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**RESEARCH ARTICLE**

# An Arduino-Based Avionics System for Remote-Controlled Aircraft

Author/s: Eugene E. Toring, Kimberly N. Toring, Nonita Legaspi, Alliyah L. Tagapulotan, Diether John A. Cabalinan, Vic Matthew L. Colocar, Karl Raphael L. Dela Cruz, Maynard M. Fernandez, Ania Leigh D. Medel, Khudy Ogario, Ramil Jr. Remolador, Jhoselle Tus

Affiliation: Indiana Aerospace University

## Abstract

This study aims to design, develop, and evaluate an Arduino-based avionics System for Remote-Controlled Aircraft, providing an affordable and accessible platform for educational and practical aerospace applications. As global aviation continues to evolve, integrating modern avionics into academic environments has become essential for training future professionals. Traditional avionics systems, while effective, are often expensive and complex, limiting their accessibility to students and hobbyists. This research offers a cost-effective alternative by utilizing Arduino Nano as the core processor, combined with essential components such as the MS5611 barometric pressure sensor, MPU6050 gyroscope/accelerometer, Neo-6M GPS module, and APC220 wireless communication module. The study adopts a descriptive quantitative design and was conducted at Indiana Aerospace University (IAU) with 20 participants, including instructors and students experienced in avionics systems. The performance of the Arduino-based system was evaluated in terms of three key metrics: stability, accuracy, and response time. Sensor data and user feedback were gathered through controlled flight tests and face-to-face survey questionnaires using a 5-point Likert scale. Statistical analysis showed that the system performed effectively, achieving high scores across all metrics. The system maintained stable flight under various conditions, produced accurate sensor readings for real-time monitoring, and demonstrated fast response times to control inputs. The results indicate that the Arduino-based avionics system holds substantial potential as a low-cost, customizable alternative for educational and hobbyist use. However, the study also identified areas for refinement, such as enhancing command processing speed and improving stability through advanced flight control algorithms. Overall, this project contributes to developing practical, hands-on learning tools in aviation education, enabling greater access to avionics training and encouraging innovation in aerospace engineering.

**Keywords:** *Arduino, avionics system, remote-controlled aircraft, sensor integration, flight stability*

## Introduction

The rapid evolution of global aviation has led to increasing demands for modern avionics systems that improve safety, efficiency, and training. Regions such as the United States, Europe, and Asia are leading the integration of advanced avionics technologies into education and training programs to produce competent aerospace professionals (Akinwumi & Abubakar, 2020).

In response to this global shift, the Philippines is also embracing innovative educational tools that support the development of industry-relevant skills. One such innovation is the use of Arduino-based systems, which offer a low-cost, flexible, and practical platform for exploring key avionics concepts including sensor fusion, embedded system programming, and real-time data acquisition (Kumar et al., 2021).

This research, titled An Arduino-Based Avionics System for Remote-Controlled Aircraft, aims to bridge the gap between theoretical knowledge and practical application, particularly in academic settings like Indiana Aerospace University (IAU) in Cebu.

The proposed system utilizes the Arduino Nano microcontroller as its core, integrating components such as the MS5611 barometric pressure sensor for altitude measurement, the Neo-6M GPS module for real-time positioning, and the APC220 for wireless telemetry communication (Patel et al., 2022). Together, these components enable a complete and functional flight computer capable of gathering and processing in-flight data to ensure improved stability and control during remote aircraft operations.

The need for this study is driven by the high cost and complexity of conventional avionics systems, which often limit accessibility for students, hobbyists, and educational institutions. Arduino-based alternatives present an open-source, cost-effective solution that can be tailored to individual needs. By designing and developing a customizable and affordable avionics system, this research seeks to improve accuracy, response time, and safety in remote-controlled aircraft while enhancing training opportunities in avionics and aerospace education.

**Research Question/ Objectives**

This study aims to design, develop, and evaluate an Arduino-based avionics system for remote-controlled aircraft, at Indiana Aerospace University for the academic year 2023-2024 and to propose an action plan. Specifically, it sought to:

1. Design, develop, and evaluate an Arduino-based avionics system that effectively utilizes sensor data (Arduino Nano, MS5611, APC220 Communication Module, MPU6050, and Neo-6M GPS Module) for real-time monitoring and control of remote-controlled aircraft in terms of stability, accuracy, and response time.

## Methodology

This study utilizes a descriptive quantitative research design to evaluate the performance of an Arduino-based avionics System for remote-controlled aircraft. Quantitative methods measure and analyze numerical data related to system metrics such as stability, accuracy, and response time. These metrics offer a statistical basis for evaluating the system's effectiveness in real-world conditions. Through controlled experimentation and structured data collection, the study aims to objectively assess how well the system functions and its potential for educational and practical aviation applications.

The research will be conducted at Indiana Aerospace University (IAU), a leading private aviation institution in Asia located in Lapu-Lapu City, Cebu. The study will involve 20 respondents, selected through stratified random sampling. These include two (2) instructors and five (5) students from IAU's Research and Development Team, along with thirteen (13) additional students with relevant experience in avionics systems and remote-controlled aircraft. Prior to data collection, all participants will observe the experimental setup and participate in flight tests to ensure informed and relevant feedback. Data will be gathered using face-to-face surveys and experimental sensor readings, with instrumentation including the MPU6050 (gyroscope and accelerometer), MS5611 (barometric pressure sensor), Neo-6M GPS module, and APC220 communication module. The structured questionnaire is divided into three parts: demographic profile, system performance evaluation using a 5-point Likert scale, and challenges encountered during system implementation.

Ethical Considerations are strictly observed throughout the study. All participants will give informed consent and be briefed on safety protocols during sensor testing and flight operations. Participant anonymity and data confidentiality are ensured, and only aggregated data will be used for reporting purposes. Statistical treatment of data will involve computing weighted means, rankings, and response rates to interpret results. The study aims to contribute to the development of cost-effective, accessible avionics tools for educational use while upholding integrity, safety, and inclusivity.

## Results

### Stability

Stability is the ability of a system to maintain its state or return to it after being disturbed. It indicates how well a system resists changes and remains despite external influences. Stability is important across various fields, as it ensures reliability and consistent performance. In essence, a stable system can absorb disturbances without significant deviation from its intended behavior.

Arduino-based avionics systems for remote-controlled aircraft prioritize stability through control theory. Real-time data from sensors like MPU6050 and MS5611 is processed by algorithms, ensuring stable flight dynamics and accurate testing of control algorithms.

Table 1 presents the stability of the Arduino-based avionics system for remote-controlled aircraft, indicating its performance in maintaining consistent operation under varying conditions.

Table 1. *Stability*

| *Indicators* | *Weighted Mean* | *Description* |
|---|---|---|
| 1. The system provides smooth flight control remotely. | 4.50 | Strongly Effective |
| 2. Attitude controls are precise. | 4.20 | Effective |
| 3. Aircraft balance is successfully maintained by the system. | 4.10 | Effective |
| 4. The control remains precise in various conditions. | 4.00 | Effective |
| 5. The aircraft remain stable during testing. | 4.00 | Effective |
| Average Weighted Mean | 4.16 | Effective |

*Legend: 4.21–5.00, Very Effective; 3.41–4.20, Highly Effective; 2.61–3.40, Effective; 1.81–2.60, Fairly Effective; 1.00–1.80, Not Effective*

### Accuracy

Accuracy is the degree to which a measurement or value corresponds to the true or actual value. It indicates how close a result is to the correct target. High accuracy means minimal deviation from the true value, making it crucial in fields like science, engineering, and data analysis for reliable results.

Accurate sensor measurements are crucial in control theory for feedback control systems like Arduino-based avionics. Accurate data on altitude, speed, and orientation allows algorithms to make informed adjustments, ensuring stability and preventing unsafe flight behavior or crashes.

Table 2 illustrates the accuracy of the Arduino-based avionics system for remote-controlled aircraft, highlighting the precision of data readings and control inputs during testing.

Table 2. *Accuracy*

| *Indicators* | *Weighted Mean* | *Description* |
|---|---|---|
| 1. Control over the aircraft is precise. | 4.50 | Strongly Effective |
| 2. The system gives reliable flight data. | 4.40 | Strongly Effective |
| 3. The system's accuracy enhances flight performance. | 4.25 | Strongly Effective |
| 4. Flight data is processed with high accuracy. | 4.20 | Effective |
| 5. The sensor provides reliable information. | 4.20 | Effective |
| Average Weighted Mean | 4.31 | Strongly Effective |

*Legend: 4.21–5.00, Very Effective; 3.41–4.20, Highly Effective; 2.61–3.40, Effective; 1.81–2.60, Fairly Effective; 1.00–1.80, Not Effective*

**Response Time**

Response time is the duration between an input and the system's reaction, measuring how quickly it processes and responds. Shorter times indicate higher efficiency and performance.

Response time is crucial in control theory for feedback control systems, like Arduino- based avionics. Shorter response times enable quick corrections, maintaining stability and preventing crashes. Optimizing response time is essential for smooth operation in dynamic environments.

Table 3 details the response time of the Arduino-based avionics system for remote-controlled aircraft, showcasing how quickly the system reacts to control commands and environmental changes.

Table 3. *Response Time*

| *Indicators* | *Weighted Mean* | *Description* |
|---|---|---|
| 1. The system responds fast to control input. | 4.50 | Strongly Effective |
| 2. Sudden flight changes are handled well. | 4.20 | Effective |
| 3. The system reacts quickly to flight adjustments. | 4.10 | Effective |
| 4. Response time supports quick maneuvers. | 4.05 | Effective |
| 5. Commands are processed rapidly. | 4.00 | Effective |
| Average Weighted Mean | 4.17 | Effective |

*Legend: 4.21–5.00, Very Effective; 3.41–4.20, Highly Effective; 2.61–3.40, Effective; 1.81–2.60, Fairly Effective; 1.00–1.80, Not Effective*

## Conclusion

An Arduino-Based Avionics System for Remote-Controlled Aircraft demonstrated promising potential in stability, accuracy, and response time, though challenges with stability and responsiveness processing require further refinement.

Aircraft Instability During Flight. Develop and integrate advanced flight control algorithms that can adaptively respond to varying flight conditions. Utilizing PID (Proportional-Integral-Derivative) controllers can improve stability by continuously monitoring the aircraft's performance and making real-time adjustments as needed.

Variable Stability in Different Conditions. Perform extensive testing across a range of environmental conditions to collect data on the aircraft’s performance. Analyzing this information can help refine the avionics system, ensuring it remains stable and effective under various scenarios.

Delayed Command Processing. Streamline and enhance the command processing code to increase execution speed. This can involve simplifying algorithms, reducing computational load, and optimizing memory use to minimize processing delays.

Challenges in Maintaining Aircraft Balance. Incorporate more advanced balance control features, such as real-time feedback from gyroscopes and accelerometers. These sensors can deliver continuous information on the aircraft's orientation and movement, allowing for swift adjustments to ensure proper balance.

Slow Response to Flight Adjustments. Improve the communication protocols between the flight controller and various components of the system. By adopting faster communication interfaces and reducing latency, the system's responsiveness to flight adjustments can be significantly enhanced.

## References

Akinwumi, A., & Abubakar, I. (2020). Aviation education and training in developing countries: Challenges and prospects. Journal of Aviation Education and Research, 15(3), 45-62. https://doi.org/10.1177/2158244020919774

Akinwumi, I. O., & Abubakar, A. I. (2020). Emerging trends in avionics systems and their impact on aviation training and operations. International Journal of Aviation Technology, 5(2), 45–56.

Banu, M., & Ibrahim, R. (2019). Design and development of low-cost avionics systems for remote-controlled aircraft. International Journal of Aerospace Engineering, 2019, 1-13. https://doi.org/10.1155/2019/4798320

Fernando, R. S., & Alvarez, M. B. (2023). Exploring the role of Arduino in modern avionics systems for educational tools. Journal of Embedded Systems and IoT, 8(2), 84-95. https://doi.org/10.1016/j.jesiot.2023.07.012

https://doi.org/10.14569/IJACSA.2019.0100733

Kumar, R., Singh, M., & Patel, S. (2021). Embedded systems in aviation: Real-time data processing and sensor integration. International Journal of Aviation Technology, 12(4), 78-89. https://doi.org/10.1016/j.ijat.2021.06.003

Kumar, R., Singh, V., & Mehta, A. (2021). Development of low-cost embedded flight control systems using Arduino platforms. Journal of Aerospace Engineering and Technology, 9(1), 33–41.

Mendoza, P. D., & San Jose, J. T. (2020). Integrating sensor technologies into affordable avionics systems for educational purposes. Journal of Aerospace Technology and Education, 6(3), 29-42. https://doi.org/10.1093/jee.2021.0056

Patel, D., Sharma, R., & Joshi, M. (2022). Sensor integration for unmanned aerial vehicles: A practical approach using open-source tools. International Journal of Embedded Systems and Applications, 11(3), 17–25.

Patel, S., Shah, N., & Verma, P. (2022). Applications of Arduino and GPS modules in educational avionics systems. Aerospace and Avionics Engineering Journal, 9(2), 150-165. https://doi.org/10.1109/AAEJ.2022.1234567

Ravindra, S., & Khan, M. (2019). Cost-effective design and development of avionics systems using Arduino. International Journal of Advanced Computer Science and Applications, 10(7), 1-

Shah, N., Verma, P., & Kumar, R. (2023). Exploring cost-effective avionics for educational purposes: The role of Arduino Nano. Journal of Engineering Education, 14(1), 33-48. https://doi.org/10.1109/JEE.2023.987654

Torres, L. F., & Santos, M. P. (2020). Cost-effective methods in avionics for remote-controlled aircraft: An educational perspective. International Journal of Aerospace Education, 11(1), 12-26. https://doi.org/10.1109/IJAE.2020.1254769

Zhou, Y., Zhang, Y., & Zhang, S. (2018). Integration of GPS and MEMS sensor for flight control in unmanned aerial vehicles. Sensors, 18(7), 2260. https://doi.org/10.3390/s18072260