

IOWA STATE UNIVERSITY

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SYSTEM REQUIREMENTS

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# CONTENTS

<b>Contents</b>	<b>i</b>
<b>Acronyms</b>	<b>ii</b>
<b>1 Customer Information</b>	<b>1</b>
<b>2 Course Requirements</b>	<b>2</b>
<b>3 Customer Requirements</b>	<b>3</b>
<b>4 Aircraft Requirements</b>	<b>4</b>
4.1 Functional . . . . .	4
4.2 Performance . . . . .	4
4.3 Interface . . . . .	4
4.4 Environmental . . . . .	5
4.5 Reliability . . . . .	5
4.6 Safety . . . . .	5

## ACRONYMS

<b>AGL</b>	above ground level. ( <i>p. 4</i> )
<b>AOI</b>	area of interest. ( <i>p. 3–5</i> )
<b>cUAS</b>	counter-unmanned aerial system. ( <i>p. 1</i> )
<b>GTOW</b>	gross takeoff weight. ( <i>p. 2</i> )
<b>sUAS</b>	small unmanned aerial system. ( <i>p. 3, 4</i> )
<b>UAV</b>	unmanned aerial vehicle. ( <i>p. 1–5</i> )

## CUSTOMER INFORMATION

Hostile drones are a growing threat to both civilian and military assets. The goal of this unmanned aerial vehicle (UAV) is to counter unmanned aerial systems by denying airspace through electronic jamming and kinetic means. The target customers for our counter-unmanned aerial system (cUAS) are U.S. government departments and agencies such as the Department of Defense, Department of Homeland Security, and the FBI. The customer will be able to deploy this system in a loiter position over a protected area or asset such as a sporting event, military convoy, high-value target, or large gathering of people. Upon identification of a suspicious drone, the craft will attempt to jam the system. If the drone has anti-jamming or anti-spoofing capabilities and continues to threaten the protected area or asset, the craft will attempt a kinetic impact to destroy or disable the threat.

## COURSE REQUIREMENTS

1. The UAV shall be capable of fixed-wing flight.
2. The UAV shall have a maximum gross takeoff weight (GTOW) of 12 lbs.
3. The UAV shall have a maximum stall speed of 25 MPH.
4. The UAV shall be capable of achieving takeoff within a maximum runway length of 100 ft.
5. The UAV shall be capable of landing within a maximum runway length of 100 ft.
  - *This requirement conflicts with our kinetic impact requirement, since a kinetic impact may preclude a landing.*
6. The UAV shall be capable of flight with wind speeds exceeding 20 MPH.
7. The UAV shall have a maximum wingspan of 90 in.
8. The UAV shall be easily transportable in a vehicle.
9. The UAV shall be designed to be manufactured using tools available to students.
10. The UAV shall be designed in a manner that allows safe use.
  - (a) The UAV shall have arming/disarming components that are easily accessible.
  - (b) The UAV shall only use electric remote control aircraft motors.

## CUSTOMER REQUIREMENTS

1. The UAV shall prevent a hostile airborne small unmanned aerial system (sUAS) from reaching the key area in an area of interest (AOI).
2. The UAV shall be capable of detecting an airborne sUAS.
3. The UAV shall support autonomous flight.
4. The UAV shall support remote control operation.
5. The UAV shall be capable of patrolling an AOI of 400 000 m<sup>2</sup>.
  - Approximately 1.25 times the area of Jack Tryce Stadium, for reference.
6. The UAV shall be capable of completing a full flight cycle—from wheels-up to wheels-down—of at least 45 min.
7. An operator shall be capable of changing the UAV battery within 5 min between flights.

## AIRCRAFT REQUIREMENTS

### 4.1 Functional

1. The UAV shall be capable of disabling a hostile sUAS by kinetic impact.
2. The UAV shall initiate a landing sequence when the estimated battery capacity would be 10 % at wheels-down.
3. The UAV shall initiate a landing sequence when the UAV battery no longer has the capacity to execute a kinetic impact event on a hostile sUAS in the AOI.
4. The UAV shall be capable of landing autonomously.
5. The UAV battery shall have enough capacity to power all onboard electrics for a full flight cycle.
6. The UAV shall be capable of jamming the radio connection of a sUAS.

### 4.2 Performance

1. The UAV shall be capable of flying at 150 m above ground level (AGL) or higher.
  - Based on the software-limited flight ceiling of the DJI Mavic 3 (DJI, 2024).
2. The UAV shall be capable of diving at an airspeed of 45 m/s or greater.
  - Based on the estimated amount of kinetic energy required to disable a sUAS.
3. The UAV shall be capable of carrying a minimum payload 1 kg.
  - Based on rough estimates from previous senior design payloads.

### 4.3 Interface

1. The UAV shall be equipped with a transmitter capable of communicating with a controller.
2. The UAV shall be equipped with equipment capable of detecting a sUAS.
3. The UAV shall be equipped with equipment capable of jamming a sUAS.

## 4.4 Environmental

1. The aircraft shall be capable of operating in temperatures from  $-10^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ .
  - Based on the operating temperature of the DJI Mavic 3 (DJI, 2024).

## 4.5 Reliability

1. The UAV transmitter shall maintain a continuous radio connection with the controller throughout the entire flight cycle.
2. The UAV transmitter shall maintain a continuous radio connection with the controller at any location in the AOI.

## 4.6 Safety

1. The UAV shall be capable of avoiding obstacles while in flight.
2. An operator shall be capable of changing the UAV battery while maintaining a safe distance from the propellers.



## BIBLIOGRAPHY

DJI (2024). *Specs*. URL: <https://www.dji.com/mavic-3-classic/specs> (visited on 09/20/2024).