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Aircraft Tracking Using Automatic Dependence Surveillance – Broadcast

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Abstract: This Paper aims at the development of flight tracking system (FTS) with an automatic dependence surveillance broadcast technology (ADS-B). The major problem existing in the present flight tracking system is the disappearance of aircrafts from radar while taking oceanic routes. In the proposed system, the air traffic controllers (ATC) are aided by ADS-B that uses satellite communication to determine location and periodically transmit it to the ground station. ADS-B is a Neaten tracking methodology that allows an aircraft to communicate with other aircraft fitted with another transponder. The project is carried out in two phases. The first phase involves the prototype model that consists of a quad copter fitted with a GPS module and an Bee transmitter connected to an Arduino that controls the Xbee transmitter. At the receiving end, is an xbee receiver connected to a second Arduino that Processes the NMEA format data. The Arduino at the receiving end is interfaced with a computer, to perform position estimation. The second phase involves the implementation of an extended kalman filter algorithm to estimate the position of the aircraft using the data from the GPS. The output responses are plotted. The positional chart and velocity graph are obtained.

I. INTRODUCTION

One of the reasons cited by experts for aircrafts disappearing is that, the aircrafts disappear from radar while taking oceanic routes. Hence, over ocean flights cannot be tracked. The flight cannot be tracked because it lost its signal while taking oceanic routes and also it will make a flight disappear forever. Because of this reason we almost lose many flights till now. To mention about a recent incident the flight disappear is that Indian air force An-32, Malaysian airlines and many more. About Indian air force An-32 is that it disappears in 22nd July in 2016 with total of 29 members in the flight. It lost its signal in Bay of Bengal where the route from tambaram to port Blair and it disappeared 280km east of Chennai. Malaysian flight disappears in 8th march in 2014 with total of 239 members in the flight. It is a passenger flight where the route from kualalumpur, Malaysia to Beijing, china. Most evidence sugget that the plane went down in the Indian ocean west of Australia and also it last transponder position is known but its final position is not known till now. For the past few years, aviation is make use of radar signal for flight tracking but nowadays aviation is make use of new technology NEXTGEN called ADS-B (automatic dependence surveillance-broadcast). Radar maks use of radio signals (electromagnetic waves) while ADS-B make use of satellite navigation. With the help of ADS-B we can able to track an aircraft above its oceanic routes while radar fail to track.

II. EXISTING SYSTEM

The existing system uses RADAR which is also known as Radio Detection and Ranging. Radar is an object-detection system that uses radio waves to determine the range, angle, or velocity of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. A radar system consists of a transmitter producing electromagnetic waves in the radio or microwaves domain, a transmitting antenna, a receiving antenna and a receiver and processor to determine properties of the object. Radio waves may be pulsed or continuous from the transmitter reflect off the object and return to the receiver, giving information about the object's location and speed.

The modern uses of radar are highly diverse, including air and terrestrial traffic control, radar astronomy, sir0defencesystems, antimissile systems, marine radars to locate landmarks and other ships, aircraft anti-collision systems, ocean surveillance system, outer space surveillance and rendezvous systems meteorological precipitation monitoring, altimetry and flight control systems, guided missile target locating systems, ground-penetrating radar for geological observations, and range-controlled radar for public health surveillance.

High tech radar systems are associated with digital signal processing, machine learning and are capable of extracting useful information from very high noise levels.

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III. PROPOSED TECHNOLOGY

In this paper, we proposed the use of a Next Gen tracking method called the automatic dependence surveillance- broadcast (ads-b). ADS-B is a nextgen surveillance technology that uses satellite communication to determine location and periodically transmits it to the Air Traffic Controllers (ATC). ADS-B is radically new technology that is redefining the paradigm of COMMUNICATIONS - NAVIGATION - SURVEILLANCE in Air Traffic Management today. Already proven and certified as a viable low-cost replacement for conventional radar, ADS-B allows pilots and air traffic controllers to "see" and control aircraft with more precision, and over a far larger percentage of the earth's surface, than has ever been possible before.

A. *Automatic*-It's always ON and requires no operator intervention.
B. *Dependent*-It depends on an accurate GNSS signal for position data.
C. *Surveillance*-It provides "Radar-like" surveillance services, much like RADAR.
D. *Broadcast*-It continuously broadcasts aircraft position and other data to any aircraft, or ground station equipped to receive ADS-B.

ADS-B also allows an aircraft to communicate with other aircraft fitted with ADS-B. This makes it possible for the aircraft to determine its route without the need of ATC to guide it. Also, the distance 128 meters required between aircrafts in air to maintain a safe flight can be reduced to 5 meters. ADS-B, which consists of two different services, "ADS-B Out" and "ADS-B In", could replace radar as the primary surveillance method for controlling aircraft worldwide. [1]It is an integral component of the NextGen national airspace strategy for upgrading and enhancing aviation infrastructure and operations. The ADS-B system can also provide traffic- and government-generated graphical weather information through TIS-B and FIS-B applications. ADS-B enhances safety by making an aircraft visible, real-time, to air traffic control (ATC) and to other appropriately equipped ADS-B aircraft with position and velocity data transmitted every second. ADS-B data can be recorded and downloaded for post-flight analysis. It also provides the data infrastructure for inexpensive flight tracking, planning, and dispatch. ADS-B Out periodically broadcasts information about each aircraft, such as identification, current position, altitude, and velocity, through an onboard transmitter. ADS-B Out provides air traffic controllers with real-time position information that is, in most cases, more accurate than the information available with current radar-based systems. With more accurate information, ATC will be able to position and separate aircraft with improved precision and timing. ADS-B In is the reception by aircraft of FIS-B and TIS-B data and other [1]-[3]ADS-B data such as direct communication from nearby aircraft. The ground station broadcast data is typically only made available in the presence of an ADS-B Out broadcasting aircraft, limiting the usefulness of purely ADS-B In devices. The system relies on two avionics components that is high-integrity GPS navigation source and a data link (ADS-B unit). There are several types of certified ADS-B data links, but the most common ones operate at 1090 MHz, essentially a modified Mode S transponder, or at 978 MHz The FAA would like to see aircraft that exclusively operate below 18,000 feet (5,500 m) use the 978 MHz link since this will help alleviate further congestion of the 1090 MHz frequency. To obtain ADS-B Out capability at 1090 MHz, one can install a new transponder or modify an existing transponder if the manufacturer offers an ADS-B upgrade, plus install a certified GPS position source if one is not already present.
ADS-B is an environmentally friendly technology that enhances safety and efficiency, and directly benefits pilots, controllers, airports, airlines, and the public. It forms the foundation for NextGen by moving from ground radar and navigational aids to precise tracking using satellite signals. With ADS-B, pilots for the first time see what controllers see: displays showing other aircraft in the sky. Cockpit displays also pinpoint hazardous weather and terrain, and give pilots important flight information, such as temporary flight restrictions. ADS-B reduces the risk of runway incursions with cockpit and controller displays that show the location of aircraft and equipped ground vehicles on airport surfaces even at night or during heavy rainfall. ADS-B applications being developed now will give pilots indications or alerts of potential collisions. ADS-B also provides greater coverage since ground stations are so much easier to place than radar. Remote areas without radar coverage, like the Gulf of Mexico and parts of Alaska, [4]-[5]now have surveillance with ADS-B. Relying on satellites instead of ground navigational aids also means aircraft will be able to fly more directly from Point A to B, saving time and money, and reducing fuel burn and emissions. The improved accuracy, integrity and reliability of satellite signals over radar means controllers eventually will be able to safely reduce the minimum separation distance between aircraft and increase capacity in the nation's skies.

IV. BENEFITS OF THE PROPOSED TECHNOLOGY

A. It also improves efficiency by reducing environmental impact and traffic capacity improvement by better ATC traffic flow management, merging and spacing, and reduced aircraft operations.
B. It also improves safety by improved visibility and situational awareness.

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C. ADS-B when used for traffic a pilot is able to view traffic information about surrounding aircraft if those aircraft are equipped with ADS-B out[2]. This information includes altitude, heading, speed, and distance to aircraft. In addition to receiving position reports from ADS-B out participants, TIS-B [USA-only] can provide position reports on non-ADS-B out-equipped aircraft if suitable ground equipment and ground radar exist. ADS-R re-transmits ADS-B position reports between UAT and 1090 MHz frequency bands.

D. ADS-B when used for whether Aircraft is equipped with Universal Access Transceiver (UAT) *ADS-B In* technology will be able to receive weather reports, and weather radar through flight information service-broadcast (FIS-B) but it is currently implemented in USA only.

E. ADS-B when used for flight information service-broadcast (FIS-B) also transmits readable flight information such as temporary flight restrictions (TFRs) and NOTAMs to aircraft equipped with UAT. Even this is also implemented only in USA.

F. ADS-B ground stations are significantly cheaper to install and operate compared to primary and secondary radar systems used by ATC for aircraft separation and control.

V. WORKING OF THE PROPOSED SYSTEM

In our proposed system, we are going to develop a flight tracking system that lets Air traffic controllers (ATC) to track an aircraft including its oceanic course. To implement this, we are going to design a tracking system using real time data from on-flight transponders and transmitters. [1]To get a real-time data from real time tracking we are going to build a tracking system using quad copter, GPS, xbee and Arduino Uno. In this project, we proposed the use of a NextGen tracking method called the automatic dependence surveillance- broadcast (ADS-B). The automatic dependence surveillance- broadcast to establish satellite communication for tracking. To use extended Kalman filter for tracking an aircraft. Construct a tracking simulation using mat lab by obtaining data from on-flight GPS module. Transmitting the data from GPS module to arduino through zigbee module.

Quad copter which is used to get a real-time data is Caterpillar 6 Channel LH-X16 Remote Controlled 6 Axis 2.4 GHz Quad copter. The quad copter comes within built transmitter gyro and accelerometer modules. An additional GPS module with transmitter is fitted and the transmitted signal is received by a receiver. The GPS module used to get a real-time data is UBLOX NEO – 6 GPS MODULE. The received data from the GPS module is fed to the arduino through the zigbee module from where it is linked to mat lab for simulation of position and hence provide real time tracking. The prototype consists of a quad copter that is drone with an inbuilt 6-axis gyroscope fitted with a UBLOX NEO GPS MODULE that takes input voltage between 3.3V – 5V. The GPS module is interfaced with a XBEE transmitter with the help of an interfacing board. The XBEE transmitter comes with an on-board transmitting antenna. This combination is connected with an Arduino Uno and programmed to read GPS data. The XBEE does not need to be programmed to transmit data. At the receiver end, a XBEE receiver interfaced with an Arduino Uno is connected to a PC loaded with MATLAB. The data is then transferred to mat lab using an Arduino to Mat lab linking code, and output is simulated.

A. Advantages

1) We work with both 1090 MHz "Extended Squitter" and 978 MHz "UAT" ADS-B, we prefer to concentrate on 978 MHz UAT product development because we firmly believe that UAT is the most capable and flexible ADS-B data link standard, because

2) It is NEXTGEN compatible, and it was the first Cooperative Dependent Surveillance (CDS) technology to bfully certified by the FAA and ICAO for critical "radar-like" air traffic control services (2002)

3) Its large bandwidth and robust design support bi-directional data link (ADS-B "IN" as well as "Out")

4) Its accurate and long range air-to-air capability has the potential to provide excellent collision avoidance and conflict resolution services.

B. Disadvantages

1) Large volumes of data are generated as every centimetre change changes the coordinates and every second data is transmitted.

2) Handling large amounts of data is difficult.

3) The ads-b transponder is an expensive unit.

VI. BLOCK DIAGRAM OF PROPOSED SYSTEM AND EXISTING SYSTEM

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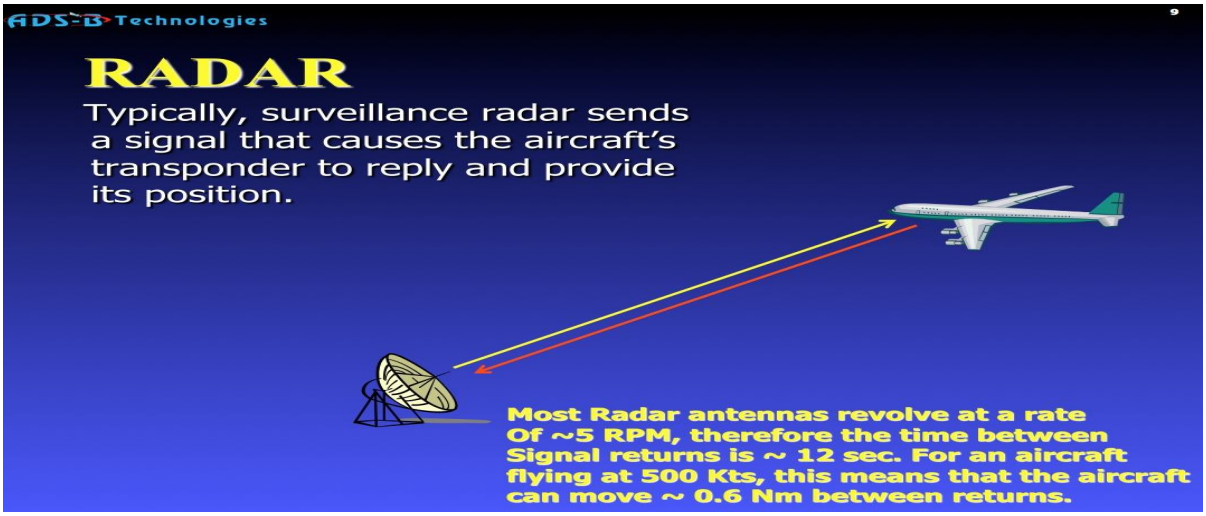

Fig. 1 Block diagram of Existing system

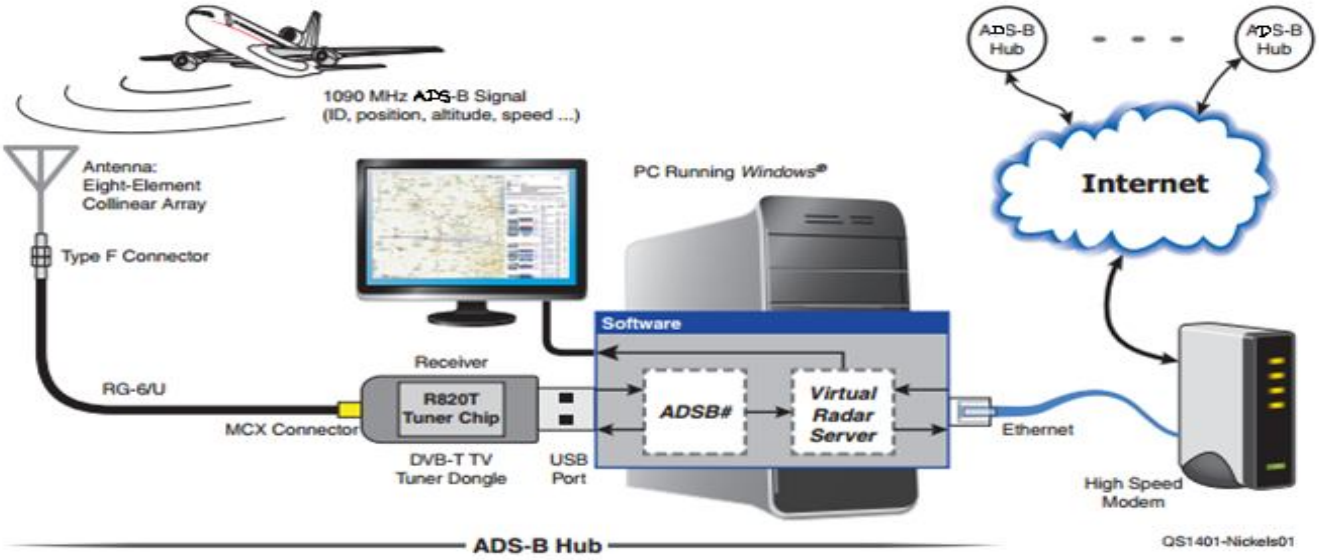

Fig. 2 Block diagram of Proposed system

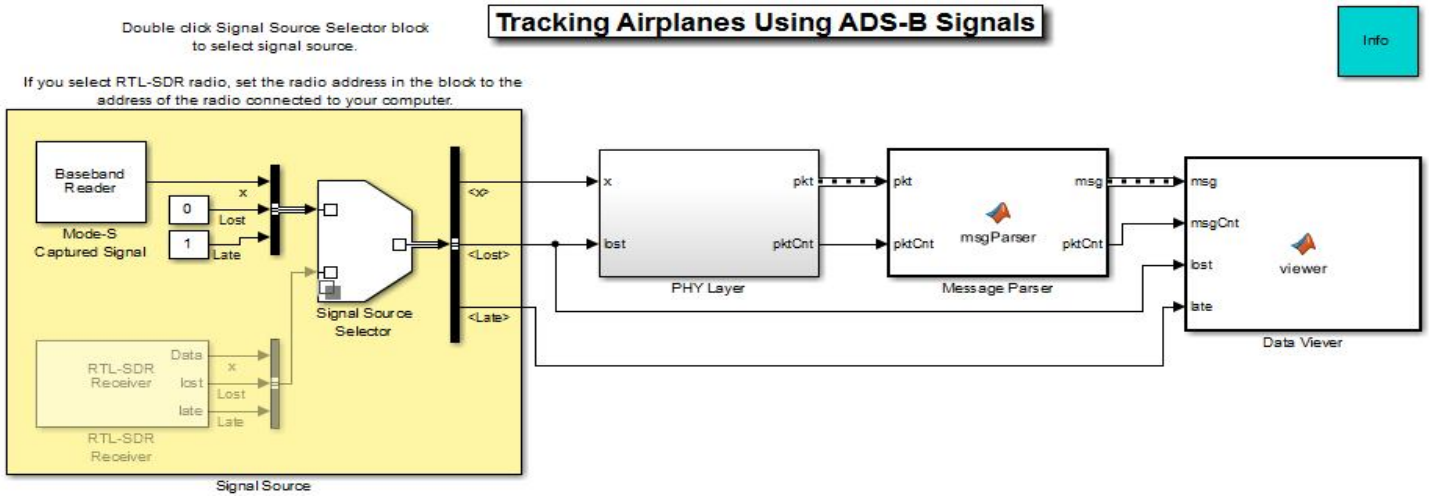

Fig. 3 Typical Block diagram of ADS-B in Matlab

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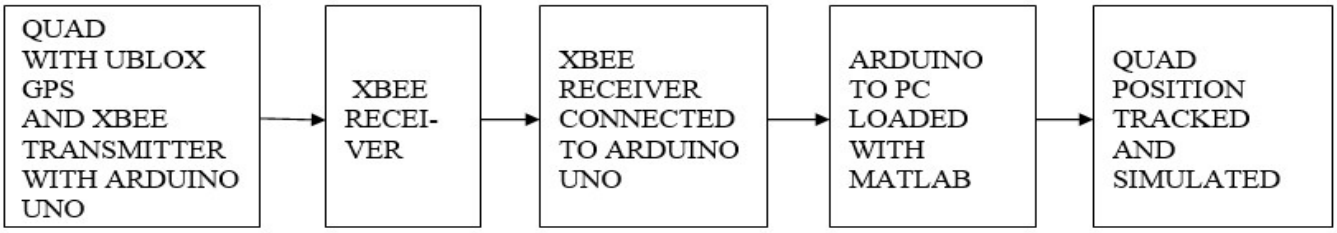


Fig. 4 Prototype Block diagram

C. Figure 4 shows the block diagram of the proposed prototype.

1) The quad comes within built transmitter gyro and accelerometer modules.

2) An additional GPS module with transmitter is fitted and the transmitted signal is received by a receiver.

3) The received data from the GPS module is fed to the arduino through the ZigBee module from where it is linked to Matlab for simulation of position and hence provide real time tracking.

4) The prototype consists of a quadcopter drone with an inbuilt 6-axis gyroscope fitted with a UBLOX NEO GPS MODULE that takes input voltage between 3.3V – 5V.

5) The GPS module is interfaced with a XBEE transmitter with the help of an interfacing board. The XBEE transmitter comes with an on-board transmitting antenna.

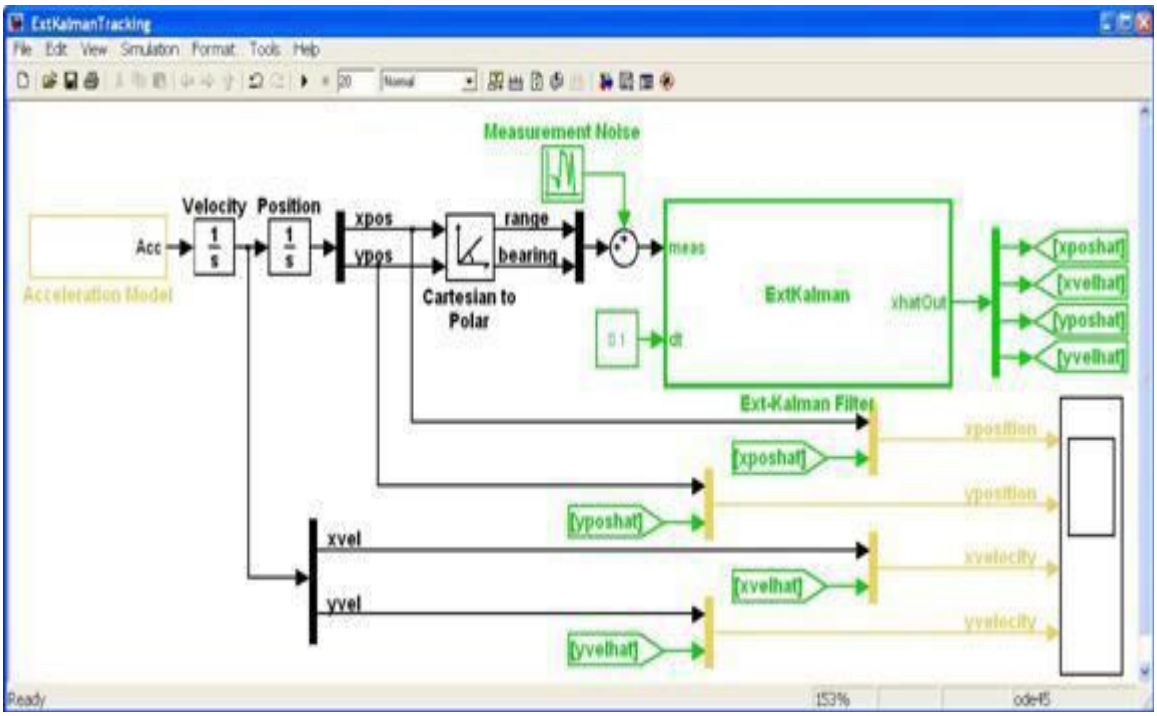
6) This combination is connected with an Arduino Uno and programmed to read GPS data. The XBEE does not need to be programmed to transmit data.

7) At the receiver end, a XBEE receiver interfaced with an Arduino Uno is connected to a PC loaded with MATLAB. The data is then transferred to Matlab using an Arduino to Marla linking code, and output is simulated.

VI. EXTENDED KALMAN FILTER ALGORITHM

In estimation theory, the Extended Kalman Filter (EKF) is the nonlinear version of the Kalman filter which linearizes about an estimate of the current mean and covariance. In the Extended Kalman filter, the state transition and observation models don't need to be linear functions of the state but may instead be differentiable functions.

VII.EXTENDED KALMAN FILTER IN MATLAB SIMULINK



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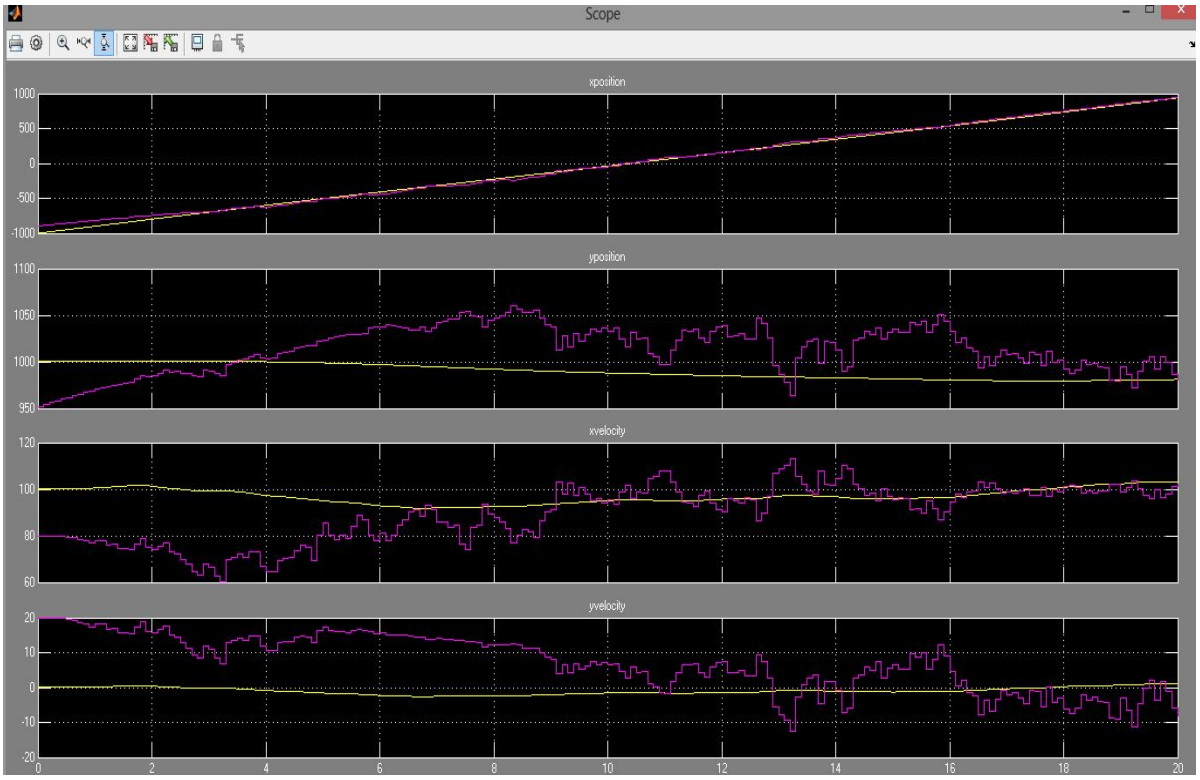
VIII. MATLAB RESULT USING EXTENDED KALMAN FILTER



IX. CONCLUSION

In the conventional RADAR technology, it is difficult to keep the track of an aircraft because of the problems and disadvantages related to the radio frequency waves. But the proposed system helps in overcoming the problems associated with the conventional RADAR technology. In the proposed system, the distance of separation between the aircrafts of the same region is reduced into 5 meters which is generally maintained around 28 meters in the existing methods. This nextgen methodology also reduces the fuel cost and it then saves the time by providing a graphical picture about the air traffics in the cockpit display, which is helpful in enhancing the pilot's situational awareness. However, this proposed system must be developed further to overcome some of the disadvantages like for every second, coordinates changes when there is change in position occurs which causes the change in data obtained, so it is really difficult to handle large amount of data's continuously and also the ADS-B transponder is an expensive unit.

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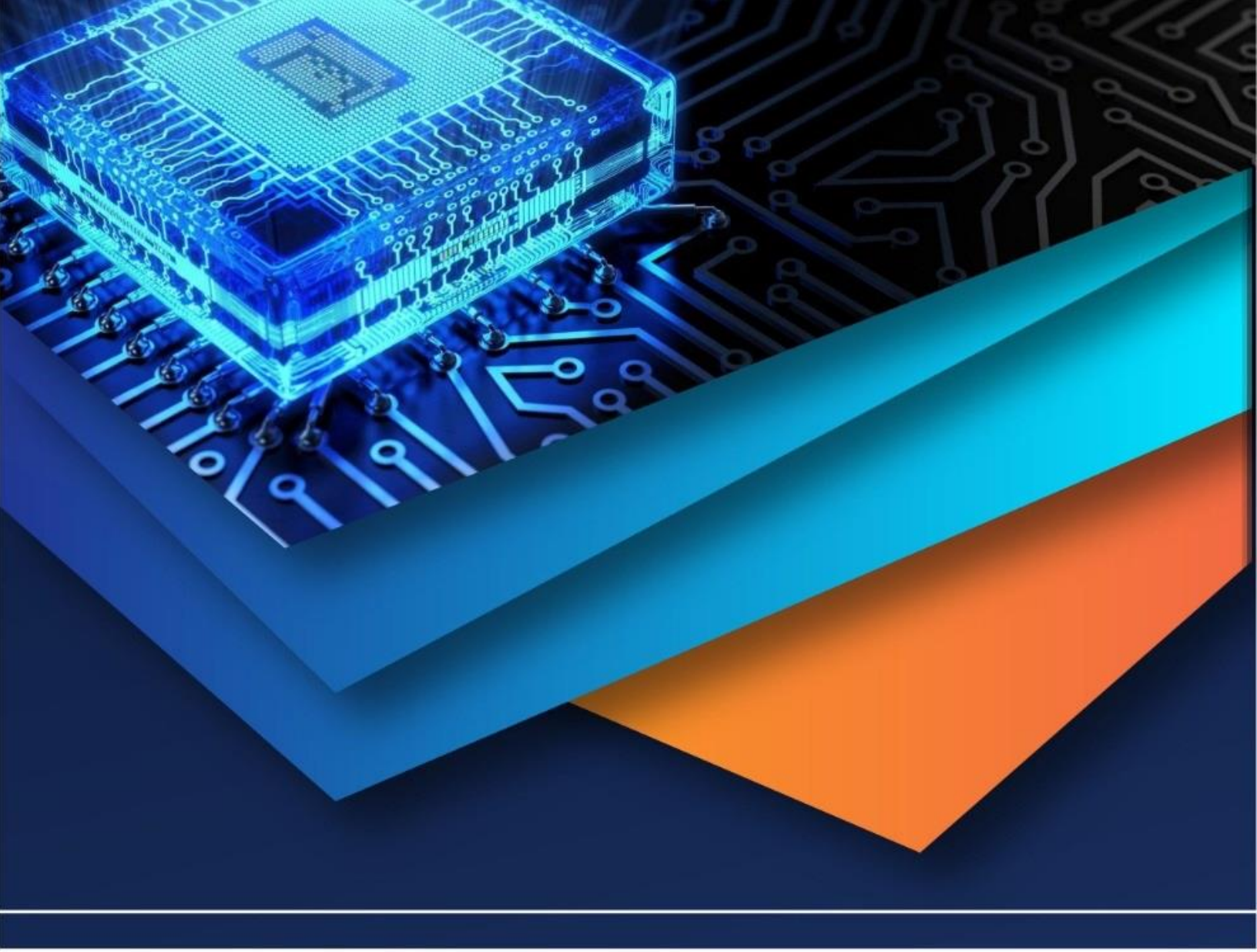

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