

Senior Design I
Group 7
Initial Project Document

Fire Extinguishing Drone

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Possible Sponsors:

FLIR

1. DESCRIPTION/FUNCTIONS

1.1 The fire extinguishing UAV project started as an idea to autonomously put out fires. The idea is that using thermal imaging and a drone, the drone will be carrying a chemical payload and will autonomously detect a fire presence in an area and fly towards the target. At this point once the target is directly below the camera at the position of the camera where the lens is facing straight down, the drone will release the chemical fire suppressant and put out the fire.

2. OBJECTIVES/GOALS

2.1 The objective is to implement a system that helps prove the concept, that an unmanned aircraft can help assist fire safety and other life-saving tools for first responders. By detecting flame presence in a vicinity, the drone will assist by providing additional fire suppressant powder, over top a flame while responders are also working on putting out fires from the ground. This system's main goal is to detect flames autonomously and put out fires. By doing so, we can prove that fires can effectively be extinguished with a reduced amount of time by use of this concept. Thus leading to less injuries, deaths and losses caused by fires.

3.MOTIVATION

3.1 The motivation behind the autonomous fire extinguishing UAV is the amount of deaths and injuries, and losses caused by fires. According to the U.S. Fire Administration, there have already been 8 fatalities in the first 2 months of 2016. Fire incidents are responsible for over 20,000 deaths and injuries and over \$11 billion in damages in the United States in 2011 alone. In order to help drive the numbers of fatalities, injuries, and losses down, the UAV is our solution. By putting out fire with more haste, the number of deaths to due structure collapse, smoke inhalation, and other associated injuries and deaths can be effectively reduced, and that is the motivation behind this project.

4.COMPETITORS

4.1 With the increasing popularity and usefulness of unmanned aircrafts, there have been several companies and individuals alike that have exploited this idea. BlueBird Aero Systems for example, uses a drone for surveillance to analyze risk before sending ground units to tackle forest fires, and develops an extinguish plan. Additionally, Sky Fire Consulting has a similar product to assess critical situations and identify dangers before they can pose a risk. These companies have helped us to determine our project idea, and how we want to implement it. We've gathered some information, and their use of FLIR thermal imaging and drones, helps influence our design and product choices for the project. However, the only product we haven't seen any products that directly help extinguish a

fire. This also, helped inspire our project, while we learned that many drones help detect risk, none of them actually help mitigate.

5.REQUIREMENTS

5.1 FUNCTIONAL REQUIREMENTS

5.1.1 USE CASE DIAGRAMS

5.1.1.1 The following Use Case Diagrams summarize the functional requirements of the Fire Extinguishing UAV.

5.2 SOFTWARE REQUIREMENTS

- 5.2.1** The system shall be able to process images received from the FLIR camera
- 5.2.2** The system shall be able to detect the target (fire)
- 5.2.3** The system shall communicate between an airborne and ground unit.
- 5.2.4** The system shall be able to receive and understand GPS coordinates and navigate towards them
- 5.2.5** The system shall be able to recognize when to dispense fire suppressant.
- 5.2.6** The system shall be able to respond to a specific programmed flight scanning patterns

5.3 HARDWARE REQUIREMENTS

- 5.3.1** The system shall consist of both an airborne unit and ground control unit
- 5.3.2** The sensors shall be installed around the circumference of the system to detect any obstacle in its flight path
- 5.3.3** The system shall include a GPS unit for navigation
- 5.3.4** The flight system shall be a quadcopter (X configuration)
- 5.3.5** The drone shall incorporate sensors for collision avoidance
- 5.3.6** The drone shall incorporate a gimbal for the camera
- 5.3.7** The system shall incorporate an IR camera

6.SPECIFICATIONS

6.1. CONSTRAINTS

6.1.1. DESIGN CONSTRAINTS

- 6.1.1.1. The infrared camera must be programmed to detect a discrete range of temperatures.
- 6.1.1.2. The system gimbal must have anti-vibration features
- 6.1.1.3. The gimbal system voltage is not to exceed 12V
- 6.1.1.4. The airborne system must be able to support 8 lbs
- 6.1.1.5. The fire system must be able to extinguish a 1 inch flame
- 6.1.1.6. 2 controllers must be integrated in the system; one for the ground unit, one for the airborne unit
- 6.1.1.7. Each motor channel must be powered by 20 Amperes

6.1.2. BUDGET CONSTRAINTS

- 6.1.2.1. TBD (in compliance with sponsor agreements)

6.2. STANDARDS

6.2.1. IEEE

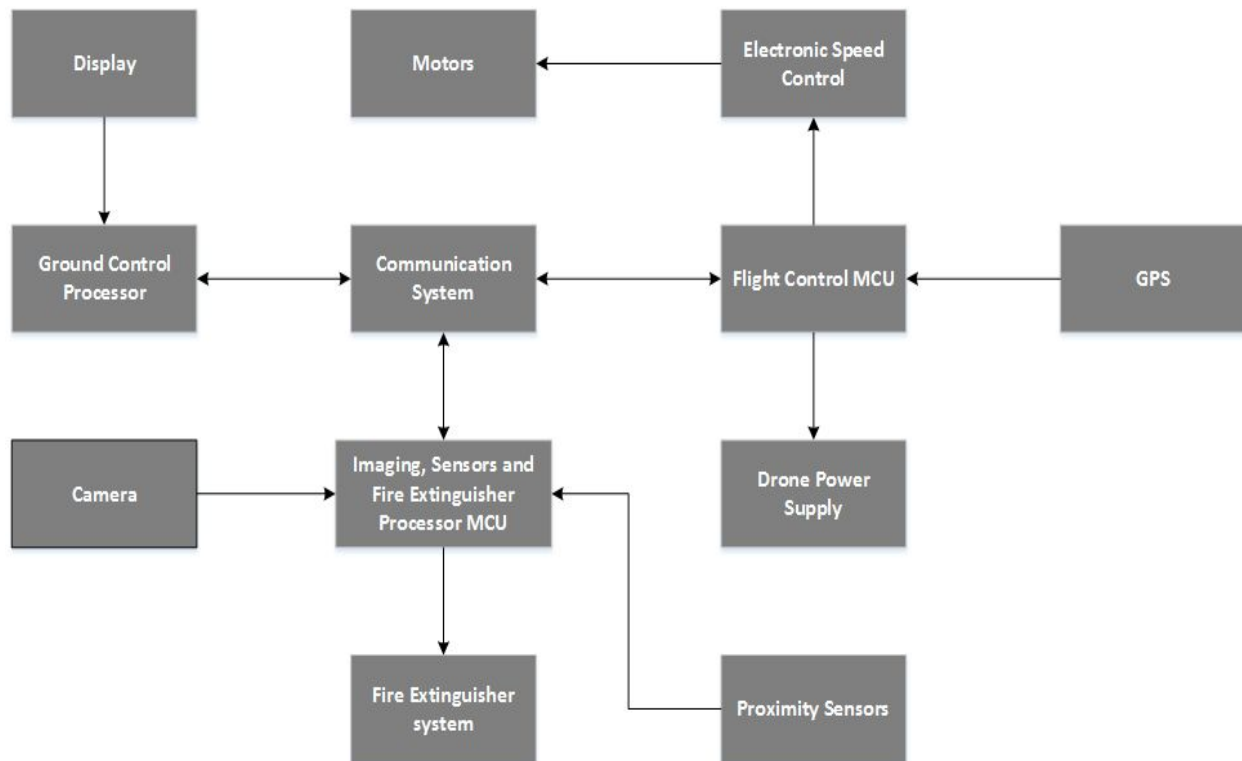
- 6.2.1.1. 802.15.4j-2013 - IEEE Standard for Local and metropolitan area networks - Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs) Amendment 4:

Alternative Physical Layer Extension to Support Medical Body Area Network
(MBAN) Services Operating in the 2360 MHz – 2400 MHz Band

6.2.1.2. 172-1983 - IEEE Standard Definitions of Navigation Aid Terms

6.2.1.3. 8130.34B - FAA Order Airworthiness Certification of Unmanned Aircraft
Systems and Optionally Piloted Aircraft

7. BLOCK DIAGRAM



8. BUDGET/FINANCING

8.1 BUDGET

Item	No. of Units	Price
Frame	1	\$200
Motor	8	\$300
Propellers	8	\$100
Flight Control	1	\$200
ESC	1	\$40
Batteries	4	\$100
MinimOSD	1	\$50
Transmitter	1	\$25
Receiver	1	\$25
Monitor	1	\$60
Telemetry	1	\$60
Gimbal	1	\$300
GPS	1	\$90
Sensors	12	\$100
Fire System	1	\$50
MCU	1	\$200
Camera	1	Provided by FLIR?
TOTAL		\$1810

8.2 FINANCING

For this project, there is consideration for possible, partial/whole sponsorship from FLIR

Systems. Otherwise, all expenses will be taken on by group members.

9. PROJECT MILESTONES

PHASE	START DATE	END DATE	DURATION (WEEKS)
RESEARCH (SENIOR DESIGN 1)	2/1/2016	3/13/2016	6
1.1 BRAINSTORMING	2/1/2016	2/7/2016	1
1.2 RESEARCH DRONES	2/8/2016	2/14/2016	1
1.3 DRONE RESEARCH CONT. (FLIGHT CONTROL)	2/15/2016	2/21/2016	1
1.4 RESEARCH CAMERAS AND SENSORS	2/22/2016	2/28/2016	1
1.5 RESEARCH FIRE EXTINGUISHING DEPLOYMENT.	2/29/2016	3/6/2016	1
1.6 RESEARCH COMMUNICATION METHODS	3/7/2016	3/13/2016	1
DESIGN (SENIOR DESIGN 1)	3/14/2016	4/28/2016	7
2.1 DESIGN DRONE	3/14/2016	3/20/2016	1
2.2 DESIGN COMM SYSTEMS	3/21/2016	3/27/2016	1
2.3 DESIGN FLIGHT SYSTEM	3/28/2016	4/3/2016	1
2.4 DESIGN FIRE EXTINGUISHING SYSTEM	4/4/2016	4/10/2016	1
2.5 DESIGN IMAGING SYSTEM	4/11/2016	4/17/2016	1
2.6 PURCHASE PARTS & TESTING	4/18/2016	4/24/2016	1
2.7 FINALIZE DESIGN PAPER & TESTING	4/25/2016	4/28/2016	1

IMPLEMENTATION & INTEGRATION (SENIOR DESIGN 2)	5/16/2016	7/10/2016	5
3.1 IMPLEMENT FLIGHT SYSTEM & NAVIGATION	5/16/2016	5/22/2016	1
3.2 IMPLEMENT FLIGHT SYSTEM & NAVIGATION	5/23/2016	5/29/2016	1
3.3 IMPLEMENT FLIGHT SYSTEM & NAVIGATION	5/30/2016	6/5/2016	1
3.4 IMPLEMENT FLIGHT SYSTEM & EXTINGUISHER	6/6/2016	6/12/2016	1
3.5 IMPLEMENT EXTINGUISHER	6/13/2016	6/19/2016	1
3.6 IMPLEMENT IMAGING SYSTEM	6/20/2016	7/10/2016	3
3.7 IMPLEMENT COMMUNICATION SYSTEM	6/20/2016	6/26/2016	1
3.8 INTEGRATION & TESTING	6/27/2016	7/3/2016	1
3.9 INTEGRATION & TESTING	7/4/2016	7/10/2016	1
FINALIZE (SENIOR DESIGN 2)	7/11/2016	7/31/2016	3
4.1 VERIFY DESIGN FUNCTIONALITY	7/11/2016	7/17/2016	1
4.2 FINALIZE DESIGN AND DOCUMENTATION	7/18/2016	7/24/2016	1
4.3 PREPARE PRESENTATION MATERIALS	7/25/2016	7/31/2016	1