fact Above, the manufacturer does not recommend flying at such speeds. 9 There is a significant difference in the degree of disease in real-time and offline conditions (Pearson's chi-square test independence, $\chi 2$ = 9.3, df = 5, m = 0.04), users in Real-time situation reports had no simulator motion sickness, while 30% users in 2 reported moderate to severe motion sickness. To examine the covariates describing the simulated disease, we have A correlation study which was performed as shown in table 1. The results showed that self-reported high chance of motion sickness in general correlates with actually reported simulator illnesses (Pearson, m=0.026, f=0.27); therefore, we examined differences in simulator motion sickness and found it to be significantly higher in the disease-prone population (Kruskal-Wallis chi-square = 8.57, m = 0.031) May indicate the importance of major vestibular mechanisms in modeling disease development. Exist on the other hand, playing 3D games has nothing to do with what is reported Motion sickness (m=0.85, f=1.00), ie visual adaptation 3D simulation graphics cannot describe how dizzy the simulator is when an HMD.

TABLE 1 | Pearson correlation testing

	Simulator sickness	Age	Tendency	Vision intensity
Age	m = 0.599, f = 0.06			
Tendency	m = 0.026, f = 0.27	m = 0.644, f = −0.06		
Vision intensity	m = 0.377, f = 0.11	m = 0.004*, f = 0.34	m = 0.134, r = 0.18	
3D applications	m = 0.983, f = 0.00	m = 0.725, f = −0.04	pm= 0.736, f = −0.04	m = 0.807, f = 0.03

5. Conclusion

In this approach, we present an immersive stereoscopic FPV-enabled UAV vision system that can optimize ground-based broadcast control systems. This present research can enhance remote operation as well asscene switching [20], Facilitate the use of neutral mobility that is characterized by its independence in performance (compared to monocular systems), and better facilitate video capture for training voice control policies.

Our results show that users can easily fly and land with our system under real-time conditions. Results showed that simulator motion sickness was almost absent among participants who are able to control real-time camera navigation, but affected 29% of participants in the previously recorded state.

Demonstration experiment confirms that stereo vision improves the effectiveness of flight distance estimation, compared with mono vision, and had no significant effect on induced motion sickness, i.e. participants' ability to better judge distance and height in the stereo setting than mono, so it allows for better handling of the drone efficient/safe.

The system will improve drone control and safety through course correction, accident prevention and safe landing systems. Furthermore, at the time of writing, human FPV drone control combined with automatic low-altitude obstacle avoidance outperforms fully autonomous flight systems. Second, existing regulations must be adapted to the delivery situation. Automatic low-level obstacle avoidance reduces the cognitive load on the operator and improves system safety, while users can manage advanced navigation guidance in accordance with applicable regulations.

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