**UAS Alert**

**2.0. Design Constraints**

UAS Alert is an awareness technology centered around safety and is targeted at the consumer and commercial UAS market. Reducing the risk of mid-air collisions between UAVs and other aircraft is the primary focus of UAS Alert. This product is a two-part design where one component is attached to a UAV and the other component is a ground station for the UAV operator. UAS Alert must support wireless communication between the UAV and the ground station in order to aggregate ADS-B data and provide information to the user. Applications include commercial and civil jobs such as security, forestry, rescue efforts, and surveying. Ensuring the pilot is given the best possible awareness of ADS-B OUT equipped aircraft are the core functions of UAS Alert. The two major sections of this document highlight the technical and practical design constraints.

**2.1. Technical Constraints**

UAS Alert must function under the technical constraints listed in Table 2.1.

**Table 2.1. Technical Design Constraints**

|  |  |
| --- | --- |
| **Name** | **Description** |
| **Transmission** | The transceiver must remain within line-of-sight range for wireless communications. The maximum range of the transceiver must be longer than the signal range of the remote controller of the UAV. |
| **Device Weight** | The device must weigh under 300 grams. |
| **Battery Life** | The battery must be able to supply the on-board device with an hour of usage. |
| **Compact Design** | The airframe attachment must fit on a typical UAV. |
| **Response Time** | The total response time of the system must be no longer than 1 minute to give the user time to adjust the flight path. |

**2.1.1. Transmission**

The wireless communication range must be at least 3.1 miles since this is the typical range of controllers for consumer UAVs [1]. Transmission of airspace information to the ground station must not interfere with the controls or video feed of the host UAV. Therefore, UAS Alert must avoid using the frequency bands of 2.4 GHz and 5.8 GHz commonly used for these purposes [2].

**2.1.2. Device Weight**

If the device being attached to the flight-frame is too heavy, most small UAVs will be unable to carry it. The typical payload capacity of popular consumer UAVs varies from 100 to 300 grams with some of the newer versions being able to reliably carry up to 500 grams [1]. In order to reduce the excessive drain on the UAV’s battery life due to increased payload, the device’s weight must fall within this range.

**2.1.3. Battery Life**

UAS Alert will be able to operate independently of the host UAV’s flight controller and power source. Thus, the system will provide its own battery. Consumer UAVs generally have a flight time of between 20 to 45 minutes [2]. The battery must be able to supply power to the on-board system for a minimum of 1 hour in order to provide its services to the UAV operator during flight.

**2.1.4. Compact Design**

UAS Alert must be smaller than the UAV to which it is attached. A typical consumer UAV such as the DJI Phantom 3 has a width of approximately 300 millimeters and a height of approximately 200 millimeters when landing gear is included [3]. Based on measurements made by the team, the height of the landing gear is approximately 110 millimeters. Therefore, UAS Alert must have a width less than 150 millimeters and a height no greater than 100 millimeters.

**2.1.5. Response Time**

The response time from the moment when the ADS-B signal is received by the UAV to the moment when the user receives the alert must be at least 1 minute. This response time ensures that the user has enough time to make adjustments to the UAV and navigate out of the way to avoid any potential conflict. The required response time varies significantly with how far away the UAV is when another aircraft is initially detected. This response time should not be longer than 1 minute for the operator to have ample time to make position corrections. For example, a plane moving at 288 miles per hour would have gone nearly 5 miles in the span of 1 minute. What this example means is that UAS Alert must be able to pick up a plane at least 5 miles away and warn the user in less than 1 minute in order to allow the user to maneuver the UAV out of the flight path of the oncoming plane.

**2.2. Practical Design Constraints**

UAS Alert must comply with Practical Design Constraints listed in Table 2.2.

**Table 2.2. Practical Design Constraints**

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| **Health and Safety** | **Safety** | UAS Alert must advise the user of nearby ADS-B OUT equipped aircraft. |
| **Environmental** | **Temperature** | The UAS Alert system must remain at a temperature of less than 85℃. |
| **Economic** | **Viable Market** | The design cost must be under $250. |
| **Sustainability** | **Reliability** | The UAS Alert system must remain operational throughout the flight time of the UAV without repairs. |
| **Political** | **Regulations** | The UAS Alert system must use advisories to inform the user of guidelines and advisories when infringing on FAA regulations.  UAS Alert must be designed in accordance with FAA and government regulations. |

**2.2.1. Health and Safety**

UAS Alert will improve situational awareness, which will assist in preventing collisions. However, improper design of an avoidance system could lead to a situation that gives the user a false sense of security during operation. If the user is completely reliant on the system for warnings, and for some reason a possible collision is not detected, the user may continue on the path into another aircraft. The product must properly address and minimize issues relating to false negatives and false positives being reported by the system.

**2.2.2. Environmental**The UAS Alert system casing must be designed with heat mitigation in mind. In any system containing a high level processor, temperature can create conditions that will affect the operation of the system as a whole. The platforms that are ideal for use in this system, based on ability and compact design, can only operate at peak performance if the temperature remains below 85℃. Any conditions that result in operation exceeding this temperature will result in an approximate 50% decrease of the system’s maximum processing speed [4].

**2.2.3. Economic**

The design must cost less than $250 and would add to the total cost of the UAS. If the cost of UAS Alert heavily outweighs the cost of the UAV, the system becomes too exclusive. This price was selected in order to remain competitive in the current market. A full explanation of the competitive market analysis is available in section 1.2 of the problem statement. With safety as the primary concern, compromising quality for affordability will need to be analyzed with care.

**2.2.4. Sustainability**

UAS Alert must remain opy can have flight times of up to one hour, and the UAS Alert system must be operational for the entire flight session. The UAS Alert system must be durable enough to withstand the normal wear and tear conditions of a UAV flight without failure. If the UAS Alert system fails in fligerational throughout the flight time of the UAV to which it is attached. UAV’s on the market todaht, the mitigating factors produced by this system will no longer be active. This could result in damage sustained, due to mid-air collision, by the UAV or any aircraft that may be sharing the same airspace.

**2.2.5. Political**

The intent of UAS Alert is to increase operator situational awareness, which will help prevent potential collisions. UAS Alert must not provide non certified ADS-B Out services [5]. Instead, it must provide its services to the user through a passive system without interrogating or broadcasting to other aircraft. In accordance with the Federal Communications Commission (FCC), the system must transmit its air traffic data to the ground station using unlicensed frequencies [6].

**7. References**

[1]"DJI Phantom 3 Professional", *Drones.specout.com*, 2016. [Online]. Available: <http://drones.specout.com/l/1/DJI-Phantom-3-Professional>. [Accessed: 07- Sep- 2016].

[2]"Phantom 3 Professional - Specs, FAQ, Tutorials, Downloads and DJI GO | DJI", *dji.com*, 2015. [Online]. Available: http://www.dji.com/phantom-3-pro/info. [Accessed: 16- Sep- 2016].

[3]"Phantom 3 size: Complete Measurements | Engabao.com", *Engabao.com*, 2016. [Online]. Available: <http://www.engabao.com/phantom-3-size-complete-measurements/>. [Accessed: 14- Sep- 2016].

[4]N. Heath, "No, your Raspberry Pi 3 won't overheat in everyday use, says its creator | ZDNet", *ZDNet*, 2016. [Online]. Available: <http://www.zdnet.com/article/no-your-raspberry-pi-3-wont-overheat-in-everyday-use-says-its-creator/>. [Accessed: 16- Sep- 2016].

[5]"ADS-B Ins and Outs", *faa.gov*, 2016. [Online]. Available: https://www.faa.gov/nextgen/media/Safety%20Briefing%20ADS-B.pdf. [Accessed: 16- Sep- 2016].

[6]"FCC Rules for Wireless Equipment operating in the ISM bands -www.afar.net", *Afar.net*, 2016. [Online]. Available: http://www.afar.net/tutorials/fcc-rules. [Accessed: 16- Sep- 2016].