

# SWEN 775

# Software Architecture

## Project

## Requirements

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# Acronyms

Acronym	Definition
UAV	Unmanned Aerial Vehicles
GCS	Ground Control Station

## Requirements

Outlined below are the requirements for a Unmanned Aerial Vehicle (UAV). A UAV (also known as a drone) is an aircraft that flies without a human onboard. The UAV is controlled by onboard software and ground control stations.

Case study:

T. Tomic et al., "Toward a Fully Autonomous UAV: Research Platform for Indoor and Outdoor Urban Search and Rescue," in IEEE Robotics & Automation Magazine, vol. 19, no. 3, pp. 46-56, Sept. 2012.

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6290694&isnumber=6299141>

In-addition to the above case study, the requirements were also obtained from other published research papers, manufacture websites and forums.

## Functional Requirements

### a. UAV Requirements

#### **Communication with ground control station**

The UAV must be able to send and receive data/commands from the ground control station (GCS). The GCS will be able to control the UAVs flight path and onboard sensors

#### **GPS based navigation**

Given the destination GPS coordinates, the UAV must be able to navigate, without human assistance/intervention, to the destination. The UAV will use the Autopilot module to fly to its destination

### **Obstacle avoidance**

The UAV must utilize built-in cameras to continually detect obstacles in its flight path and make necessary course corrections to its flight path and/or altitude in order to avoid collisions

### **Simultaneous localization and mapping**

If the UAV is in an unknown location, the UAV should construct a map of the location and also identify its location within this map

### **Path Planner**

The UAV must follow a predefined course. This course takes into account output by built-in sensors and GCS commands

### **Oversized flight area**

The UAV must not accept a flight plan in which the area to be covered is larger than the flight range of the UAV

### **Image capturing**

The UAV must have the ability to capture (and store) images from its built-in cameras at regular intervals. The interval must be configurable.

### **Autopilot**

The UAV must be able to utilize all available sensors to fly without human intervention (i.e. not controlled by the GCS). This also includes managing velocity and altitude.

### **Video streaming**

The UAV must provide a continuous video stream, captured by its built-in cameras, to its GCS. The quality of the video being streamed must be configurable. The GCS must have the ability to turn on/off this feature in the UAV

### **Battery power monitoring**

The UAV must continually monitor (in real time) the battery level and provide details on available battery charge. The details should be accessible by the GCS as and when needed.

### **Object Recognition**

When an object is detected, the UAV must be able to recognize if the object is a person, animal or other object (e.g. landmarks, signs, or a landing zone).

### **Object Distance Calculation**

The UAV must be able to calculate the relative distance of a detected object from the UAV

### **Emergency Landing**

In the event of sudden loss of engine power, the UAV must perform an emergency landing

### **Emergency Cargo Release**

The UAV must be able to release the cargo load in case of an emergency situation.

### **Aerial Traffic Control**

The UAV must monitor the airspace it is flying in in-order to detect other aerial vehicles

### **Automatic Landing**

The UAV must be able to land without human intervention from the GCS

### **Automatic Takeoff**

The UAV must be able to takeoff without human intervention from the GCS

### **Heat monitoring of the Electronic Speed Controllers (ESC)**

Since the ESC's are prone to heating, the UAV must continuously monitor the temperature of the ESC's to make sure that the ESC's are not overheating.

### **Parachute deployment**

The UAV must deploy a built-in parachute in the event of an emergency landing

### **Geofencing**

The UAV must have the ability to store a list of "no-fly-zone" GPS coordinates. The UAV should not violate the no-fly-zone if geofencing is enabled.

### **UAV teamwork**

If required, the UAV must be able to work in a team with other UAVs and be able to communicate with other these UAVs

### **Bird attack prevention**

The UAV must be able to detect approaching birds and increase it flying height to prevent collision with the birds

### **UAV switch controlling GCS**

The control of a UAV can be pass from one authorized GCS to another authorized GCS.

### **Weather Avoidance Maneuver**

Hazardous weather is defined as any atmospheric or space environment phenomena that could be detrimental to the UAV mission. The UAV should be able to routinely access aviation weather information. The UAV should maneuver to avoid hazardous weather.

### **Identify current position**

The UAV shall be able to identify its current position and send the location to the GCS if needed.

### **Prioritize Contingency Events**

The UAV shall be capable of prioritizing simultaneous contingencies so the most critical one can be addressed first.

### **Abort Takeoff**

Just prior to takeoff, the UAV must have the ability to abort takeoff if conditions are not optimal for takeoff or flying (e.g. obstacles on the runway).

### **Abort Landing**

Just prior to landing, the UAV must have the ability to abort landing if conditions are not optimal for landing (e.g. obstacles on the runway).

### **Cruise**

Once the UAV is airborne and reached its cruising altitude, the UAV shall maintain a steady-state (non-accelerating) flight.

### **Evaluate collision potential**

The UAV must continually evaluate the potential of collision with objects that it detects.

## **b. GCS Requirements**

### **GCS - Multi UAV Control**

The GCS must be able to control more than one UAV at the same time

### **GSC - Selectable video output**

If the UAV has multiple onboard cameras, the GCS must have the ability for the user to select from which camera the video should be shown

### **GCS - UAV flight path monitoring**

The GCS system must have the ability to track the flight path of the UAV

### **GCS - View Telemetry data**

The GCS system must have the ability to display all telemetry data collected from the UAV

### **GCS - landing and takeoff coordinates**

The GCS must be able to specify exact coordinates for landing and taking off so the UAV can follow the instructions for landing and taking off provided by the GCS

### **GCS - User management**

The GCS must have a user management feature to add/remove users that have access to the GCS application

## **Non-Functional**

### **c. Availability**

#### **Crash recovery**

If the UAV crashes or lands unexpectedly, the GPS coordinates must be sent back to the GCS within 3 seconds of the event occurring

#### **Complete loss of GPS connectivity**

In the event GPS connectivity is lost, the UAV must utilize its built-in sensors to remain airborne until manual control is established from a GCS

#### **Poor GPS connectivity warning**

The UAV should notify the GCS when the GPS signal strength drops below 70%

#### **Low battery warning**

The UAV should notify the GCS when the battery strength drops to 30% and 15%

#### **Automatic landing**

The UAV should start descending and prepare to automatically land if any of the given conditions occur:

- The battery strength drops below 15%
- GCS control is not established 3 seconds after GPS connectivity is lost

### **Unfavorable atmosphere condition**

The UAV should be able to return to its launching site and land if the weather is inappropriate for flying

## **d. Performance**

### **Video streaming**

The video streamed from the UAV to the GCS must be in real time with a maximum latency of 5 seconds

### **Sensor Failure Notification**

If a failure/malfunction of a built-in sensor in the UAV is detected, the GCS must be notified within 3 seconds of the event occurring

### **Response Time**

The UAV should respond to GCS commands in less than 5 seconds.

### **Sensor Monitoring**

Monitor payload and telemetry data in real-time, and record all the data for future review and processing.

### **Video Processing**

The GCS must be able to process video data received from the UAV in real-time

## **e. Security**

### **GCS authorization**

At any given point of time, a UAV can only communicate and be controlled by only one authorized GCS

### **Maximum altitude**

The UAV must fly below 400 feet above the ground to prevent collisions with FAA regulated aircraft in public airspace

### **Takeoff**

The UAV shall not takeoff if the battery is not completely charged (i.e. full)

**Logging**

All actions performed by/on the UAV and GCS must be logged as and when the action occurs. Each log entry must also contain a timestamp

**Secure communication to GCS**

Communication between the UAV and GCS must be secure and encrypted