ADS-B aircraft safety system assembled at less than EUR/USD 100

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Automatic Dependent Surveillance-Broadcast (ADS-B) has been commonly used in today's aviation industry. Aircraft with ADS-B equipment sends its own identification and position on a frequency of 1090 MHz that can be received by other aircraft and also by anyone on the ground. Almost all large-size civil airplanes in the world now carry ADS-B equipment. It will mandate in Europe and also in the USA in 2020, but no such plan is announced in Japan.

The current satellite laser ranging stations are mostly not eye-safe, and ADS-B receivers has been implemented in several stations to avoid firing a laser to aircraft. In Hitotsubashi University, we collected a minimal set of instruments that is needed to receive the ADS-B signal: an ADS-B USB receiver (FlightAware Pro Stick; USD 19.75), an ADS-B 1090MHz antenna (USD 25) and a small single-board computers Raspberry Pi 3B (USD 38.50). Adding to a software tool "PiAware" supplied by FlightAware running all the time on a Raspberry PI 3B, a key software component for SLR safety is developed by ourselves: (1) to fetch the aircraft position data, (2) to make a radar (Az-El) plot of aircraft and spacecraft and (3) to provide a safe/unsafe decision state. When the decision is unsafe, the software generates an electric signal as well as alter a file content, so that a user can take action both in hardware and software.

We also examine the ADS-B-based aircraft position accuracy by comparing it with nighttime photographs that provide a 2-dimensional position aligned with stars. The majority of aircraft flying over Hitotsubashi University are precisely matched (below 1 deg Az/El). However, there are cases that photographed aircraft-like objects cannot be detected in ADS-B and also that the matching precision is poor (> 5 deg). It is found that the ADS-B position errors become large when an ADS-B indicator called "Navigation Integrity Category (NIC)" is low. It is advisable that the unsafe zone should be enlarged when aircraft sends a low NIC.

Our software component is available upon request. We plan to test this receiver system at NICT Koganei where the long-time operation data will be collected.