Low Cost Real Time Flight Tracking And Monitoring System Using Ads-B

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Abstract- *Air traffic is continuously increasing worldwide, with both manned and unmanned aircraft looking to coexist in the same airspace in the future. Next generation air traffic management systems are crucial in successfully handling this growth and improving the safety of billions of future passengers. The Automatic Dependent Surveillance Broadcast (ADS-B) system is a core part of this future. Unlike traditional radar systems, this technology empowers aircraft to automatically broadcast their locations and intents, providing enhanced situational awareness. ADS-B is becoming of widespread use in modern Air Traffic Management (ATM) system. Extending the capacity of a stand-alone ADS-B receiver system into a centralised ADS-B one, with multiple remote receivers, and a centralised processor that merges data, might be one of key factors in the future of next generation systems for both commercial, UAV and civil aviation flight surveillance.*

Keywords- Surveillance, Automatic Dependent Surveillance

I. INTRODUCTION

The Flight/airline tracking has been growing due to the obvious reason to know whether a flight has safely landed or whether everything goes according to the schedule. Indeed, modern trackers can track airlines virtually all around the world and inform concerned parties via SMS, e-mails. Tracking is not limited to aircraft activity, it can also include airport activity. Air traffic management (ATM) encompasses three main areas: Communications, Navigation and Surveillance. The goals is to improved safety, shortened routes, reduced traffic delays and increased fuel and time efficiency. ADS-B is a Surveillance technique that relies on aircraft or airport vehicles broadcasting their identity, position and other information derived from on board systems (GNSS). This signal can be captured for surveillance purposes on the ground or on board other aircraft in order to facilitate airborne traffic situational awareness, spacing, separation and self- separation .It is one of several ATM Surveillance technologies that shift air traffic control from expensive 70-year-old radar technology to a sophisticated network of airborne-, ground- and satellite-based systems. Over the next decade, ADS- B is expected to replace radar as the primary surveillance method for air traffic control. Currently, about 65% of aircraft in Europe are equipped with ADS-B but only 35% in the US. This was the first Cooperative Dependent Surveillance (CDS) technology to be fully certified by the FAA and ICAO for critical "radar-like" air traffic control services (2002) and obeys NEXTGEN compatibility Two companies, Virginia-based Aireon and Alaska- based ADS-B Technologies, are majorly working on new satellite-based surveillance solutions.

II. LITERATURE SURVEY

This provides the details regarding origin of surveillance, evolution since the early stages and ADS-B system overcoming the shortcomings of traditional methods.

1. Primary Surveillance

Primary surveillance is a conventional radar sensor that illuminates a large portion of space with an electromagnetic wave and receives back the reflected waves from targets within that space. Radar system is to detect and localize potentially non-cooperative targets. Primary radar operation is based on the principle of echolocation. ADS-B replaces radar technology with satellites, bringing major advantages. ,ADS-B uses conventional Global Navigation Satellite System (GNSS) technology and a relatively simple broadcast communications link as its fundamental components. Radars used today can takes 5 to 12 seconds to update an aircraft's position. ADS-B equipment provides air traffic control (ATC) with updated aircraft information almost every second.

2. Secondary surveillance

Secondary surveillance radar (SSR) is a radar system used in air traffic control (ATC), that not only detects and measures the position of aircraft, but also requests additional information from the aircraft itself such as its identity and speed. SSR relies on targets equipped with a radar transponder , that replies to each interrogation signal by transmitting a response containing encoded data. The purpose of SSR is to improve the ability to detect and identify

aircraft while automatically providing the flight level of an aircraft. An aircraft transponder within line-of-sight range 'listens' for the SSR interrogation signal and transmits a reply on 1090 MHz that provides aircraft information.

1) ADS-B Evolution

Dependent Surveillance-Broadcast (ADS- B) is FAA's satellite-based successor to ground based air traffic control (ATC) radar. Air traffic control (ATC) and radar were first used together in 1943 when Air Force air traffic controllers began using Ground

Controlled Approach (GCA) equipment to help military pilots land safely in poor visibility. GCA matured and was widely accepted through the mid-1950s at which time the Instrument Landing System (ILS) began replacing GCA. Though ILS uses similar course guidance principles to GCA, ILS instrumentation on-board aircraft displayed course deviation directly to the pilot. In the 1970s, the Air Traffic Control Radar Beacon System (ATCRBS), also known as Secondary Surveillance Radar (SSR), was upgraded to improve surveillance performance in dense airspace and transmissions between ground and aircraft. In the 1980s, the airborne collision avoidance system (ACAS) was developed. It uses air-to-air surveillance and is required on all commercial aircraft operating in the US and Europe. In the 1990s, radar surveillance of runways and taxiways was added. This, coupled with transponders, a technique called 'multilateration', make surveillance accuracy at the surface good enough to feed into the automatic safety warning devices. Next in the evolution of surveillance technology was the Traffic Collision Avoidance System (TCAS). With TCAS, one aircraft interrogates another's transponder, thereby detecting potential airspace conflicts. The resulting information can be graphically displayed depicting another aircraft's range and bearing. TCAS does not require ground infrastructure but does require a TCAS system on one aircraft and at least a Mode C transponder on the other. And most recently, Automatic Dependent Surveillance – Broadcast (ADS-B) was developed to transmit aircraft position and velocity in 3 dimensions to other aircraft via an air-to-air datalink and to ground stations via an air-to- ground datalink (ADS-B Out). In turn, other aircraft can use this state vector information along with their own state vector to calculate and display relative range and bearing (ADS-B In). In addition, data gathered from ADS-B Out equipped aircraft are fed to ATC.

III. METHODOLOGY AND IMPLEMENTATION

Automatic dependent surveillance – broadcast (ADS–B) is a surveillance technology in which an aircraft determines its airborne information via satellite navigation and periodically broadcasts it, enabling it to be tracked. The information can be received by air traffic control ground stations, hence enables enhanced tracking system. Automatic Dependent Surveillance-Broadcast (ADS-B) is an element of the US Next Generation Air Transportation System (NextGeN), which is the successor of traditional radars.

ADS-B system consists of two sections:

The ADS-B receiver built using Raspberry Pi and low cost DVB-T USB Stick which receives the data from the flights. With a DVB-T USB dongle attached and dump1090 software installed, Pi will be able to receive and decode the ADS-B transmissions. Then we can view a virtual radar representation of the fed data. FR24 offer more comprehensive virtual radar maps on their feature rich sites.Figure 2 shows system assembled view.

1. ADS-B Transmitter (ADS-B OUT) –

This class of device is capable of transmitting ADS-B data. ADS- B Out transmits information about altitude, airspeed, and location derived through GPS from an aircraft to ground stations and to other equipped aircraft in the vicinity.

2. ADS-B Receiver (ADS-B IN) –

An ADS-B receiver will receive both traffic information and weather information. These information provides situational awareness of other airplanes and vehicles on the airport surface and situational awareness of other airborne traffic, such as assistance in finding targets outside the cockpit.

The ADS – B receiver system shown in figure 1 consists of antenna, ground system, Ethernet and display system.

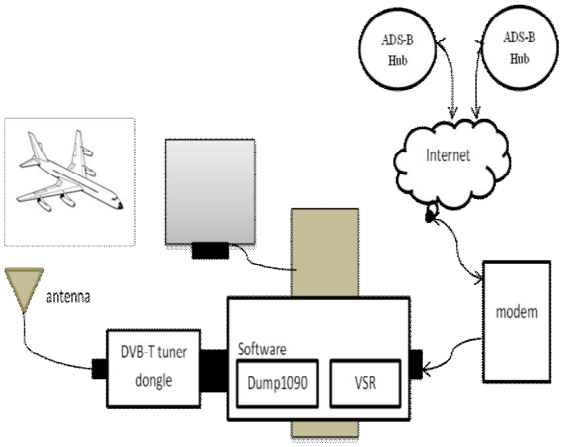

Figure 1. Block diagram of ads-b receiver section

Figure 2. System setup

With the availability of cheap DVB-T sticks that can be turned into broadband radio scanners, anyone can now also receive and decode ADS-B signals and feed them into a worldwide network. Probably desktop or laptop computer won't run 24h/7d, but credit-card sized computers like the Raspberry Pi do provide just enough computing power to do the job. All that is needed is a stable internet connection and a power supply that delivers 5V for the Raspberry Pi.

A. ADS-B message format

ADS-B signals from aircraft to ground stations are transmitted at 1090MHz. Each packet is either formed of 7 bytes (for Short Squitter transmissions) and 14 bytes (for ADS-B Extended Squitter messages). They contain 112 bits of data, encoded using pulse position modulation with a data rate of 1Mbps.

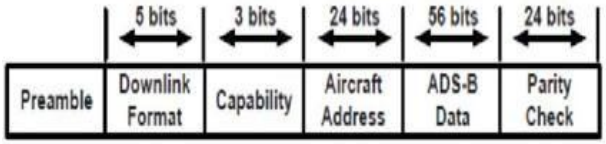

Figure 3. ADS B message format

Preamble field: This field of 8 microsecond duration is a fixed bit sequence that can allow the receiver to identify and synchronize with a message received.

Downlink Format (DF): The DF number tells the decoder whether it is dealing with a short or extended squitter packet. For extended squitter messages, it is set to 17 or 10001(binary).

Capability (CA): This describes the specific data being transmitted by the ADS-B message and is set to binary "101" for all tests.

Aircraft address: The aircraft's ID, which is 3-byte that contains the ICAO designation aircraft. It contains information about the altitude, latitude, and longitude of the aircraft.

Ads-b data: 56 bits of ADS-B data, containing information about airborne velocity, position, ID message for each aircraft. It contains information about the altitude, latitude, and longitude ofthe aircraft.
Parity check: The 24bit field is reserved as an error detection code that can help a receiver to detect errors in the received message.

B. LOW LEVEL DESIGN

Flow chart below describes how various data like velocity, heading, position, altitude and flight number are decoded by the received ADS-B message frame format inside the receiver system.

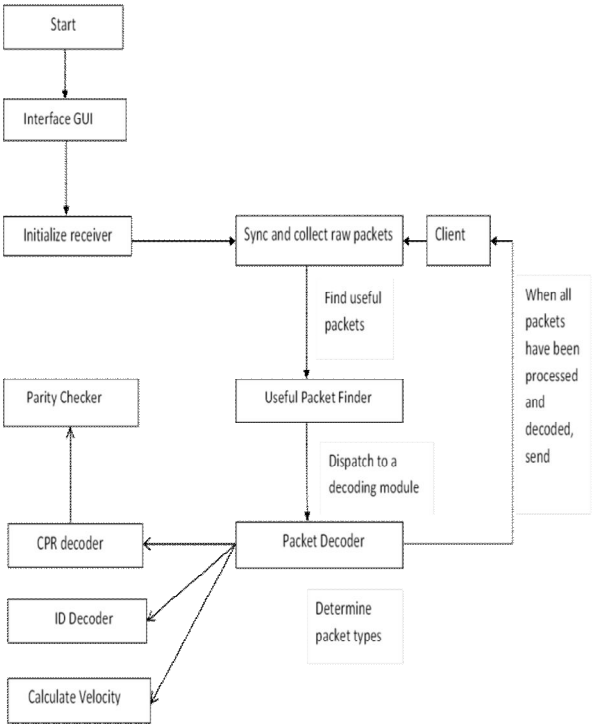

Figure 4. Flowchart for low level design

IV. COMPONENTS

The main components required are elucidated below:

Raspberry pi3

The Raspberry Pi is a series of small single-board computer. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor. CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3.

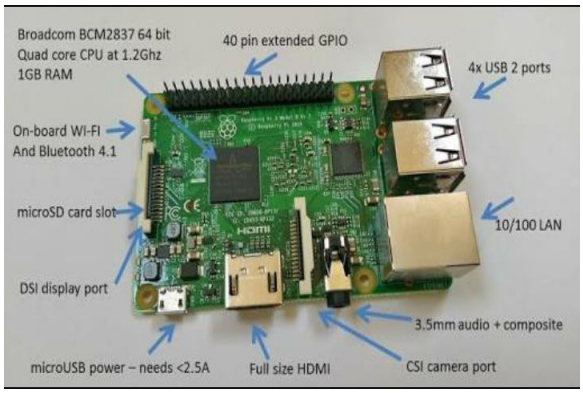

Figure 5. Raspberry pi3 architecture

3. DVB-T Dongle

The device transmits compressed digital audio, digital video and other data in an MPEG transport system, using coded orthogonal frequency-division multiplexing modulation. DVB-T TV tuner dongle uses the Rafael Micro R820T tuner chip.

Figure 6. DVB-T Dongle

4. High-Gain Antenna (HGA)

A high-gain antenna (HGA) is a directional antenna with a narrow radio beam that is used to increase signal strength. These antennas provide a more precise way of targeting radio signals. The ADS-B-1090 antennas are centre fed design which eliminates the distortion of the radiation pattern and ensures a true omni directional horizontal pattern. The bandwidth of the ADS-B antenna is fairly narrow, which can help to eliminate inter-modulation problems from adjacent strong signals in urban areas

V. RESULTS AND DISCUSSIONS

System interprets ADS-B transmissions. It displays live air traffic in real time in a the client's local machine and allows receivers to be used to increase the It is publically accessible from the URL www.flightradar24.com as shown in figure. The client to plot a flight path for a each to plot a flight path from the database of the flights unique ID's and allows the iew a flight through the eyes of the pilot google Earth. It also allows the client to plot orts in their country on the map and bring about it such as its name and location and provides information about flight origin and destination as shown in figure5.1. Users can create queries to retrieve information from the database and gives the client the ability to export the raw data from the database so it can be used for other applications.

Figure 7. ADS-B (T-VOMY2)Data shared statistics.

VI. CONCLUSION AND FUTURE WORK

Automatic Dependent Surveillance Broadcast (ADS-B) system is intended to transform ATC by providing more accurate and reliable tracking of airplanes in flight and on the ground. ADS-B avionics enables an aircraft to broadcast its position information derived from GNSS, its identity, velocity and other information with a high degree of accuracy and integrity. ADS-B provides improved surveillance in remote or inhospitable areas where radar installation isn't feasible. Compared to massive radars, ADS-B transponder are roughly the size of cell phone repeaters and consisting of antenna, receiver, target processor and telecomm links to ATC facilities can be installed almost anywhere. Hence the system is much compact and cost effective.

Aircraft with an ADS-B transponder broadcast their identification and this three dimensional position (latitude, longitude, altitude) on 1090MHz or 978MHz, which can be received by a radio within line of sight of the aircraft (a maximum of 300mi / 480km) at cruise. Servers enhance the ADS-B data with additional information such as aircraft registration/tail number, departure airport, destination, position, altitude, velocity and other flight data.

There are important safety benefits of the ADS-B implementation. In addition, search and rescue activities can be improved both inside current radar coverage and outside of radar coverage. The last few ADS-B position reports are invaluable in helping rescuers locate a force landed aircraft.

After modelling of a prototype of ADS-B receiver, further steps would include to install multiple receivers with centralised tracking facility. Developing several protocols for the encrypted data transmission to the ground station.

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