**UAS Alert**

**2.0 Design Constraints**

UAS Alert is an awareness technology consisting of a UAV outfitted with antennas, two SDRs, Xbee transceiver, and a ground station. The ground station will be based on use of a laptop computer. Applications include everything from UAV hobbyist to UAVs used in industry. Keeping UAS pilots within the regulations set by the FAA and making sure the pilot is given the best possible awareness of other ADS-B OUT equipped aircraft are the core functions of UAS Alert. This section is dedicated to briefly explaining the product’s 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 Distance | The Xbee-Pro 900HP has a line-of-sight range of 28 miles. For effective alerts the UAV must stay within this range. |
| Device Weight | The device must weigh under 0.66 pounds. |
| Battery Life | The battery must be able to supply the on-board device with an hour of usage. |
| Compact Design | The on-board device must be small enough to not significantly affect the aerodynamics of the UAV. |
| Response Time | The total response time of the system must be no longer than 1 minute to give the user time to adjust their flight path. |

**2.1.1. Transmission Distance**

The RF module of choice for prototyping is the Xbee-Pro 900HP. Other Xbee RF modules can be used if the consumers prefers a different frequency for wireless communication between the UAV and ground station. The Xbee-Pro 900HP has a range of 28 miles in optimal line-of-sight situations [1]. Outside this range the ground station will not be able to communicate with the UAV due to the low signal-to-noise ratio of the received signal.

**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 vary from 100 to 300 grams (0.22 to 0.66 lbs) with some of the newer versions being able to reliably carry up to 1 lb [2]. In order to reduce the effect on the UAVs battery life, 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 UAVs flight controller. Thus, the system will provide its own battery. Consumer UAVs generally have a flight time of between 20 to 45 minutes. The battery must be able to supply power for minimum of 1 hour in order to provide its services to the UAV operator during flight.

**2.1.4. Compact Design**

UAS Alert will have to be smaller than the UAV it is attached to. If the on-board device is close to the size of the UAV, significant air resistance will cause the UAV to operate incorrectly.

**2.1.5. Response Time**

The response time from the moment when the ADS-B signal is received on the drone to the moment when the user receives the alert must be very small. This ensures that the user has enough time to make adjustments to their UAV and navigate out of the way to avoid any potential conflict. The required response time varies significantly with how far away the aircraft is when the aircraft is initially detected. This response time should not be longer than 1 minute for the operator to change their path. The average plane moving at 575 miles per hour would have gone 10 miles in the span of one minute.

**2.2 Practical Design Constraints**

|  |  |
| --- | --- |
| **Name** | **Description** |
| **Ethical** | The design should not encourage users to break the law or any FAA regulations. |
| **Health and Safety** | UAS Alert will keep planes and its occupants safe from UAV collisions. |
| **Political** | The FAA has an extensive set of rules and regulations for UAVs. Non-compliance with the FAA will result in prosecution from authorities. |
| **Economic** | The design cost should be proportional to the cost of the UAV. |
| **Sustainability** | Must last for five years and battery must operate correctly after hundreds of recharges. |

**2.2.1 Ethical**

The design will need to follow all regulations implemented by the Federal Aviation Agency (FAA). The intent of UAS Alert is to increase operator situational awareness, which will help prevent potential collisions. UAS Alert is not intended to be used as a tool to violate regulations in place by the FAA.

**2.2.2 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 team must properly address and minimize issues relating to false negatives and false positives being reported by the system.

**2.2.3 Political**

With the government’s progression of laws being passed regarding UAVs, an aircraft avoidance system will be very beneficial for drones. In fact, by 2020 most aircraft will be required to use the ADS-B system [3]. The FAA lists a maximum altitude of 400 feet above ground level and within sight of the operator for recreational UAVs. This system is not intended to replace visual confirmation from the operator, nor is it intended to encourage flying outside of the 400-foot limit set by the FAA. New rules and regulations are constantly being made to reduce the chance of mid-air collisions caused by UAVs, with one as recent as the announcement that commercial UAVs will require a pilot’s certificate and be at least 16 years of age; a unique registration number visible on the UAV is also required. This rule was announced in June 2016, and is effective as of August 29, 2016 [4].

**2.2.4 Economic**

This design would cost approximately $250 and would add to the total cost of the UAV. If the cost of UAS Alert heavily outweighs the cost of the UAV the system becomes too exclusive. With safety as the primary concern, compromising quality for affordability will need to be analyzed with care.

**2.2.5 Sustainability**

UAS Alert must operate consistently for five years of regular use without failure. The battery must be able to be recharged many times and still supply the on-board system with ample power for operation.

**7. References**

[1]"XBEE-PRO® 900HP", Digi.com, 2016. [Online]. Available: http://www.digi.com/pdf/ds\_xbeepro900hp. [Accessed: 07- Sep- 2016].

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

[3] Fiorino, Frances (2014, Aug/July) *ADS-B Ins and Outs* [Online]:<https://www.faa.gov/nextgen/media/Safety%20Briefing%20ADS-B.pdf>

[4]"Federal Register | Operation and Certification of Small Unmanned Aircraft Systems",*Federalregister.gov*, 2016. [Online]. Available: https://www.federalregister.gov/articles/2016/06/28/2016-15079/operation-and-certification-of-small-unmanned-aircraft-systems. [Accessed: 07- Sep- 2016].