Presentation 1 Team 307 – Emergency Management Drone

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Team Introduction

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Sponsor

Florida State University
Emergency Management and Homeland Security Program

- **David Merrick, Director**

Introduction: Problem, Needs, and Requirements

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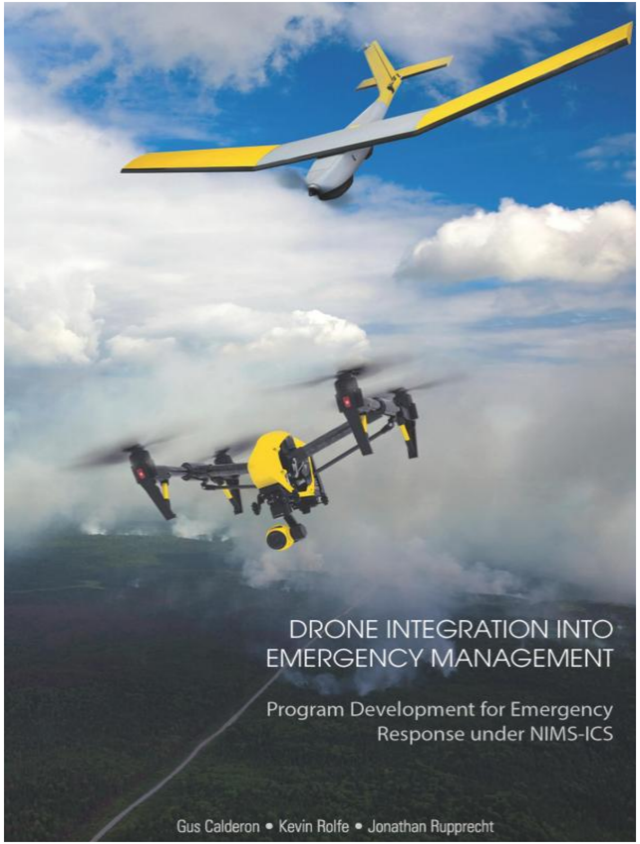
The Project

Emergency Management Drone

- Purpose
  - To design a drone capable of assisting search and rescue teams in finding targets
  - Should help search in hard to navigate areas, and in large, dense environments



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Problem

Search and Rescue

- “Saurus”
    - Designed to be a UAV capable of assisting in search and rescue missions
- Features
    - Hexacopter
    - Li polymer batteries
    - FlytOS
    - Nvidia TX1
    - OpenCV
- Issues
    - Flight time is insufficient
    - Range makes it functionally useless
    - Image capturing is blurry

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Needs

Customer Needs

- Increased range
    - Range must significantly increase
- Longer flight time
    - Flight time of at least 20 minutes
- Clear images transmitted to the ground device
    - Reduce image blurriness
- Improved user interface
    - Create additional options such as fullscreen images
- Autonomous flight options
    - Automatic pathfinding
- Reliable
    - Obstacle detection and collision avoidance
    - Longevity

Needs Cont.

Why does the problem exist?

- What could the past team have done?
  - Multirotor design may not have been able to carry enough power
  - Better choice of communication frequency
  - Increased camera stabilization
  - Better use of processing capabilities
- Are these problems important, or can they be bypassed entirely?
  - Alternative designs could be more power efficient
  - Single-image processing vs live video
  - Autonomous flight will reduce necessary piloting skills

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Requirements

List of design requirements defined from customer needs

- Increase range significantly
- Flight time of at least 20 minutes
- Reduce image blurriness
- Additional user interface options
- Automatic pathfinding

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Trade Offs and Project Scope

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Trade Offs

Setbacks/Disadvantages

- Limitations provided by the current design of the drone
  - Limitation depends solely on what the current drone is capable of
  - Using a previous model will not yield the most efficient and optimal results
- Implementing a new design for the drone
  - Some components of the current drone will not be usable
  - Numerous new parts required will result in an increase in budget

Trade Offs Cont.

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Trade Off Matrix

	Fixed	Chosen	Adjustable
Resources		✓	
Schedule	✓		
Budget			✓

Project Scope

Features Being Addressed

- Flight Time
  - Previous drone design only allowed for ~10 min flight time
  - Previous flight time is nowhere near the capability needed for the customer
- Flight Range
  - Current flight range of the drone is inefficient
  - Fight range needs to be increased in order to be used successfully in search and rescue missions
- Camera Stabilization
  - Stabilizing the camera is required so the drone can produce clear images
  - Clear images are essential for the drone to properly detect objects

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Project Scope Cont.

Features not being addressed

- Speed
  - The goal of the drone is to be as efficient as possible
  - Speed is not a priority as long as the drone is successfully detecting objects in an efficient matter
- Image Processing
  - The drone is successfully able to differentiate between colors
  - Current drone is set to detect colors on the red spectrum - a color usually not seen in natural environments
  - Few adjustments need to be implemented to the drone's image processing

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Project Scope Cont.

Project Goals

- Increase flight time, flight range, and stabilization of the camera
  - Optimize both the power consumption and the vehicle’s mass to increase flight time
  - Redesign the structure of the design to increase power efficiency, resulting in longer flight time
  - Change the drone’s live video footage to still imagery and GPS coordinates to cut down on power consumption and bandwidth
  - Introduce more power transmitters and a lower frequency band to enhance flight range

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Functional Decomposition

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Functional Decomposition

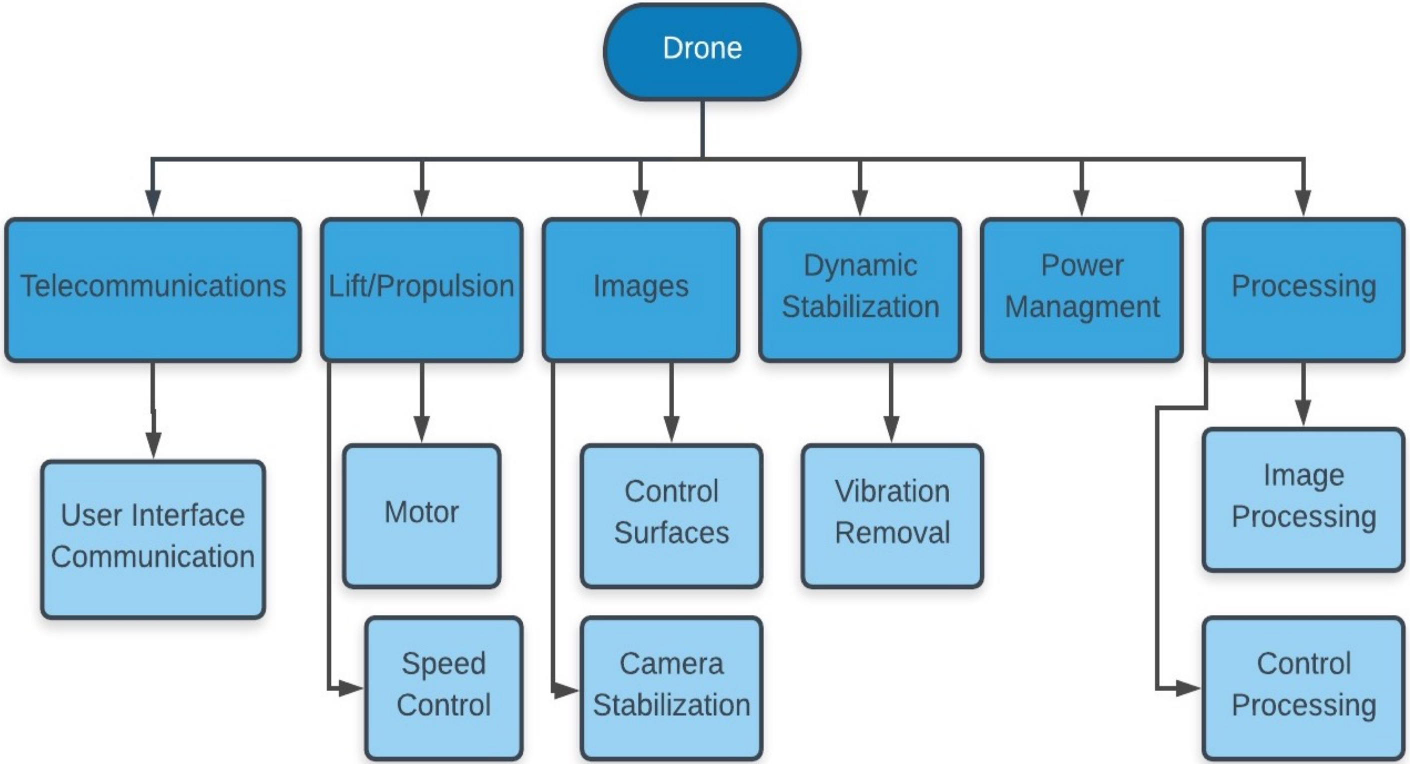

Figure 1. Functional model of the drone design

Functional Decomposition Cont.

Lift/Propulsion

- Purpose
  - Overcome forces such as gravity and drag to become, and remain, airborne
- Motor
  - Convert electrical energy to mechanical
  - Provide the drone with necessary lift
- Speed Control
  - Regulate the movement of the drone once in flight
  - Control the speed of an electric motor

Functional Decomposition Cont.

Dynamic Stabilization

- Purpose
  - Essential to keep the drone controllable at all times
  - Activate stability mode to keep the drone upright when no commands are being given
- Vibration Removal
  - Minimizing vibrations will improve the flight controls of the drone as well as the images taken

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Functional Decomposition Cont.

Telecommunications and User Interface

- Purpose
    - Allow communication between the drone and a source on the ground
- Communication
    - Use of directional and/or omnidirectional to maximize gain
    - Combining both image signals and motor signals along the same band
    - Adding controls system to “point” amplifiers toward ground station
- User Interface
    - Allows User to be able effectively fly drone and receive images and GPS coordinates
    - If autonomous flight is applied, routing of drone and graphical UI for routing patterns
    - Easy to navigate UI means less training and quicker response times

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Functional Decomposition Cont.

Images

- Purpose
    - Capture images, either still or live footage, to transmit back to a computer on ground
- Control Surfaces
    - Important function needed to stabilize the drone
    - Needed if a fixed wing design is chosen
- Camera Stabilization
    - Provide the user with quality images
    - Reduce the vibrations on the camera attachment

Functional Decomposition Cont.

Power Management

- Purpose
    - Route power from batteries to the computer and motor in the drone
    - Regulate power efficiency
    - Control the amount of thrust produced by the motor

Fly-Buck-Boost Topology

Related to the Fly-Buck, the Fly-Buck-Boost is another useful circuit for drone applications, especially if low input voltage operation or a negative-polarity output is required. Figure 5 shows the LM5017, a 100-V, 0.6-A synchronous buck converter configured to provide nonisolated ±12-V rails.

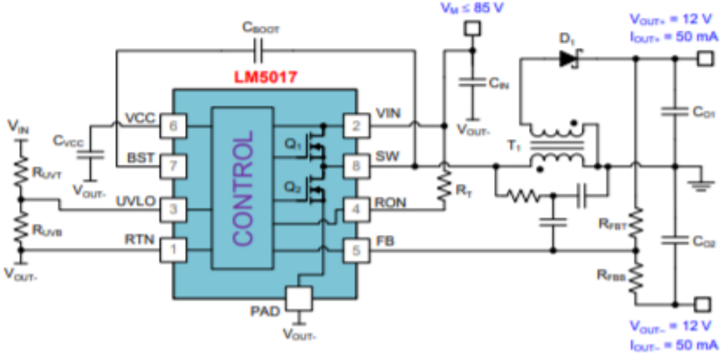

Figure 2. TI Circuit schematic for a drone application [1]

Functional Decomposition Cont.

Processing

- Purpose
    - Provide a network communication system with data processing capabilities
- Image Processing
    - Transmit imaging data from the drone to a backend server via a wireless connection
    - Allow vision-based navigation to avoid obstacles
- Control Processing
    - Convert command signals into vibration commands that control the thrust of the drone
    - Store in-flight data such as GPS coordinates

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Work Breakdown

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Work Breakdown

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Major Tasks

- Project Definition
  - Project Description
  - Adviser Meet and Greet
- Customer Needs
  - Pre and Post Adviser meeting 1
- Functions
  - Functional Decomposition
  - Targets
  - VDR1
- Research
  - Test Drone from previous project
  - Determine main design choice and equipment needed
  - Account for available components

Work Breakdown Cont.

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Major Tasks Cont.

- Concepts
  - Concept generation
  - Sponsor concept meeting 2
  - Pre and Post Adviser meeting 2
  - Concept Selection
  - VDR2
- Fall Closing
  - Bill of materials
  - Risk Assessment
  - Spring Project Plan
  - Pre and Post Adviser Meeting
  - VDR3

Gantt Chart

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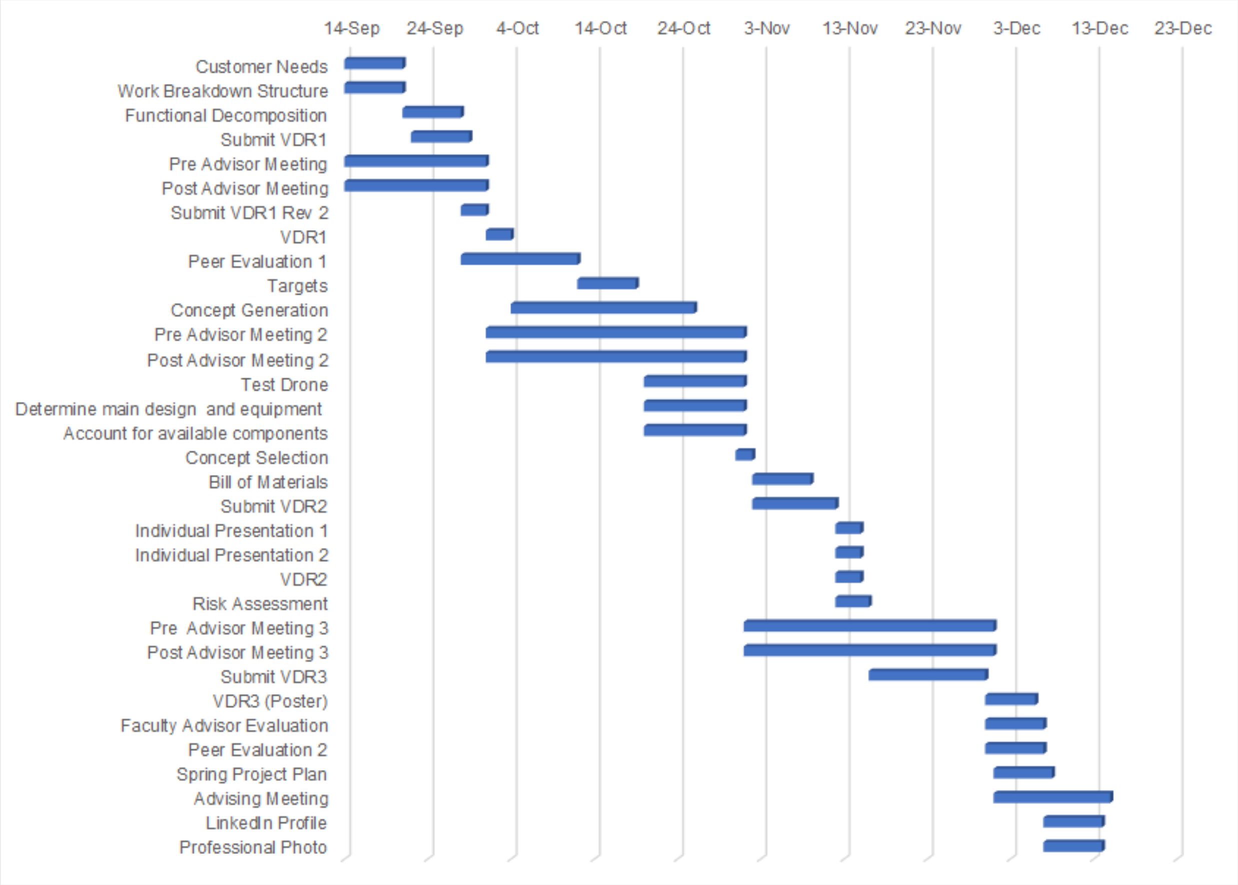

Design Choices

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Design Choices

Looking Forward: Possible Design Choices

- Fixed Wing
  - Power efficient
  - Large area needed for take-off/landing
  - Larger footprint due to heavy payload
  - Possibility of extending flight time through solar panels
  - Restricts ability to explore detected objects in better detail
- Multi Rotor
  - Easier to fly in tight spaces (small area needed for take-off/landing)
  - Ability to hover in one location
  - Smaller footprint
  - Vibrations lead to poor image quality
  - Power hungry

Design Choices Cont.

Fixed Wing

Figure 3. Fixed wing solar plane [2]

Figure 4. Fixed wing cargo plane [3]

Multi Rotor

Figure 5. Previous drone design. Image by: Josh Reid

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Conclusion

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Conclusion

What to leave with...

- Drone potential needs to be raised to increase practicality
- Fixed wing and multirotor design can both meet expectations
- The choice for either design is situational (range vs accessibility)
- Many ideas come from existing projects; Melding parts together
- The team is fully aware of the obstacles and are being proactive about incorporating their solutions into the design

Conclusion Cont.

It’s more than a Drone

- Not your typical fancy drone
    - Designed specifically with Search and Rescue in Mind

Drones can save lives!

“DJI, the drone industry’s leading manufacturer, has published a report highlighting the many incidents in which people have been saved by drones over the past year. It says that at least 65 people have been rescued using the technology.” (Murison)

References

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4. Murison, M. (2018, May 08). *65 lives saved by drones last year, says DJI*. Retrieved from https://internetofbusiness.com/dji-lives-saved-drones/

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