UNMANNED AERIAL VEHICLE (UAV) FOR SPRAYING PESTICIDES ON ALOCAL FARM

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ABSTRACT: This research intends to provide a sufficing solution in solving agricultural predicament, specifically pest control, and to integrate modern technology that can support local farmers' need. The project (UAV) Drone Sprayer utilized a RC Timer Drone Kit and Raspberry Pi that serve as access point between the android application and the drone. A six channel radio controller was also used as another option. For the development of the tank kart, Arduino and 3V-36V Dual Motor Driver Module that serve as DC-DC converter, were also used. Information bits were collected through the surveys conducted by the researchers and data were gathered from testing the prototype and the mobile controller on different Android mobile devices. The drone was able to spray the pesticide at least 1 ft. distance from the tree. The heavy tank of pesticides was carried by the tank kart and pesticide level was monitored. Thus, the local farmers realize the potential of the project in avoiding possible illness from the long-time direct spraying of pesticides. Overall, the testing results of the drone sprayer, tank kart and android application based from the data, and the acceptability of the project indicates that it can be of help in our local farmers.

KEYWORDS:*Drone Sprayer; Tank Kart; Fruit Bearing Trees; Agriculture; Pest Control; Arduino*

1.0 INTRODUCTION

New innovations for modern farms and agricultural operations worked very distinctive years ago. Modern farms already operate new innovations and high technology piece of equipment for farming including sensors and machineries. Today's agriculture routine modern farms use sophisticated automations and high-tech innovations such as water, moisture, temperature including aerial images, robotic system and Global Positioning System Technology. These will allow businesses to more profitable, safer, and environmental friendly and efficient. Farmers no longer have to apply directly the water, fertilizers and especially the dangerous pesticides across the integrated fields and monitoring the crops and yields is no longer needed instead they can use required target on specific areas in the farm and also treat individual plants separately. [5]The conceivable ease of deployment, reduction in operator prone to chemical compounds and the elevated capability toapply chemicals in a surprisingly well timed and particularly spatially resolved manner make UAS spray application anattractive proposition from a technical viewpoint. However, there are worries and barriers due to flight andchemical safety, plausible environmental contamination, vehicle cost, flight staying power and payloadconstraints. Moreover, the regulatory treatment via aviation and environmental organizations stays unresolved.Spray deposition, car suitability and work price facts are requisite to analyze the technical and economic feasibility of UAV deployment in agricultural spray applications, [11].Drones may someday perform all kinds of “work” in the field, like spraying or seeding. However, today the product of the drone industry is not drones, its data. Two ideas proved that there is a business here. The first is that variability information has real value to growers — it is production control data. The second is that there are places where drone technology allows real data to replace heuristics and estimation in order to initiate action [10].Drone imaging and ground sensor information are so expected to assume a significant job in accuracy agriculture, giving wide space to scientific innovative work. Besides, a few metrological viewpoints must be considered for growing such stages, from the sensors implanted on them up to the instrumentation and the adjustment methodology for their testing. Regardless of their effectiveness and value, the primary downside lies on the way that these frameworks are aligned uniquely for a specific task (e.g., arranging different sorts of vegetation, water bodies, urban, exposed soil, and so on.), without the capacity of making an all-encompassingperspective on agrarian forms. This absence of interoperability causes extra work for the human administrators, since they need to physically encourage the yield information starting with one framework then onto the next. For every such reason, programming modules, rambles and other hardware are object of research so as to build up a typical data middle-ware and application interface. The point is to diminish dreary and tedious work. [7] UAV known as drone has many uses. Several researchers and manufacturers of military aircrafts believe that drones maybe very useful to farming. UAV are aircrafts that can be manipulated without a person who will operate inside. It is for a huge mission, exploration, surveillance; way of transportation and attack roles and it is now used for agricultural purposes. A lot is occurring these days on the difficulty of drone purposes in agriculture and precision farming. From the potential to image, recreate and analyze individual leaves on a corn plant from a hundred and twenty meters height, to getting facts on the water-holding capability of soils to variable-rate water applications, agricultural practices are altering due to drones turning in agricultural intelligence for each farmers and agricultural consultants. Unfortunately, many of the promises being made to farmers, drone service companies certainly could

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not deliver, even backed up through suitable research yet.[2]

The main objective of this research is to design and develop an Unmanned Aerial Vehicle (UAV-Drone) for spraying pesticides on fruit bearing trees on a small scale farm. Specific objectives are as follows:

- To design and develop a (UAV) Unmanned Aerial Vehicle that includes pesticide sprayer and pesticides level monitoring system and an Android Application that will be used to monitor Drone Sprayer, point of view of the camera and the tank level.
- To test and analyze the system and the drone to acceptable standards
- To redesign a drone capable of carrying the needed load that conforms to the standard.

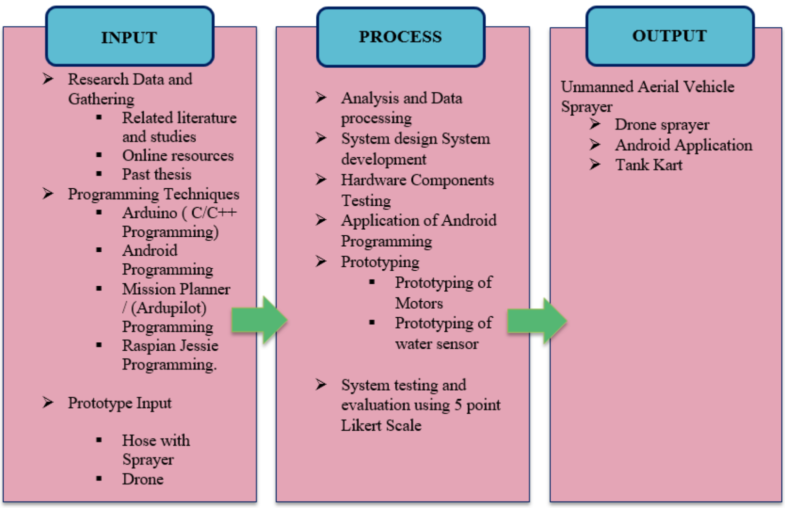

Figure 1: Conceptual Framework

The input shows the requirements for the development of the system. Researchers have gathered the information needed for the study. These include the data accumulated from related literature, related studies, online resources and journals as well as the programming techniques used. The analysis and data processing, system design, system development, component or material testing, and prototyping were performed in the process phase. The output was the Unmanned Aerial Vehicle for spraying pesticides on local farms. To explain further on how the system works, Figure 2 shows the block diagram of the project.

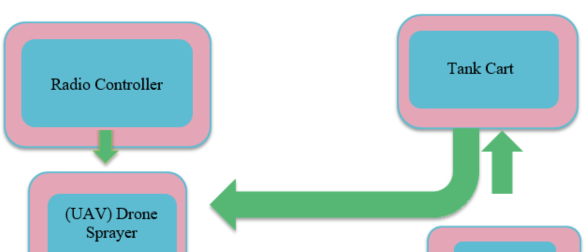

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Figure 2: System Block Diagram

The six channel radio controller serves as the controller of the drone. The chances of farmers being affected by the harsh chemical of any pesticides and fertilizers and getting sick because of fatigue or stress will be lessened. The android application is used to monitor the pesticide level and the point of view of the camera. The toggle button serves as the on and off switch of the tank kart. The tank kart carries the pesticides for the farmer and drone. Figure 3 shows how the tank application works.

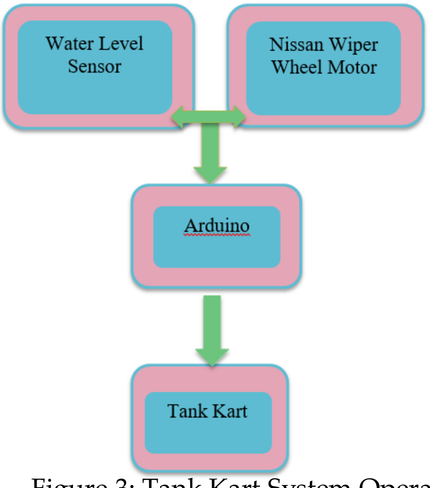

Figure 3: Tank Kart System Operation

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The Nissan wiper wheel motor is responsible for the forward, backward, left and right operations of the tank kart and it sends the signal to the Arduino. The ultrasonic sensor detects the pesticide level of the tank and send signal to the Arduino. The Arduino is in charge to run the motor. By using the tank kart, it carries all the heavy loads of the pesticides, The heavy works of the farmers will be lessened, especially they will avoid health risks that they might encounter due to direct spraying of pesticides. The Figure 4 shows how the drone sprayer works.

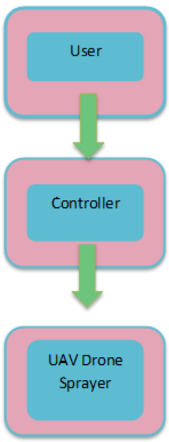

Figure 4: Drone Sprayer System Operation

The user controls the drone using the 6 channel radio controller to spray the pesticides on fruit bearing trees. The battery level is being monitored by the 1-8S li-po battery monitor with buzzer. If the battery is less than 10%, the li-po monitoring automatically makes noise.

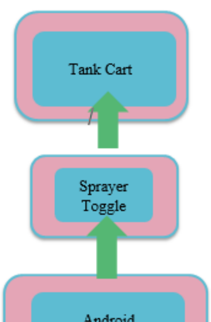

Figure 5: Mobile Application System Operation

The tank kart is used to carry the tank pesticide. It has full automatic forward, backward operations and manual left and right operations to easily carry the pesticide. The sprayer toggle serves as the on and off switch of the pesticide tank. With that, the farmer can easily control the flow of the water. The pesticide level is monitored by the Android application.

2.0 METHODOLOGY

2.1 Research Design

Addressing the project objectives, the researchers used the descriptive research design method. This method involves recording, analysis and interpretation of the present composition or process of phenomena [6]. It is a purposive process of gathering, analyzing, classifying and tabulating data about prevailing conditions, practices, beliefs, processes, trends and cause effect relationships and then making adequate and accurate interpretation about such data with or without the aid of statistical methods [9].This study focused on Unmanned Aerial Vehicle intended for local agricultural purposes. The researchers' findings of this study aimed to strengthen the programs regarding the use of drones in agriculture sectors.

2.2 Instruments/Tools

For the hardware, the researchers used a RC time drone kit, an Arduflyer, 2 SSL 2212/920KV CW motor screw type M*36), 2 SSL 2212/920KV CCW motor screw type M*36) brushless motor , A SkyRCiMax B6 Mini Balance Charger/Discharger SK-10084, a power distribution pcd , one radio controller with 6 channel and 5400mAh Atomic Platinum battery , Computers with Windows (OS) with at least 3 GB RAM, A Raspberry Pi 3 Model B+ that serves as the wireless connection. For the hardware part of the tank kart, the researchers used A Wiper Motor and Arduino Uno.For the development of the system, Arduino software version 1.7.10, Rasbpian Jessie software with a kernel version of 4.4 for the controller development was used. For the development of the Unmanned Aerial Vehicle (UAV-Drone Sprayer), the researchers used a Mission Planner or the ArduPilot firmware. It is an advance open-source computing platform. The Ardupilot is an open source autopilots based on

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Arduino open-source computing platform. It is also an IMU autopilot based also on Arduino Mega platform which can turn any RC vehicle into a fully autonomous Unmanned Aerial (or Ground) Vehicle.

2.3 Participants

The intended participants of this research project were the farmers of the chosen locale. The researchers used random sampling, a technique where each member of the population has an equal chance of being included in the sample size.

2.4 Instruments/Sources of Data

The primary sources of data were obtained from the UAV drone testing and conducted survey. The researchers used a questionnaire where thefirst 1-6 questions were answerable by 1= yes and 2= no and closed ended questions in a Likert Scale type. The secondary data were accumulated from online sources, journals, studies, projects and past theses of other researchers. Programming and techniques were studied thoroughly. Online resources and open- source software were used in completing the project and writing the codes.

2.5 Procedure

The requirements for the project development were identified first followed by resources used for development. Designing and coding were collected and studied. After which, the researchers developed and tested the Unmanned Aerial Vehicle (Drone Sprayer) with tank kart for the local farmers.For the hardware design and development, the researchers used a RC Timer Drone to manually build the drone. Generally quad copters use two pairs of identical fixed pitched propellers SSL 2212/920KV CW motor screw type M*36), 2 SSL 2212/920KV CCW motor screw type M*36) with a 2212 revolution per minute and 920KV Battery consumption were used to develop the drone and these motors served as the wings of the drone. While the Arduflyer served as the arduino or receiver. With the RC time spider kit do it yourself drone, the Unmanned Aerial Vehicle was created. For the development of the tank kart, the researchers used a Nissan DC wiper motor and an Arduino Uno. For the software design and development, the researchers used Raspberry Pi 3 model b with an operating system of Raspbian Jessie. A controller needs to be configured to do the functions that will control the drone. Arduino UNO was used for the tank kart to carry the pesticides tank. For the software development, the mission planner or Ardupilot firmware, an open-source code autopilot system was used. Such also supports conventional helicopters, multi copters and control ground rovers. Autonomous stabilization can be manipulated using this software. It allows fully scripted camera control and waypoint missions and it can support a 6-8 RC channel controller. It is builtby the autopilot code using an ordinary C++ compiler, giving a native executable that allows user to test the behavior of the code.

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2.6 Data Analysis

A series of Unmanned Aerial Vehicle (Drone Sprayer) testing was conducted to meet the objectives of this project. A pre-survey was conducted for the first 1 to 6 questions answerable by yes or no where 1= Yes and 2= No. For the evaluation of the system, a 5- point Likert Scale was used for the questionnaire where 1=Strongly Agree, 2= Agree, 3= Neutral, 4= Disagree and 5= Strongly Disagree. The data gathered were used to evaluate the effectiveness of the system.

2.7 Drone Standards

"Unmanned aircraft systems (UAS) can range greatly in size, capabilities and cost. Standardization in the field of UAS is a timely issue, due to the increasing market demand for civil unmanned aviation vehicles as well as aviation for usage in the monitoring of borders, forestry and fisheries, oil and gas pipelines, and the delivery of cargo into orbit. The regulations require pilots to keep an unmanned aircraft within visual line of sight. Operations are allowed during daylight and during twilight if the drone has anti-collision lights. Piloted aircraft should keep them at least 30m away from structures, buildings and people, and to check with the local council where they could be used. The pilot should be 16 years old and above. The pilot is responsible for ensuring a drone is safe before flying, The FAA might still require preapproval before sale premised on the vendors demonstrating that performance standards are satisfied. Similarly, self-certification by vendors is not enough; test protocols to ensure satisfaction of the performance standards may be so extensive that substantial cost and delay would result before the vendor can certify compliance". [1]

3.0 RESULTS

The results obtained were from the series of tests of the research project. The data captured by the system were the variables in the objective: drone sprayer and tank kart.

Table 2: Sample accumulated updates (Data for Drone/Battery)

Date and Time	Flight Time (Min)	Drone Elevation (ft.)	Drone Battery Level (%)	Drone Controller Radio Controller Battery Level (%)

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02/03/2017	17mins	15ft.	100%	100%
02/03/2017	16mins	18ft.	100%	90%
02/05/2017	14mins	22ft.	100%	100%
02/05/2017	13mins	25ft	100%	90%
02/05/2017	12mins	30ft.	100%	80%

The results shows the different tests on flight time, height, and how the drone battery level depletes in relation to flight time. It also shows the elevation height capability of the drone for the purpose of comparing the height of the trees and its limit to flight height.

Table 3: Sample accumulated updates (Data for Tank Kart)

Date and Time	Pesticide Level (cubic lt.)	Hose Sprayer Length (ft.)	Hose Distance (ft.) From the tree	Time Accumulated (mins)
02/11/2017	4.18 cubic lt.	10-34ft.	3ft.	17 mins 40 sec
02/11/2017	2.09 cubic lt.	10-30ft.	3ft.	8 mins 50sec
02/11/2017	1.045 cubic lt.	10-25ft.	2ft.	4 mins 25sec
02/11/2017	0.5225 cubic lt.	10-20ft.	2ft.	2 mins 13 sec

These results exhibit the pesticide dispersion spray length, distance from the tree and the time it take to apply the pesticide on a single tree.

Table 5:Data Gathered for Drone Standard

Definition		**Not Met**
Operation During Daylight	✓	

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Operation during twilight with anti-collision lights		✓
Piloted 30m away from the structures.	✓	
The Pilot is 16 years old and above	✓	

Meeting the drone standards is a necessary step towards the completion of the research. The researchers managed to acquire pertinent data but showed some small discrepancy as seen on the table.

Table 6:Data Gathered from Drone Sprayer

Distance From The Tree	**Spray**	**Sprinkle**
0.5 ft. 1ft. 2ft.	✓ ✓ ✓	
3ft. 4ft.	✓ ✓	

3.0 Discussion

In the test flight conducted, results show that the drone sprayer was able to spray 3-4 ft. away from the tree where thirty four ft. (34 ft.) hose was attached to the drone sprayer. In the testing, it also shows that the drone sprayer can also lift the attached hose, approximately around 20 ft. above. The researchers met the drone standards through the testing of the drone. In Table 5 and 6, the drone pesticide can be applied 3-4 feet away from the tree. With the help of the tank kart, the farmer can carry the 4.18 cubic lt. pesticide. Tank kart testing was also conducted. The compressor uses a (kilogram per square centimetre) P=kg/〖cm〗^2 pressure. In the test conducted the researchers used a 40 kg/〖cm〗^2 pressure. The tank kart is used to carry the heavy amount of pesticide. The regular pesticide sprayer pump that is currently used by the farmers weighs around 7 kilogram without liquid inside.

The tank kart has full automatic forward, backward operations and manual left and right operations to guide the farmers in carrying the tank. For the Android Application testing, the application worked well into several android devices except for the devices that have an Android version lower than 4.0.

Figure 12: Loading view of App

Figure 13: Camera Point of View

Figure 14: Drone Sprayer

Figure 15: Tank Kart Compressor

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