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MoniKorn: Autopilot Drone System for Real – Time Monitoring and Detection of *Ostrinia Furnacalis* Infestations Using Image Processing

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ABSTRACT

Pest management remains one of the biggest hurdles in corn farming, especially with infestations caused by the Asian Corn Borer (Ostrinia furnacalis). In many farming communities across the Philippines, pest detection still relies heavily on manual labor and broad pesticide use methods that are not only time-consuming but also harmful to the environment and human health. This study introduces MoniKorn, a smart farming solution in the form of an autopilot drone system designed to monitor and detect Ostrinia furnacalis infestations in real time using image processing and artificial intelligence. Built with Raspberry Pi 5, Pixhawk Pro M10, and powered by YOLOv8 object detection, the drone can fly autopilot or be remotely controlled via a mobile application. It captures aerial footage, detects signs of infestation like leaf discoloration, holes, and wilting, then geo-tags the affected areas while providing actionable recommendations to farmers. Using a mixed-methods research approach, the researchers tested the MoniKorn system in cornfields across Pampanga and Tarlac, engaging with local farmers, agricultural experts, and drone specialists. The system proved effective covering one hectare per flight, operating within safety regulations, and significantly cutting down the time and labor required for pest monitoring. Its most notable feature was its ability to geo-tag infested areas, helping farmers respond more quickly and effectively. In blending technology with agriculture, MoniKorn not only offers a smarter way to protect crops but also empowers communities with tools that promote sustainable and resilient farming.

Keywords: *Artificial Intelligence, Geo-tagged, Mobile Application, Pixhawk Pro M10, Radio Controller, Raspberry Pi 5, YOLO v8*

INTRODUCTION

Modern agriculture continues to face significant pest management challenges, as traditional methods such as manual inspection and excessive pesticide application remain labor-intensive, environmentally harmful, and often ineffective in large-scale farming operations. In response, Integrated Pest Management (IPM) has emerged as a sustainable alternative that promotes ecological balance while reducing dependence on synthetic chemicals. Increased global support for IPM is evident through initiatives such as the United States Department of Agriculture Crop Protection and Pest Management program, which invests in sustainable pest management technologies (Wyckhuys et al., 2021). Studies further emphasize that IPM reduces environmental risks, improves farmer awareness, and supports long-term agricultural sustainability (Vatn, 2021; Wu, 2022).

Among the world's major food crops, corn (Zea mays) remains highly vulnerable to destructive pests, particularly the Asian Corn Borer (Ostrinia furnacalis), which threatens maize production in the Philippines, especially in Pampanga and Tarlac. Corn is globally important because of its extensive use as food, livestock feed, industrial raw material, and biofuel (The Editors of Encyclopaedia Britannica, 2025). However, pest infestations significantly reduce yield and farmer income, highlighting the need for more sustainable and proactive pest management strategies.

Advancements in smart agriculture provide promising solutions through the use of drones, image processing, and artificial intelligence (AI) for automated crop monitoring and early pest detection. Drone-based systems enable real-time field surveillance, helping farmers identify infestations before severe crop damage occurs while reducing unnecessary pesticide use (Wu, 2022). Geographic Information Systems (GIS) have emerged as a transformative tool in this sector, enabling the integration and visualization of spatial data to support evidence-based policy-making and resource optimization (Acuzar et al., 2025). However, the adoption of these advanced spatial tools in the Philippines faces hurdles, including the high cost of technology and the requirement for advanced technical skills among stakeholders (Acuzar et al., 2025).In line with this, the study MoniKorn – Autopilot Drone System for Real-Time Monitoring and Detection of Ostrinia furnacalis Infestations Using Image Processing proposes an innovative approach that integrates autonomous drone technology with AI-driven image analysis to improve pest monitoring efficiency, reduce labor requirements, and promote more sustainable corn production.

The main objective of this study is to design and develop an autopilot drone system that optimizes the efficiency of real-time monitoring and detection of Ostrinia furnacalis by using image processing. Specifically, it involves the following sub-objectives:

- To create an Infestation mark through geo tagging via a mobile application that allows farmers to detect the infected in the cornfields.
- To create real-time monitoring via a mobile application to provide an aerial video capture
- To provide recommendations to the farmers that can help to manage and control Ostrinia furnacalis effectively.
- To create a manual reporting system for tracking infestations and requesting timely assistance when severity increases.
- To develop an autopilot or remotely navigate a drone using a mobile application that allows farmers to schedule flight missions and adjust drone parameters.

METHODS

This study employed a Mixed Method Research Approach to develop and evaluate MoniKorn, an autopilot drone system for real-time monitoring and detection of Ostrinia furnacalis infestations in corn fields. The quantitative component involved field surveys and drone-based measurements to collect numerical data on pest occurrences, crop damage, and system performance. These data enabled the researchers to objectively assess infestation severity and validate the drone's technical functionality under actual agricultural conditions. The qualitative component consisted of semi-structured interviews with local farmers in San Rafael, Mexico, Pampanga, and Café, Concepcion, Tarlac, as well as drone experts and licensed agriculturists from the Department of Agriculture. These interviews provided valuable insights into existing pest management practices, labor and cost challenges, and farmers' readiness to adopt new technologies. In addition, the developed system was evaluated by selected respondents, including farmers and experts, to assess its functionality, usability, efficiency, reliability, portability, and security in real-world agricultural settings. Their feedback contributed to validating the system's practical relevance and identifying areas for improvement. Development followed an Agile methodology, utilizing iterative phases of planning, design, development, testing, review, and deployment, allowing continuous refinement based on field data and user feedback. This integrated approach ensured that

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MoniKorn is technically robust, user-centered, and suitable for sustainable pest management in local corn farming communities.

Figure 1. *Block Diagram.*

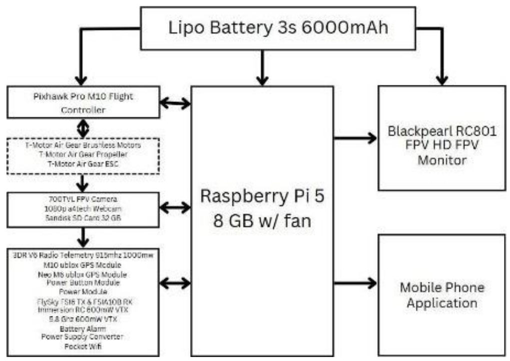

Figure 1 presents the MoniKorn block diagram, powered by a 3S 6000mAh LiPo battery and centered on a Raspberry Pi 5 (8 GB RAM) with cooling fan for onboard processing. A Pixhawk Pro M10 Flight Controller manages flight dynamics through T-Motor Air Gear Brushless Motors, Propellers, and ESCs. Visual input from a 700TVL FPV Camera and 1080p Webcam is stored on a 32 GB SD card. Navigation and communication are enabled via 3DR V6 Radio Telemetry (915 MHz, 1000 mW), M10 and Neo M6 u-blox GPS modules. Control is provided by a FlySky FS-i6 transmitter with FS-iA10B receiver, while an ImmersionRC 600 mW VTX handles video transmission. The system features a power button, power module, and converter for stable power, along with a battery alarm triggering Return-to-Land (RTL) at 3.6V. A Pocket WiFi module enables real-time data transmission to a BlackPearl FPV monitor and mobile app.

Figure 2 illustrates the system process; the drone utilizes Raspberry Pi 5 and a webcam for data handling and real-time monitoring. These are connected to a Pixhawk Pro M10 Flight Controller, which serves as the heart of the drone. The system is integrated with brushless motors, ESCs (electronic speed controllers), propellers, an FPV camera, and is powered by a 3S 6000mAh LiPo battery. The primary objective is to gather and analyze all areas infested by Ostrinia furnacalis using a mobile application. After geotagging the infested locations, the application identifies the types of infestation such as: holes, wilting, and discoloration and displays the data in a pie chart. The classifications are automatically tallied, and users can easily generate a report by setting a specific time frame.

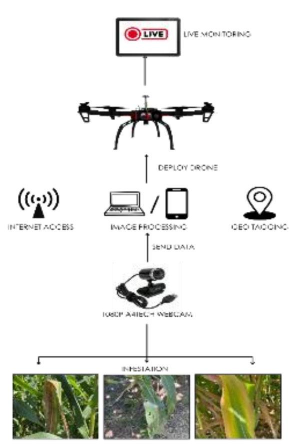

Figure 2. *System Process*

In this study, Weighted Mean and Overall Mean were employed to analyze and interpret the collected data. The weighted mean is particularly appropriate when different data points carry varying levels of importance, such as infestation levels from farms of different sizes or production capacities. It is calculated by multiplying each data point by its corresponding weight, summing these products, and dividing by the sum of the weights. This method ensures that larger or more critical fields have proportionally greater influence on the overall assessment of pest infestation. A decision threshold is then applied to the weighted mean to guide interventions; for example, if the weighted mean infestation exceeds a pre-set value, pest control measures are triggered. In contrast, the overall mean treats all data points equally, providing a general measure of infestation across the study area without weighting. Using both measures allows researchers to interpret the data accurately, identify areas of high concern, and prioritize actions effectively.

Equation 1 Weighted Mean = Sum of Weighted Terms / Total Number of Terms

Equation 2 Overall Mean = Sum of Terms / Number of Terms

In addition to statistical analysis, several formulas were used to design and evaluate the drone system for real-time pest monitoring. The Total Battery Voltage of the drone is determined by multiplying the nominal voltage of a single cell by the number of cells connected in series:

Equation 3 Low / High Voltage Battery (Volts) = V x n

Equation 3 ensures that the drone receives sufficient voltage to operate its motors and electronic systems efficiently. Proper voltage design is crucial to maintaining stable flight and reliable performance during aerial monitoring missions.

Equation 4 Speed of Motor with Low / High Voltage Battery (Rpm) = kV x V

Equation 4 calculates the rotational speed (in revolutions per minute) of a brushless motor based on the motor's kV rating (RPM per volt) and the battery voltage (V). It helps researchers estimate the expected speed and performance of the drone's propulsion system, which is critical for optimizing flight dynamics, stability, and efficiency.

Equation 5 Amount of Electrical Energy Consumed (Watt-hour) = mAh /1000 x V

Equation 5 is used to compute the electrical energy capacity of the drone's battery in watt-hours (Wh), converting milliamp-hours (mAh) to amp-hours by dividing by 1000 and then multiplying by the voltage (V). Researchers use this to understand the energy available for a flight, which helps in predicting flight time and determining if the battery meets the drone's energy demands.

Equation 6 Flight Time (Minutes) = wh x 60 mins / P

Equation 6 estimates the flight duration of a drone in minutes, where Wh is the battery's energy in watt-hours, and P is the average power consumption in watts. By multiplying Wh by 60 and dividing by the power draw (P), researchers can forecast how long the drone can stay airborne under typical operating conditions. This is essential for mission planning, energy management, and ensuring the drone meets endurance requirements

The researchers used purposive sampling to select expert respondents, including a Licensed Drone Expert and a Registered Agriculturist, following ISO/IEC 25010 standards for system evaluation. . For the agricultural context, the researchers engaged directly with farm owners in the target locales who have experienced significant crop losses due to borer infestations. The researchers used a 5-point Likert Scale to categorize the responses which

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allows the structure measurement of participant feedback, providing a consistent method to evaluate perception and satisfaction levels in the prototype.

RESULTS AND DISCUSSION

The MoniKorn drone prototype, built with a durable alloy frame and DJI parts for stability as illustrated in Figure 3. It uses T-Motor Air Gear motors and a Pixhawk Pro M10 controller with dual GPS modules for precise flight. A Raspberry Pi 5 runs YOLO v8 for detecting Ostrinia furnacalis, using a 700TVL FPV camera and 1080p webcam. Video is transmitted via a 600mW VTX to an HD monitor. Communication relies on a 915 MHz 3DR telemetry module and a FlySky FSI6 controller. Powered by a 3S 6000mAh LiPo battery, it includes a power converter, SD storage, and pocket Wi-Fi. Software tools include Visual Studio Code, PHP/MySQL backend, an Android app, and Mission Planner for flight control.

Figure 3. *MoniKorn*

Figure 4 presents the developed mobile application using Android Studio and Visual Studio to support the drone system in detecting corn leaf infestations. The mobile application features a user-friendly interface that allows users to view real-time drone footage, receive infestation geotags, and access image analysis results. It also includes simple UI and visual indicators for easy monitoring and control during field operations.

Figure 4. *Mobile Application GUI*

Table 1. *Detection Testing via Image Processing*

No. of Testing	Accuracy Rate (%)					
	Phase 1			Phase 2		
	Discolor.	Holes	Wilted	Discolor.	Holes	Wilted
1	0.00 %	2.93 %	4.27 %	87.64 %	83.52 %	90.31 %
2	4.49 %	6.20 %	8.07 %	71.28 %	91.27 %	99.12 %
3	10.2 %	11.67 %	12.54 %	93.41 %	76.45 %	74.82 %
4	17.22 %	17.33 %	19.22 %	97.25 %	88.13 %	88.96 %
5	25.78 %	25.11 %	24.08 %	89.12 %	94.82 %	91.75 %
6	29.78 %	27.97 %	29.54 %	90.76 %	72.64 %	93.29 %
7	39.33 %	31.24 %	30.44%	75.53 %	98.31 %	86.51 %
8	41.52 %	34.59 %	36.27%	99.38 %	85.90 %	70.64 %
9	42.36 %	35.78 %	38.42%	78.21 %	90.12 %	82.42 %
10	44.68 %	37.87 %	40.01%	84.21 %	74.53 %	98.07 %
11	46.92 %	45.90 %	43.69%	92.44 %	79.65 %	77.31 %
12	49.11 %	48.38 %	47.85%	86.19 %	96.08 %	95.48 %

Table 1 presents accuracy rates for detecting Ostrinia furnacalis symptoms discoloration, holes, and wilting across two phases and twelve tests. Phase 1 had low accuracy, gradually improving to around 47–49% by the twelfth test. Phase 2 showed significant gains, with accuracy peaking near 99% for all symptoms, demonstrating effective model improvements and learning over time.

Table 2. *Autopilot Flight Testing*

No. of Testing	Flight Time (s)		
	Phase 1	Phase 2	Phase 3
1	0.00	292.45	653.21
2	5.00	263.11	799.18
3	5.43	315.22	812.67
4	8.20	221.98	721.34
5	13.53	345.07	689.99
6	18.92	298.62	845.12
7	20.22	317.30	964.27
8	23.65	336.80	732.66
9	28.18	378.41	901.54
10	118.34	354.29	744.68
11	132.77	399.50	978.22
12	100.89	240.75	683.45

Table 2 presents twelve autopilot flight tests across three phases, highlighting the drone’s performance improvements. In Phase 1, flight times gradually increased from 0 to over 100 seconds as system calibration and waypoint tuning were refined. Phase 2 showed consistent flights ranging from 222 to 399 seconds, reflecting ongoing adjustments and improved stability. Phase 3 achieved the longest and most stable flights, with durations rising from 653 to 978 seconds, demonstrating the maturity and reliability of the autopilot system.

Table 3. *Final Flight-Testing Phase of Drone with Image Processing*

No. of Testing	Flight Time (s)	Accuracy Rate %
1	727.45	88.67
2	947.32	92.45
3	901.12	74.18
4	1095.27	81.53
5	675.45	96.22
6	510.37	63.78
7	840.00	71.29
8	900.67	90.35
9	985.26	85.47
10	1198.45	59.66
11	802.14	64.80
12	1102.78	78.94

Table 3 shows the twelve drone flight tests assessing flight duration and image processing accuracy. Flight times varied from 510.37 seconds (Test 6) to 1198.45 seconds (Test 10), showing the drone's capability for long flights but with some performance inconsistency likely due to environmental or system factors. Accuracy rates also fluctuated, peaking at 96.22% in Test 5, while the longest flight (Test 10) had the lowest accuracy at 59.66%. Lower accuracy in Tests 6 (63.78%) and 11 (64.80%) suggests occasional challenges in image recognition or navigation during some flights.

Table 4 presents the researchers conducted a structured interview with a registered agriculturist to gather expert recommendations for managing Ostrinia furnacalis (Asian Corn Borer). The agriculturist shared insights on identifying, detecting, and treating infestations, including chemical controls, dosages, timing, and damage prevention. This expert advice was analyzed and integrated into the MoniKorn application, which offers farmers real-time detection coupled with practical, science-based treatment guidance for effective pest management.

Table 4. *Recommendations on How to Control Ostrinia furnacalis*

RECOMMENDATIONS AND CONTROL OSTRINIA FURNACALIS
1. **Discoloration** (Mild to Moderate) Yellowing or browning leaves may signal corn borer presence. Check for eggs/ corn borer and remove affected parts. Spray: Lambda-cyhalothrin or permethrin, 250-300 ml/ha, applied at night during the early eggs stage.
2. **Wilted Leaves** (Moderate to Severe) Wilting signs that corn borers are in the leaves. Inspect for damage and burn contaminated leaves after harvest. Spray: Chlorantraniliprole, 100 ml/ha, early morning or late afternoon.
3. **Holes** (Severe) Holes and frass show heavy feeding. Act quickly. Spray: Bacillus thuringiensis (Bt) or Spinosad, 400–500 ml/ha, when corn borers are small. Note: Apply during severe damage to stop further feeding

Table 5 shows the drone evaluation by a drone expert and an agriculturist across key performance indicators. The drone scored highest in Functional Stability (4.11), Usability (4.00), Portability (4.00), and Security (4.00), all rated "Agree," reflecting positive views on its operation, ease of use, mobility, and safety. Performance/Efficiency (3.00) and Reliability (3.11) received Neutral ratings, indicating room for improvement. The overall mean of 3.70 suggests the drone is generally well-regarded but could enhance performance and reliability for agricultural use.

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Table 5. *Experts Evaluation about the Drone*

Indicators	Weighted Mean	Descriptive Rating
Functional Stability	4.11	Agree
Performance / Efficiency	3.00	Neutral
Usability	4.00	Agree
Reliability	3.11	Neutral
Portability	4.00	Agree
Security	4.00	Agree
Overall Mean	3.70	Agree

CONCLUSION

For the Conclusion, the study confirms that the MoniKorn – Autopilot Drone System for Real-Time Monitoring and Detection of Ostrinia furnacalis Infestations fully meets its functional requirements. Field deployment in San Rafael, Mexico, Pampanga showed that local farmers found the system effective for identifying and monitoring cornfield infestations. It integrated real-time aerial monitoring with a mobile application that geo-tags infestation areas and provides pest management recommendations. The autopilot system supports adjustable parameters, waypoint missions, and return-to-launch (RTL) functionality. Farmers rated the system as "Good," and subject-matter experts agreed with its effectiveness. Feedback from a registered agriculturist called for improved battery life and imaging, while a drone expert emphasized the need for a hardware upgrade to accommodate a higher-capacity battery, including modifications to the alloy frame and propulsion components.

Evaluating all the results, for future researchers who wish to continue and improve this study, several recommendations are offered for future researchers aiming to enhance the MoniKorn system. Suggestions from a registered agriculturist and drone experts include integrating Real-Time Kinematic (RTK) technology for precise positioning and reliable signal transmission, and adding an infrared (IR) sensor to improve sensing during autopilot mode. Using a 3D-printed lightweight casing is advised to protect internal components and ensure functionality in rainy conditions. Additional improvements involve upgrading to a high-quality GPS module and camera for better image processing and object detection. Minor enhancements to the mobile app should focus on security and added features. When upgrading components, careful consideration must be given to drone weight, propeller type and configuration, and battery capacity and efficiency, as these directly affect flight time, stability, and overall performance.

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