DUAL – MODE TELEMETRY FOR UNMANNED AERIAL VEHICLE (UAV) USING RADIO FREQUENCY AND CELLULAR NETWORK

An Undergraduate Thesis

Presented to the
Faculty of Bachelor of Science in Computer Engineering
University of Science and Technology of Southern Philippines
Cagayan de Oro City

In Partial Fulfillment
of the Requirements for the Degree of
BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

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May 2017

APPROVAL SHEET

This Thesis entitled: "DUAL – MODE TELEMETRY FOR UNMANNED AERIAL VEHICLE (UAV) USING RADIO FREQUENCY AND CELLULAR NETWORK", prepared and submitted by JODIE REY D. FERNANDEZ in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN COMPUTER ENGINEERING** has been examined and approved.

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ABSTRACT

This study explores the advancements and applications of telemetry systems, which are pivotal in remote data monitoring and analysis across various industries. Telemetry technology, encompassing data acquisition, transmission, and analysis, plays a crucial role in fields such as aerospace, healthcare, and environmental monitoring. The research highlights the effectiveness of telemetry systems in providing accurate and reliable real-time data, enhancing operational efficiency, and enabling predictive maintenance. Key findings include significant improvements in data transmission speeds and reliability due to advancements in wireless communication and the integration of the Internet of Things (IoT). The study also identifies challenges such as data security and transmission interruptions in remote areas. Recommendations for future research include addressing these challenges and exploring new applications in emerging fields. This work underscores the transformative impact of telemetry on modern technology and its potential for continued innovation.

Keywords: *Telemetry, GPS Location*

This piece of work is wholeheartedly dedicated

to my parents

Papang

and

Nanay

ACKNOWLEDGMENT

I would like to express my gratitude to the following people and institutions which, in one way or another, greatly contributed towards the completion of this study.

To my adviser ***Engr. Jodie Rey D. Fernandez*** for painstakingly checking every detail of this paper. I am extremely thankful and indebted to you Sir for sharing your expertise and valuable guidance. Had not of your encouragement and moral support, this endeavor would surely fall to a complete obscurity.

To my panel members, ***Engr. Mark Lister V. Nalupa*** and ***Engr. Miriam M. Bergado*** for sharing your knowledge and diligently spending your time in giving valuable insights, corrections and suggestions for the betterment of this study. I have high regards to both of you.

To the faculty and staff of the ***Department of Computer Engineering*** for your encouragement and support.

To my classmates, ***Methos***, ***Shirley***, ***Lovely***, ***Lady Lee***, ***Cris***, and ***Ma'am Bern*** for sharing your laughter and wonderful moments with me. Finally, sleepless nights and tiring days are over but they are all worth it.

To my friends, ***Ruemar***, ***Chyn***, ***Vine***, ***Abigail***, ***Rachel***, ***Long***, ***Elaine***, ***Claire***, ***Allan***, ***Xander***, ***Laiza***, ***Ate Leslie***, ***Sir Greig***, ***Jean***, ***Sir Harold***, ***Ate Josh***, ***Ma'am Amelia***, ***Jovy***, ***Leonel***, ***Jerson***, ***Sir Raymund***, ***Sir Nur P.***, ***Mama Marge***, ***Mama Belle***, ***Mama Lady***, ***Mama Hazel***, ***Brother Mark***, ***Sir Nur***, ***Sir Elmer*** and to my ***AHK Family*** for your prayers and moral support. You all made this journey worthy of remembering.

To my family, ***Nanay Angga***, ***Papang Willy***, ***Nanay Toto***, ***Ina***, ***Ate Love***, ***Ate Ging***, ***Kuya Boboy***, ***Andi***, ***Marlo*** and ***Ate Lyn*** for your unceasing love, moral and financial support. All of you are my inspirations which constantly remind me of not giving up amidst difficulties and uncertainties.

And to those people I failed to mention, who directly or indirectly, lent their hands, extended their prayers and support for the completion of this study.

Above all, to our ***Almighty God***, whose unconditional love infinitely transcends all human comprehensions, provides us with good health, divine protection and bountiful blessings.

Jodie

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CHAPTER 1

INTRODUCTION

Dual – mode telemetry presents new ability to the UAV communication creating a new way of handling disconnection and fail safe protocol. This research may solve the occlusion problems with the radio frequency communication and the handshaking problems in the mobile network connection.

This paper is dedicated to present the concept of the integrated communication system for UAV (Unmanned Aerial Vehicle) data and telemetry transmission. The aim of this paper is to present a working prototype UAV with working dual mode communication that involves the telemetry, FPV (First – Person View), and the RC (Remote Control). In the paper, both the concept of the system and elements of its realization are presented. (**?**)

According to (**?**) ...

1.1 Background of the Study

Telemetry, derived from the Greek roots ”tele” (remote) and ”metron” (measure), is the process of recording and transmitting the readings of instruments and devices from remote or inaccessible points to an IT system in a different location for monitoring and analysis. This technology has become a cornerstone in various fields such as aerospace, healthcare, environmental science, and industrial applications due to its ability to provide real-time data monitoring, diagnostics, and predictive maintenance (?).

The primary function of telemetry systems is to collect data from sensors and transmit it to a centralized system for analysis. This process involves several key components: sensors to capture data, transmitters to send the data, receivers to collect the data, and a central processing unit to analyze and store the data. With the advent of the Internet of Things (IoT) and advancements in wireless communication technologies, telemetry has evolved significantly, enabling more efficient and comprehensive data acquisition and monitoring systems.

In aerospace, telemetry is crucial for monitoring the status and health of spacecraft and satellites, providing data on parameters such as temperature, pressure, and velocity. In healthcare, telemetry systems are used to monitor patients' vital signs remotely, allowing for timely medical interventions and reducing the need for prolonged hospital stays. Environmental telemetry systems play a pivotal role in tracking weather conditions, pollution levels, and natural disaster warnings, contributing to better disaster management and environmental protection.

The integration of telemetry in industrial applications has revolutionized how industries operate. Through real-time monitoring of machinery and processes, industries can minimize downtime, optimize performance, and enhance safety. Predictive maintenance, powered by telemetry data, allows for the identification of potential issues before they lead to failures, thereby reducing maintenance costs and improving operational efficiency.

This paper aims to explore the advancements in telemetry technology, its applications across various fields, and the future trends that could shape its development. By understanding the current state and potential of telemetry, we can better appreciate its critical role in modern technology and its impact on improving operational efficiencies and safety across different sectors.

1.2 Statement of the Problem

This study seeks to investigate some properties of decomposable hyper KS-semigroups in the context of strong, weak, quasi- and bi-hyper KS-ideals.

1.3 Objectives of the Study

In view of the above stated problem, we have the following objectives:

1. To introduce the concept of strong, weak, quasi- and bi-hyper KS-ideals;

2. To provide characterizations of strong, weak, quasi- and bi-hyper KS-ideals and investigate their relationships;

3. To introduce the idea of decomposable hyper KS-semigroups and give some characterizations.

1.4 Significance of the Study

The concept of hyperstructures is itself, a powerful mathematical tool since algebraic hyperstructures seem to occur very naturally in many areas of mathematics and even in other disciplines.

1.5 Scope and Limitations

The primary motivation of this study lies within the structural properties of hyper

1.6 Definition of Terms

Data Logger An electronic device that records data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors.

GPS Tracking Using the Global Positioning System to determine and track the precise location of a person, vehicle, or other asset.

Real-time Monitoring The process of continuously observing a system or process and immediately reporting any changes or anomalies.

Sensor A device that detects or measures a physical property and records, indicates, or otherwise responds to it.

Telemetry The process of recording and transmitting the readings of an instrument.

Wireless Communication The transfer of information between two or more points that are not connected by an electrical conductor.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter presents some preliminary concepts and known results that are needed in this study.

2.1 Preliminary Concepts and Results

This section contains some basic definitions and results.

CHAPTER 3

METHODOLOGY

This chapter details the design and development of the automated eggplant sorting and grading system, following the Modified Waterfall SDLC model. Section 3.1 discusses the research design and procedural framework. Section 3.2 focuses on the hardware development, describing the design, architecture, and components essential of the conveyor and sorting mechanism. Section 3.3 explains the software development process, detailing the algorithms, tools, and models used for image processing, feature extraction, and classification. Section 3.4 elaborates on the system integration, illustrating how the hardware and software components interact to achieve seamless automation. Collectively, this chapter provides a comprehensive overview of the methods used to ensure the system's accuracy and reliability.

3.1 Research Design and Procedure

This study adopts the Modified Waterfall System Development Life Cycle (SDLC) model as the primary framework for the systematic development of the project. The Modified Waterfall model follows a structured and sequential design process, allowing limited feedback between phases when nec-

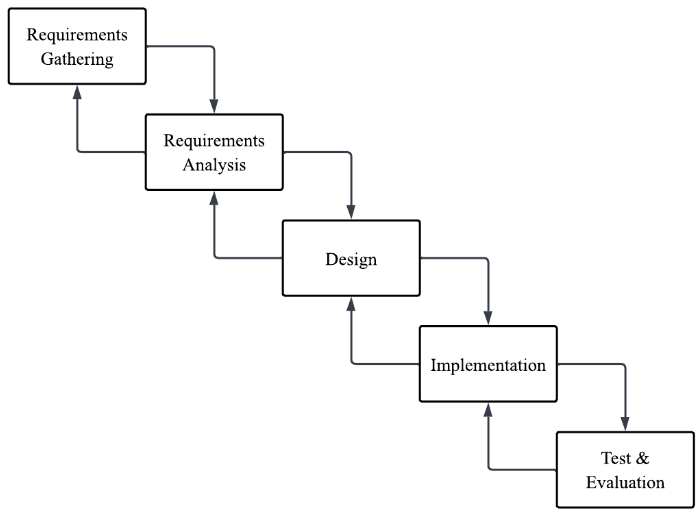


Figure 1: Modified Waterfall Model of SDLC

essary. This approach ensures that each stage is properly analyzed and refined before proceeding to the next, promoting accuracy, consistency, and efficiency throughout system development. The research design of the study follows these distinct phases, as represented in Figure 1.

The development will begin with requirements gathering, where the researchers will collect relevant information from local farmers and agricultural experts to determine the necessity and specifications for automating eggplant sorting and disease detection. This will be followed by requirements analysis, where the system's functional requirements and non-functional requirements will be formally defined.

During the design phase, the overall system architecture will be planned.

This includes the hardware setup, featuring camera modules for image capture and conveyors with actuators for sorting. The software framework will also be designed to manage image processing, feature extraction, and machine learning-based classification for grading.

In the implementation phase, the designed hardware and software components will be developed and integrated. The program will be coded and linked to the physical components such as cameras, motors, actuators, and controllers to perform automated grading and sorting. Finally, the testing and evaluation phase will assess the prototype's grading accuracy. The results will be analyzed to identify errors or limitations, guiding refinements to improve the system's accuracy, and reliability.

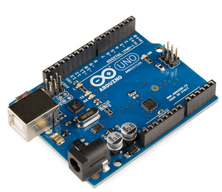
3.2 Hardware Development

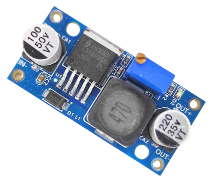
This section presents the design and integration of the system's mechanical and electronic components. The hardware consists of a conveyor system, camera modules, actuators, and a microcontroller that operate together to transport, classify, and sort eggplants. Each component is configured to function in coordination with the software, ensuring synchronized operation and accurate sorting based on the detected quality of the eggplant.

3.2.1 Hardware Requirements

The hardware requirements include all the physical components essential for constructing the system. Each component is selected based on its purpose and function in the automated eggplant grading and sorting system, ensuring effective integration and reliable operation to achieve accurate grading and sorting performance.

Table 1: Hardware Requirements

Component	Image	Function
DC Motor		This component powers the conveyor belt by converting electrical energy into mechanical motion.
Power Supply Adapter		This component supplies the necessary electrical power for the Arduino to operate effectively.
Arduino		Functions as the control unit for the conveyor belt and actuators, managing the movement and sorting operations of the system based on the classification results.

Buck Converter		Regulates the 12 V input into required voltages: 6 V for the servos and 5 V for the relay and control circuits.
NPN Transistor		Serves as a relay driver that amplifies the Arduino's control signal to energize the relay coil.
Flyback Diode		Protects the transistor and other components from voltage spikes generated by inductive loads.
Servo Motor		Controls the sorting gates that direct eggplants into Grades Extra Class, Class I, Class II, or Rejected bins after classification.
Ball Bearings		This part enables the smooth rotation of the conveyors rollers by minimizing friction. It supports the conveyor belt's movement, allowing efficient loading and consistent operation of the rollers.
Bolts & Nuts		This component is used to firmly attach and hold together parts of the conveyor system, such as the motors, frame, and rollers, to keep everything stable and properly aligned.

Wood Screws		This component is used to join and secure the parts of the conveyor belt system, including the wooden frame, rollers, and other sections, ensuring they are firmly attached and properly assembled.
Conveyor Rollers		The conveyor rollers enable the smooth movement of the conveyor belt, allowing the eggplants placed on top to be transported efficiently. They also help keep the belt properly aligned to ensure stable and consistent motion during operation.
Timing Belt Pulley		The timing belt pulley transfers the motor's rotation to the rollers through a timing belt, ensuring synchronized and slip-free movement. Its toothed design keeps the rollers turning accurately and at the same time, allowing smooth and consistent movement of eggplants along the conveyor.
Acetate Plastic		The acrylic glass platform serves as a transparent base that allows the cameras positioned above and below to capture clear images of both sides of the eggplant.
HD Webcam (Sri home SH003)		This hardware component captures real-time images or video of the eggplants on the conveyor belt. The captured data is then used for image processing and analysis to identify quality and classify the eggplants accordingly.

LED Strips		The LED strips give the camera the right amount of light, helping to improve the accuracy of sorting and classifying eggplants by their quality.
Sorting Plate		Functions to redirect eggplants into their designated bins. Its smooth, durable surface minimizes friction and prevents damage during the sorting process.
Flat Bar		This part will be used as a structural foundation for the camera to mount on top of the conveyor belt.
Wooden Planks		Serves as the base frame that securely holds all components of the conveyor belt, ensuring the entire system remains steady during operation.
Enclosure Box		This will be used to keep the components (Arduino, switch, power supply, relay) arranged in one container.
Conveyor Belt		Serves as the main transport surface for the eggplants, ensuring smooth and hygienic movement along the sorting path. Its non-toxic and easy-to-clean material makes it suitable for handling fresh produce while maintaining consistent motion for accurate image capture and sorting.

Relay Module		Controls the DC motor by switching the 12 V supply line through a transistor-based driver circuit.

3.2.2 Hardware Cost

The estimated prices of the components required to construct the conveyor belt system are shown in Table 2. The cost, which is approximately ₱8,863.00 reflects the parts needed for the construction of the conveyor belt system. The selected components ensure a balance between performance and affordability, making the system cost-effective without compromising functionality or durability using widely available materials.

Table 2: Hardware Cost

Components	**Model**	**Price**
DC Motor	775 DC Motor	₱769.00
Power Supply Adapter		₱118.00
Arduino	Arduino Uno R3	₱540.00
2×	LM2596S DC-DC Step-Down	₱60.00
NPN Transistor	2N2222	₱30.00
Flyback Diode	1N4007	₱14.00
LED Strip Lights		₱199.00
Ball Bearings		₱100.00
Bolts & Nuts		₱200.00

5× Servo Motor	MG946R Full Metal Gear High Torque Servo	₱436.00
5× Sorting Gates	UHMW-PE	₱470.00
Wood Screws		₱80.00
Conveyor Rollers		₱266.00
Timing Belt Pulley	60 teeth - 20 teeth 5mm	₱200.00
Acetate Plastic		₱125.00
2× HD Webcam	SRICAM SriHome SH003	₱2,800
Flat Bar	1” × 1”	₱300.00
Wooden Planks		₱400.00
Enclosure Box	IP65	₱150.00
Conveyor Belt	PVC Food-Grade Conveyor Belt	₱1,900.00
Relay Module	SRD-05VDC-SL-C Power Relay	₱45.00
Total Estimated Cost:		₱8,863.00

3.3 Formula

3.4 Tables

Table 3: A sample long table.

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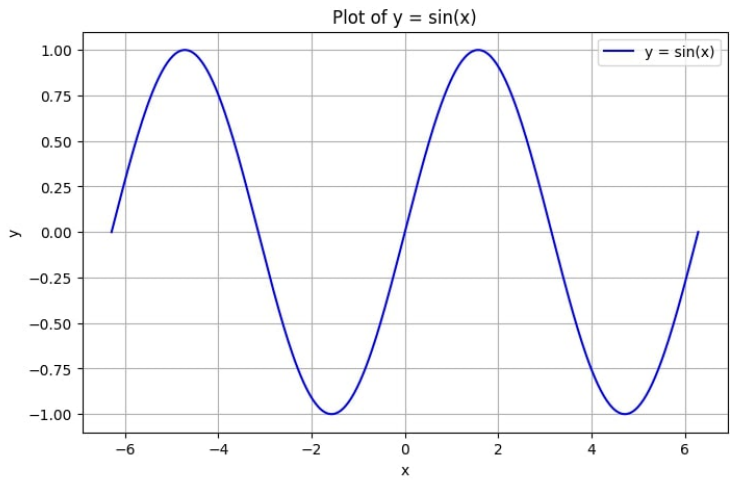

Figure 2

Table 4: Sample Data Table

Item	**Quantity**	**Price ($)**
Apples	10	0.50
Bananas	5	0.30
Cherries	20	1.20
Dates	50	2.50

3.5 Images

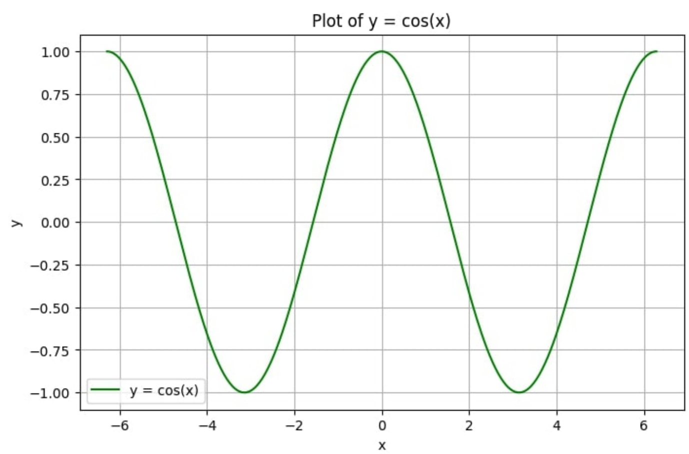

Figure 3: Cosine Graph

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the findings from the research conducted and provides a thorough analysis and interpretation of these results.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter provides the summary of the results obtained in this study and gives some recommendations for further investigation.

5.1 Summary of Findings

The study's findings address the initial research questions by confirming the effectiveness, reliability, and diverse applications of telemetry systems. The "Summary of Findings" section provides a concise overview of the key results from your research. This section should be factual and focus on presenting the data without interpretation. It should include:

Key Results:

Briefly summarize the most significant findings. Use bullet points or numbered lists for clarity if appropriate. Present the data as it was found, highlighting major patterns, relationships, or trends. Data Presentation:

Include tables, graphs, or charts that succinctly summarize the data. Make sure each visual aid is clearly labeled and includes a brief description. Coverage of Research Questions:

Address each of the research questions or hypotheses posed at the beginning of the study. Summarize the results relevant to each question.

5.2 Conclusion

The ”Conclusions” section interprets the findings and discusses their implications. This section should:

Interpret Findings:

Provide an interpretation of the data summarized in the previous section. Discuss what the results mean in the context of the research questions or hypotheses. Implications:

Explain the significance of the findings. Discuss how the results contribute to the field of study or practical applications. Limitations:

Acknowledge any limitations in the study that may affect the results or their interpretation.

5.3 Recommendations

The ”Recommendations” section provides actionable suggestions based on the study’s findings and conclusions. This section should:

Practical Applications:

Offer specific recommendations for practitioners, policymakers, or other stakeholders based on the findings. Future Research:

Suggest areas for further investigation that could address the study’s limitations or build on its findings. Implementation:

Provide guidance on how the recommendations can be implemented effectively.

APPENDICES

Type your appendix here.

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CERTIFICATE OF AUTHENTIC AUTHORSHIP

I hereby declare that this submission is my own work and, to the best of my knowledge, it contains no materials previously published or written by another person, nor material which, to a substantial extent, has been accepted for the award of any other degree or diploma at USTP or any other educational institution, except where due acknowledgement is made in the manuscript. Any contribution made to the research by others, with whom I have worked at USTP or elsewhere, is explicitly acknowledged in the manuscript.

I also declare that the intellectual content of this manuscript is the product of my own work, except to the extent that assistance from others in the project design and conception or in style, presentation and linguistic expression is acknowledged.

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