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PROTOTYPE OF SHEPAT DRONE BASED ON BOMB FIXEDWING

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ABSTRACT

The rapid development of drone technology has led to innovations in various fields, including surveillance, security, and transportation. One of the latest advancements is the *Shepat Drone* prototype, designed based on the aerodynamics of the *bomb fixed-wing* concept. This study aims to develop a drone that adopts the flight mechanics and stability characteristics of a *bomb fixed-wing* system, which is known for its high maneuverability and energy efficiency. The methodology involves aerodynamic analysis, biomimetic-based structural design, and performance testing through simulations and direct experiments. The results indicate that the *Shepat Drone* prototype exhibits better stability in various environmental conditions and higher energy efficiency compared to conventional rotary-wing drones. With this approach, the *Shepat Drone* has the potential for applications in search and rescue, environmental monitoring, military operations, and industrial use.

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1. INTRODUCTION

The development of unmanned aerial vehicles (UAVs), commonly known as drones, has significantly evolved over the past century. Initially conceptualized for military applications, drones have played a crucial role in reconnaissance and offensive operations. The earliest form of bomber drones can be traced back to World War I, with the development of the Kettering Bug, an experimental unmanned aircraft designed for aerial bombing. However, technological limitations at the time prevented its widespread deployment.

During World War II, the advancement of drone technology led to the introduction of radio-controlled aircraft, such as Project Aphrodite, which repurposed manned bombers into remotely piloted explosive-laden drones (Doyle, 2017). These early efforts laid the foundation for modern precision-strike UAVs. The Cold War era saw further refinements in drone capabilities, with the advent of high-altitude reconnaissance UAVs like the Lockheed D-21 and the MQ-1 Predator, which revolutionized aerial surveillance and targeted strikes.

In recent decades, drone technology has expanded beyond military use, influencing various fields such as search and rescue, environmental monitoring, and logistics. The latest advancements focus on biomimetic drone designs, inspired by natural flight mechanisms to improve efficiency, agility, and stealth. One such innovation is the Shepat Drone, a prototype designed based on the bomb fixed-wing concept, which mimics the flight characteristics of high-speed aerodynamic gliders used in precision bombing.

The Shepat Drone aims to integrate advanced aerodynamics with cutting-edge propulsion systems to enhance maneuverability and endurance. By adopting the bomb fixed-wing flight principles, this prototype seeks to optimize stability and energy efficiency, making it a versatile solution for various applications, including surveillance, disaster response, and military operations. This paper explores the evolution of bomber drones, leading to the development of the Shepat Drone, highlighting its design principles and potential impact on future UAV technologies.

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2. MATERIALS AND METHODS

Materials

The development of the *Shepat Drone* prototype required several key components to achieve its aerodynamic efficiency and maneuverability. The materials used in the construction included:

- Frame Structure: Carbon fiber and lightweight aluminum to ensure durability while minimizing weight.
- Wing Design: Fixed-wing structure inspired by bomb gliders, utilizing a high-lift airfoil for enhanced glide ratio.
- Propulsion System: Brushless electric motor paired with a high-efficiency propeller for optimized thrust.
- Control System: Flight controller equipped with GPS, inertial measurement unit (IMU), and autopilot software for stability.
- Power Supply: Lithium-polymer (Li-Po) battery to provide extended flight time and efficient energy consumption.
- Communication Module: Long-range radio transmission system for remote piloting and telemetry data acquisition.

2. METHODS

The methodology for designing and testing the *Shepat Drone* consisted of the following stages:

Design and Simulation

The fixed-wing design was developed using Computational Fluid Dynamics (CFD) analysis to optimize aerodynamic performance. The wing shape and airfoil profile were selected based on simulations in ANSYS Fluent and XFLR5 software to achieve stable flight characteristics.

Prototyping and Assembly

The components were 3D-printed and assembled to create a functional prototype. The electronic flight control system was integrated, ensuring compatibility between the motor, servos, and sensors. The final assembly was tested in a controlled indoor environment before outdoor trials.

Flight Testing and Performance Evaluation

Field tests were conducted in an open-area flight zone, where parameters such as:

- Lift-to-drag ratio,
- Stability under various wind conditions,
- Glide efficiency, and
- Battery endurance were measured. A PID tuning process was applied to optimize the flight controller's response.

Data Collection and Analysis

Telemetry data, including speed, altitude, and power consumption, were recorded using onboard sensors. The results were compared against conventional UAV designs to assess the advantages of the *bomb fixed-wing* configuration.

3. RESULTS AND DISCUSSION

Results. The data from this research test was obtained from the design of the Shepat drone, a flight test consisting of variable speed in m/h, accuracy in %, target destruction in Newton (N), control distance, flight stability, waypoint from the mission planner.

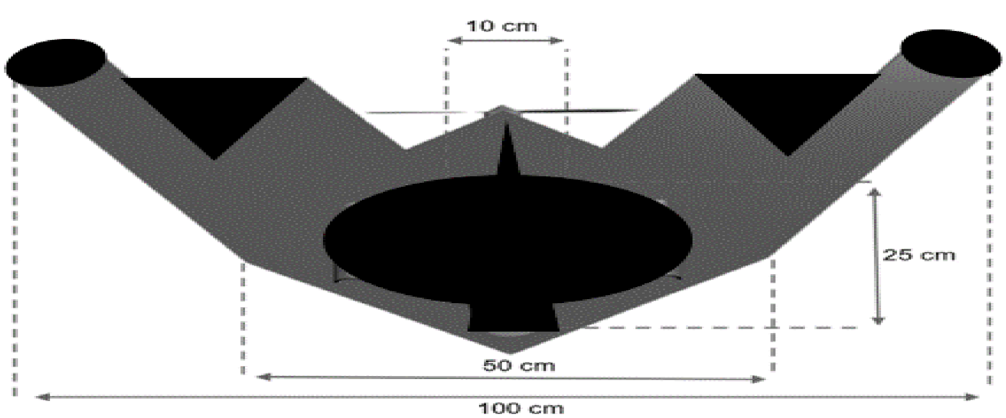

Figure 1 Top View of SHEPAT DRONE Fixed wing Design

Table 1. Test Results Using Mission Planner Program Simulation

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No	Speed (km/h)	Accuracy (%)	Target Destruction Power (N)
1	60	100	100
2	66	99	108
3	72	98	116
4	78	95	125
5	84	94	135
6	90	93	146
7	96	92	157
8	102	91	165
9	108	90	169
10	120	88	180

Table 2. Control Distance Test Results Using Mission Planner Program Simulation

No	Distance (meters)	Control Status
1	200	Stable
2	300	Stable
3	400	Stable
4	500	Stable
5	600	Little Delay
6	700	Maximum
7	800	Delay
8	900	Unstable
9	1000	Unstable
10	1100	Loss of Signal

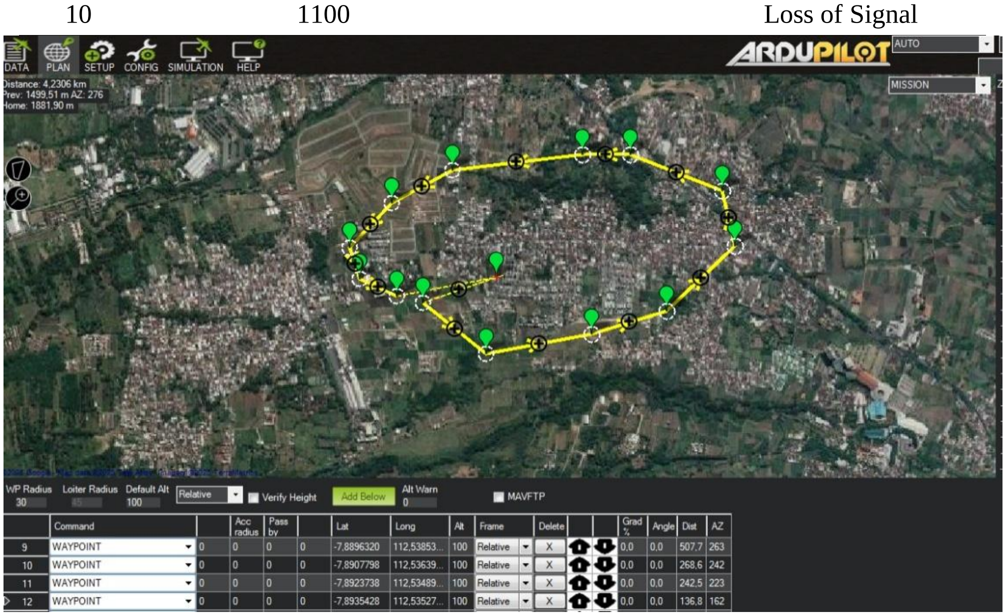

Figure 2. Autonomous drone maneuver using waypoints

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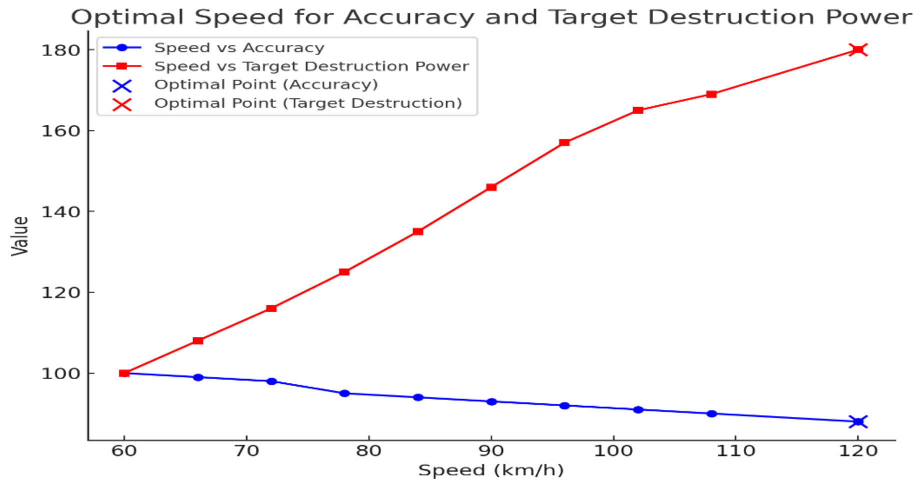

Figure 3. Tests the results of speed, accuracy and target destruction

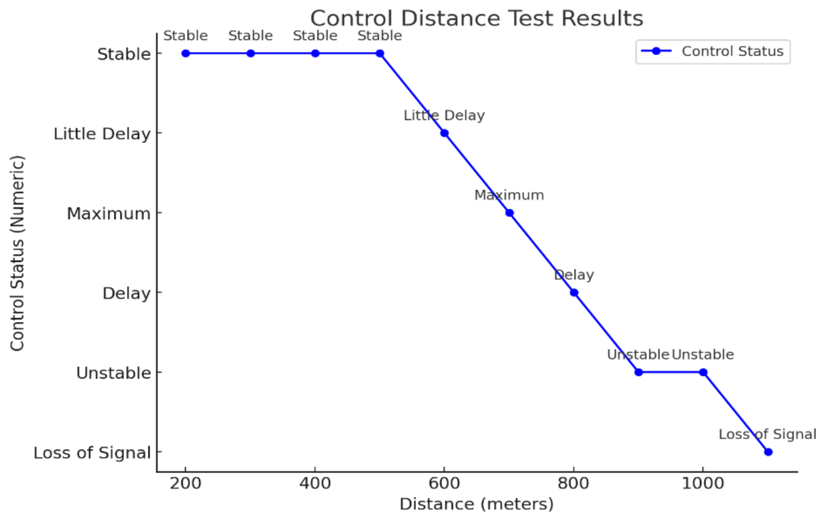

Figure 4. Graph of Flight Test Results Of Shepat Drone

Discussion

As shown in Table 1 The relationship between speed and accuracy, at a speed of 60 km/h, the accuracy reaches 100%, indicating that the drone is very precise at low speeds. As the speed increases, the accuracy decreases gradually. At 120 km/h, the accuracy drops to 88%, indicating that the faster the drone flies, the more difficult it is to maintain the precision of the attack. The relationship between speed and power Destroy, at a speed of 60 km/h, the crushing power is only 100 N. As the speed increases, the crushing power also increases gradually and significantly. At a speed of 120 km/h, the destructive power reaches 180 N, indicating that the drone generates greater impact force when traveling faster. The balance between accuracy and breaking power, low speed (60 - 78 km/h) provides high accuracy but less breaking power. High speeds (90 - 120 km/h) increase the destructive power but reduce accuracy. The optimum speed is likely to be in the range of 90 - 102 km/h, as it still maintains accuracy above 90% while significantly increasing the destructive power. As shown in table 2 where the safe distance to control the drone is up to 500 meters, because the signal is still stable and there is no interference. Disturbances begin to appear at 600 - 800 meters, with increased response delays. Above 900 meters, the drone's control becomes unstable, and eventually loses signal completely at 1100 meters. The optimal operational limit of the drone is about 500 - 700 meters, depending on the acceptable interference tolerance.

As shown in figure 4 of the speed, accuracy and target destruction graphs, at low speeds (60 - 78 km/h) it is better for missions that require high accuracy, because the accuracy level is still above 95%. High speeds (90 - 120 km/h) are better for missions that require large destructive power, but with reduced accuracy. A balanced optimal speed is likely to be around 90 - 102 km/h, where the accuracy is still quite high (>91%) and the destructive power has increased significantly.

In Figure 5. describe the relationship between distance and control status in drone trials using Mission Planner Program Simulation. Here are some key points that can be taken from this graph: Control Stability at Close Range (200 - 500 meters), at a distance of 200 - 500 meters, the drone is in a Stable condition, which means there is no interference in control. This shows that at this range, the communication and control systems work optimally. At a distance of 600 meters, a Little Delay appears, which indicates the beginning of a delay in the drone's communication or response. At 700 meters, the disturbance increases to Maximum, which means that the control is close to the maximum limit before the instability begins. At 800 meters, the control status changes to Delay, indicating that the delay is already more significant and can affect the drone's response. At a distance of 900 - 1000 meters, the control starts to become Unstable, meaning that the drone has a fairly severe signal interference, causing the possibility that the drone does not respond properly. At 1100 meters, there is a Loss of Signal, which means that the drone loses communication completely with the controller. This is the maximum limit at which the drone can no longer be controlled.

Based on the entire analysis of tables and graphs, the optimal value for the operation of the drone can be determined by considering the balance between accuracy, destructive power, and control stability. The Optimum Speed is 90 km/h - 102 km/h, providing still high accuracy (>91%) and significantly increased destructive power (>146 N). It is balanced between attack precision and impact power, making it suitable for different types of missions. The optimal control distance is between 500 - 700 meters, still within the control stability limit with little delay and above 700 meters, the drone begins to experience disturbances that can hinder the effectiveness of operations. The optimal combination for mission effectiveness, if the mission requires high accuracy, speed 60 - 78 km/h, control distance ≤ 500 meters. If the mission requires greater destructive power at a speed of 102 - 120 km/h, but the accuracy is lower. If the mission requires a balance between accuracy and destructive power, the speed is 90 - 102 km/h, the control distance ≤ 700 meters. The optimal value for a drone to remain effective and stable is a speed of 90 - 102 km/h and a control distance of 500 - 700 meters, providing the best balance between accuracy, destructive power, and signal stability.

4. CONCLUSION

In Shepat drone missions that require high accuracy, the drone should be operated at 60 - 78 km/h to get the best precision. For missions that prioritize destructive power, drones are more effective at 90 - 120 km/h, although their accuracy is slightly reduced. The drone control distance should be limited to 500 - 700 meters, so that it remains stable and responsive. The maximum operational limit of the drone is 1100 meters, but at this distance the signal will be lost, so it is not recommended. The optimal value for a drone to remain effective and stable is a speed of 90 - 102 km/h and a control distance of 500 - 700 meters, providing the best balance between accuracy, destructive power, and signal stability.

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