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Design and Manufacture of Eagle Robot Drone for Reconnaissance

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ABSTRACT:

The eagle drone is an unmanned aerial vehicle in the form of an eagle that can be controlled remotely based on the internet of things. In the current military sphere, drones have been widely used for combat tasks including reconnaissance, shooting and destruction. Bird drones designed for combat have the characteristic of flying like an eagle with the force of flapping two wings that are about 2 meters wide. The wing flapping movement is driven by a gear motor which has a torque of 10kg/cm, the lift force is capable of carrying a total payload load of 1kg so it can carry explosives and cameras weighing 500 grams and throw the explosives at the target point. This bird drone is equipped with GPS to determine flying coordinates, the bird drone control system from a distance of up to 2 km can be controlled manually using a remote control and internet of things waypoint-based autopilot. This bird drone is equipped with frequency hopping and data encryption so it is not easily jammed or controlled by enemies. The sound of flapping wings produced by bird drones when flying is relatively low, below 10 dB (silent). In this way, the bird drone's movements can be disguised towards the target so that the enemy can be fooled by the bird drone's camouflage.

Keywords: The eagle drone, AI, reconnaissance, and camouflage

1. INTRODUCTION

Hybrid war is a concept that refers to a form of conflict that uses different types of strategies and tactics. Asymmetric combat tactics have given birth to new types of tactics in combat that utilize the role of technology. Effective and efficient values are a measure of success in achieving main tasks. Moving quickly, precisely, quietly, with large and measurable destructive power becomes effective when the role of technology dominates the use of defense equipment today. One of them is the development of unmanned weapons which have been widely used by many countries to strengthen the country's combat actions. High speed and accuracy have greatly benefited the country's battle tactics for victorious exploits. Therefore, the Indonesian National Army is required to adapt to the transformation of modern weapon system technology and the personnel who man it are able to master and utilize leaps in the fields of robotic technology, information technology and artificial intelligence technology, so that they are ready to anticipate the new character of future battles, which have the power destroyed more (high level of destruction) and ready to face battles that last shorter in determining the winner (decisive battle), and ready to face hybrid battles that combine various tactics at once, both conventional and non-conventional tactics, as well as cross-dimensional tactics, both social and social. politics and economics (KEP Doctrine, 2021)

Faced with the regional topology in conflict areas in Indonesia, such as Papua, which is known for its hilly terrain and lots of trees, this creates obstacles and requires a lot of energy to scout, chase or paralyze separatists (Armed Criminal Groups). Currently, the Indonesian National Army is also reinforced with "reconnaissance drones" to detect the presence of the KKB. However, the use of reconnaissance drones is only limited to viewing targets without being able to carry out shooting or destruction actions against targets. This condition gives the opponent the opportunity to escape from monitoring and lose the moment/opportunity to paralyze the opponent. The use of Drone Bombers with quadcopter or hexacopter models to destroy targets was used during the Ukraine - Russia war. Current technological innovations in quadcopter and hexacopter drones are still considered to make it easy to release bombs mounted on the bottom of the drone, however, the sound of the drone's propeller or propeller can be heard, thereby raising suspicion and the readiness of opposing forces to shoot the drone or avoid being chased by the drone. Therefore, it is necessary to make a drone that can maneuver and throw bombs without being suspected because it has a silent aspect and does not look like a drone but has camouflage that resembles an animal, in this case a bird, to trick the enemy. From the background that has been explained, it is necessary to have bird drones as an alternative for using silent, stealthy and IoT-based technology. This bird drone has a shape and movement like an eagle, which is controlled remotely either manually by RC or IoT. With a real-time data telemetry system, the program is able to direct the drone and destroy opponents at programmed coordinates, by launching or throwing bombs and the results can be monitored remotely via GSU (Ground Station Unit).

2. LITERATURE REVIEW

NRS Muda et al (2023) The hexacopter bomber drone can be controlled manually and on autopilot towards targets, especially tanks. The limitation of this drone is that the size of the drone is too large, causing noise from the movement of the propeller so that it is not disguised and easily heard by opposing parties due to drone threats.

KEP doctrine (2020). The use of drones in operational areas if faced with hilly terrain, critical terrain and good fire protection for the enemy, then using drones can be advantageous for reconnaissance and shooting tasks. This is because the maneuverability of drones can reduce risks and provide personnel safety from ambush or gunfire enemy/opponent. Because of this, drones are designed to help with wartime military operations that can provide tactical air support in difficult and narrow terrain.

Materials and Methods

Materials

Servo Motors is a device or rotary actuator (motor) designed with a closed loop feedback control system, so that it can ensure and determine the

angular position of the motor output shaft. The power of servo motors varies, from a few watts to hundreds of watts. Servo motors are used for various purposes such as tracking systems, machine tools and so on. Servo motors are divided into two, namely AC and DC serco motors, as shown in figure 1 servo motor

Figure 1. Servo Motors

Electronic Speed Control is a drone component that functions to regulate the speed of the brushless motor and current driver on the brushless motor according to the motor capacity and torque used. The greater the current capacity of the ESC, the greater the power capability to drive the motor. The ESC connection to the brushless motor is 3 feet, 2 feet for the +/- voltage source and 1 foot for the PWM (Pulse Width Modulation) data pulse, the ESC input from the FCS (Flight Control System) as shown in figure 2. ESC (Electronic Speed Controls).

Figure 2. ESC (Electronic Speed Controls).

Bird Drone Wings, the basic shape of the aircraft is an imitation of the shape of a bird's skeleton. Meanwhile, birds fly by flapping their wings without using turbines or propellers. The entire anatomy of a bird's body is the beginning of the formation of various types of aircraft. Starting from low-tech aircraft to even advanced technology. However, almost no one has a flight mechanism like birds. This is an opportunity for the robotics field to expand its field of knowledge by creating ornithopters as bird robots which can later be used as tools in the fields of intelligence, entertainment, military, geophysics, and so on as shown in figure 3 bird drone wings

Figure 3. Bird Drone Wings

IMU (Inertial Measurement Unit) is a drone component that is used to control the balance of the drone's body position regarding 3 axes by maintaining 6-degree-of-freedom (DOF) which estimates movement, namely position (X Y Z) and orientation (roll, pitch, yaw) . The IMU system maintains continuous calculation of the Atitude and Heading Reference System (AHRS) orientation, as shown in figure 4. IMU 6 dof.

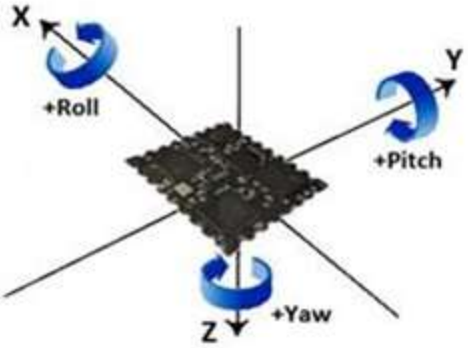

Figure 4. IMU 6 dof

The Taranis X7 transmitter is a radio control that works on the 2.4 GHz frequency, has 8 channels and a transmit power of 1000 mWatt. This radio control is used as a carrier frequency transmitter that will be received by the robot's receiver to control the robot's motor movement. The carrier frequency on the control radio is connected to the receiver placed on the robot. As shown in figure 5. Taranis X7 transmitter. The Radio Control system consists of a throttle lever used to regulate motor speed, a yaw lever used to rotate left and right, a pitch lever to regulate forward and backward movement, a roll lever used for azimuth movement left and right, a channel switch can be used for elevation movement up and down, as well as to shoot guns or rockets.

Figure 5. Taranis X7 transmitter.

The Frsky 8 channel receiver is a carrier frequency receiver emitted by the Taranis X7 transmitter. This receiver output has 8 channels which are used to output PWM (Pulse Width Modulation) data which is connected to the microcontroller. As shown in figure 6. 8 channel Frsky receiver.

Figure 6. 8 channel Frsky receiver.

GPS (Global Positioning System) is a navigation system using satellites and determining latitude and longitude coordinates is determined by a minimum number of 6 satellites. GPS Tracker will report at any time about the position or position of the GPS or user, the GPS form is as shown in figure 7. GPS tracker.

Figure 7. GPS Tracker

Video Sender is a device that transmits (Tx) video signals from the camera. Images received from the camera are processed into video signal data sent by the video sender. The capability of the video sender depends on the transmit power used, for example the video sender power used is 1000 mWatt. As shown in figure 8. 1000 mWatt video sender

Figure 8. 1000 mWatt video sender

A video receiver is a video signal receiver that works by converting video signals into data signals which will be processed by the video turner into video data and displayed on the laptop monitor. As shown in figure 9. video receiver of 5.8 GHz. The video turner application is used to display video data results on a laptop combined with a mission planner program to determine the coordinates of the bird drone

Figure 9. Video Reciver of 5.8 GHz

Video Turner is an electronic component that functions to convert video signals from a camera into digital data that can be processed by a computer or program into a visual video display. As shown in figure 10. Video Turner.

Figure 10. Video Turner

The camera is used as an eagle's eye to see the target to be processed into digital data which is sent via the video sender and sent analogously to the controller with a transmission distance of 1 km. The video sender's information is received by the video receiver and processed by the TV turner into digital data which then becomes video data which is displayed with the mission planner. So that what the camera sees is the same as what the eagle robot drone sees, the shape of the camera used is as shown in figure 11. Eagle drone camera.

Figure 11. . Eagle drone camera modul 4K

Methods

The method used is experimentation starting with bird drone design, component assembly, component testing, static measuring tests using static instruments in the laboratory, dynamic measuring tests using in the field. The design of the eagle robot drone is as shown in figure 12. Top view and front view. Drone design using the 2022 version of the 3D smax program.

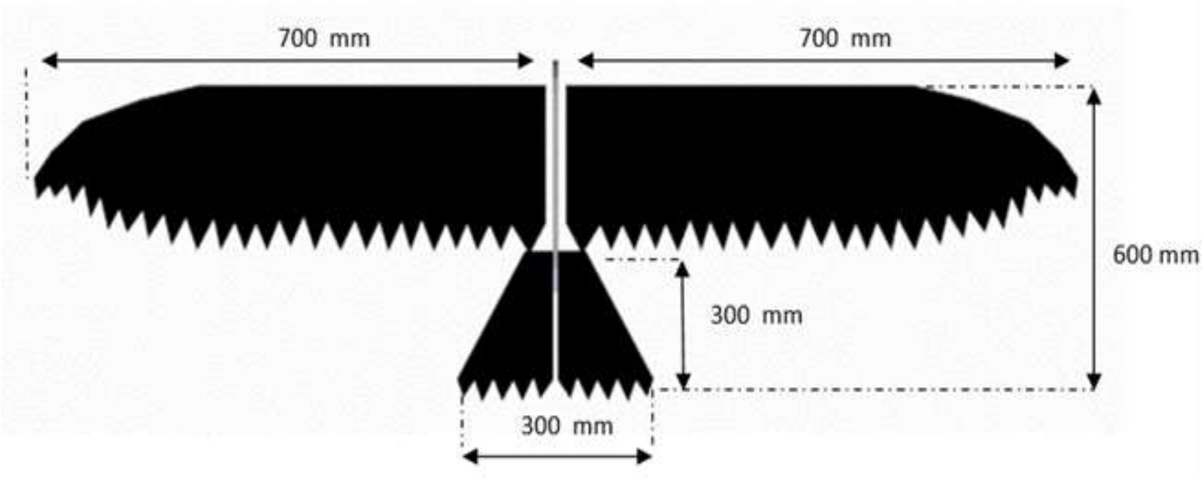

Figure 12. Design of Eagle Robot Drone

Bird Drone Wing Propulsion Mechanics. The choice of frame material is adjusted in such a way that the bird drone frame is made from materials that are light, strong and cheap. The material for the average commercial drone is carbon fiber which is very light and strong but is quite expensive. To develop a frame from materials available on the domestic market, Aluminum Composite Panel (ACP) and PVC Foam (Foam Board) were chosen. Both materials are light and strong so they meet the basic requirements for making a drone frame. The mechanical design of bird drone wings is made according to the concept of birds. The mechanical movement of the bird drone's wings is made symmetrical with a central position in the middle for the controller component, and the end of the frame arm for the brushless motor. The length and thickness of the frame arms are adjusted to the ability to lift the load so that when flying it remains stable and does not sway, as shown in Figure 13. Wing drive mechanical design.

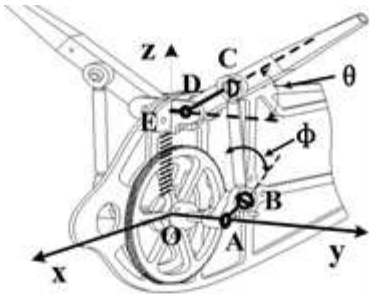

Figure 13. Wing Drive Mechanical Design.

The control system on the Eagle robot drone uses 2 methods, namely manual and autopilot. If using the manual method, the eagle drone is flown using radio control by the operator to the specified place or target. If you use the autopilot method, the flight control has programmed the coordinates of the selected route using waypoints so that the eagle drone can fly following the route coordinates that have been determined and can return to the initial flight location. The block diagram of work way of the system shown in figure 14 the Eagle robot drone flight control system.

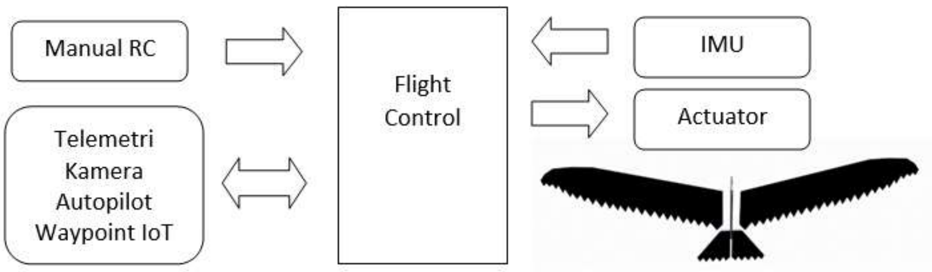

Figure 14. The Eagle robot drone flight control system.

Results and Discussions

Results

As shown in Figure 15. The process of making an eagle robot drone starts from assembling the bird's body frame, assembling components, installing wings made of textile material, installing the tail part which has a servo to regulate the bird's movement to the right and left depending on the pull of the servo. Meanwhile, a brushless motor is used to move the wings, the wing flapping speed is regulated by a throttle on radio control. The camera will see the target and send target video data to the controller for execution. Throwing explosives can be done because the bird platform also provides explosives to destroy targets.

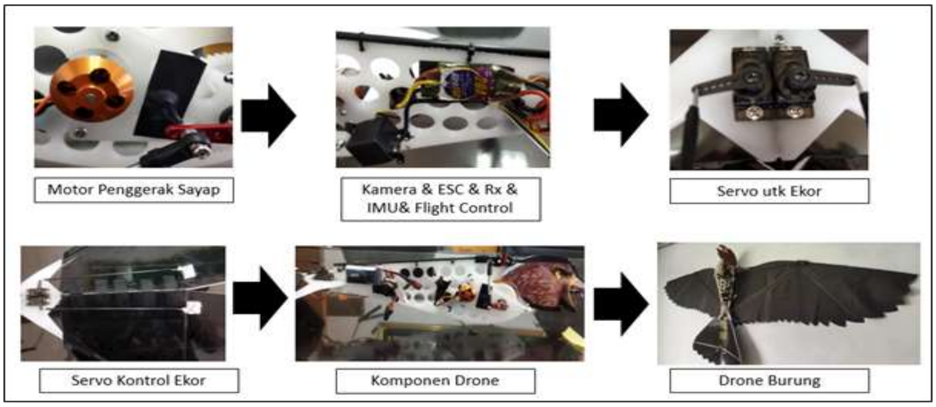

Figure 15. The process of making an eagle robot drone

The components used are adjusted to the specifications of the control system so that the bird drone can be controlled manually by RC and waypoint autopilot. Hardware installation includes: FCS (Flight Control System) as processor, ESC (Electronic Speed Control), 6 Brushless Motors, 3 CW propellers, 3 CCW propellers, GPS, IMU, Camera, Data link, Receiver, Battery as power. After the components have been assembled, the next step is programming the Flight Control System (FCS). The FCS used is the Ardupilot type using Mission Planner. The mission planner programming system uses APM 2.4 64 bit version. As shown in Figure 16, the APM 2.4 64 bit program and Figure 3.17 Filling in the program.

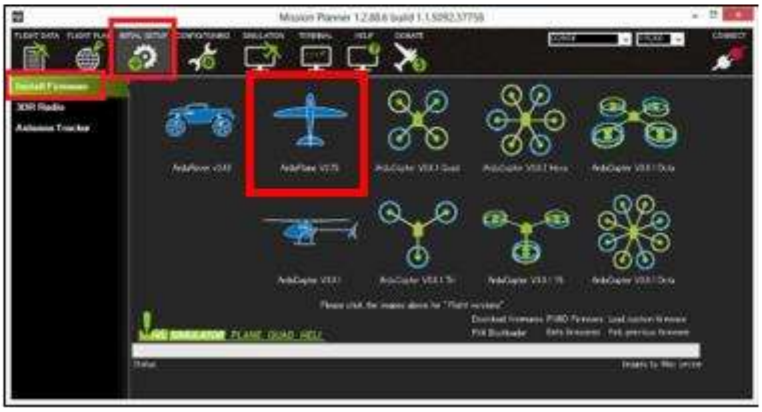

Figure 16. Autopilot Setting of Eagle Drone

Discussion:

Waypoint Autopilot is a programming system for the coordinates or travel routes that will be traversed by bird drones from home to the target until returning to home as shown in figure 17. Waypoint Autopilot. The waypoint program method is connecting flight control with the mission planner application on a laptop using the internet of things, then communicating IoT telemetry data from coordinate points as a travel route for the bird drone to the target and back home.

Figure 17. Waypoint Autopilot

Flight Test and Target Destruction. Test flight and target destruction, as shown in Figure 18 mode manual flight and Figure 19 for flight testing, and Dropping Bomb Drone Eagle robot bird

Figure 18. Flight Manual Mode

Figure 19. Autopilot Mode and Bomb Dropping from Eagle Drone

Conclusion

Eagle Drone Control System, can be done manually by RC and Waypoint Autopilot, the drone is also capable of carrying an explosive load of up to 300 grams. The flight duration of the drone is 30 minutes. The flight control distance reaches 2 km using a manual/RC control system. If you use waypoint coordinate data plotting, the control distance is more than 2 km. The eagle robot drone produces 10 dB or almost inaudible noise when flying.

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