International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-2, December, 2019

Design of Low Cost Wireless Surveillance System for Aircraft

K. Nandakumar, Adarsh Vijayan Pillai, S. Priyadarshini, R. Sitharthan, K. R. Devabalaji

Abstract: The aim of the project is to estimate the position and orientation of a moving platform in a 3D environment which is of significant importance in many areas such as robotics, sensing, surveillance and Unmanned Aero Vehicles. In order to perform this, one can employ single or multiple sensor fusions to improve the accuracy of estimation and to compensate for individual sensors deficiencies. We are using camera surveillance controller system in which we control the movement of the camera and it is live video streaming to a remote location. The camera is made to view +180 to -180° by using servomotor. The GPS and IMU sensor modules are implanted onto the model for controlling and monitoring the flight. Wireless technology allows viewing remotely and controlling the flight as required. This paper focuses on LOW-COST WIRELESS SURVEILLANCE for improved security, more flexible and efficient systems.

Keywords: IMU, GPS, SURVEILLANCE, LabVIEW

I. INTRODUCTION

Surveillance historically occurred as a means to gather and collect information, supervise the actions of other people (usually enemies), and to use this information to increase ones understanding. Modern surveillance technologies such as CCTV, RFID and GPS help to highlight the extent to which surveillance practices have evolved throughout history. Surveillance has become an essential importance in defense, which facilitates in monitoring a changing situation in real time and capable of capturing a static picture for analysis. In the current scenario, the pilot in his cockpit is able to view all the necessary details needed to guide the way to the destination. This is achieved by the use of Avionics LRUs (Line Replaceable Units) and Sensors. In a case of a misadventure of the systems on aircraft, the pilot has to be guided to reach a safer place as soon as possible. Also, in the scenario of an Unmanned Air Vehicle (UAV), the need for ground stations for controlling flight control systems become very essential. The ground control systems enable us to get the information of the aircraft throughout the flight and it manoeuvre of UAV remotely. This is achieved by equipping sensors and instruments to follow up the UAV during flight. We make use of a surveillance camera which can transmit the view of the flight, a GPS module to share the location, time and speed details and an IMU sensor which delivers the position, pressure and temperature information. The transmissions of the above information's are carried through a wireless medium.

Revised Manuscript Received on December 30, 2019.

* Correspondence Author

K. Nandakumar, Department of Electrical and Electronics Engineering, Hindustan Institute of Technology and Science, Padur, Chennai (Tamil nadu) India. E-mail: nandak@hindustanuniv.ac.in

Adarsh Vijayan Pillai, Department of Electrical and Electronics Engineering, Hindustan Institute of Technology and Science, Padur, Chennai (Tamil nadu) India. E-mail: adarshvp@hindustanuniv.ac.in

S. Priyadarshini, Department of Electrical and Electronics Engineering, Hindustan Institute of Technology and Science, Padur, Chennai (Tamil nadu) India.E-mail: spriya@hindustanuniv.ac.in

R. Sitharthan, School of Electrical Engineering,Vellore Institute of Technology,Vellore, Chennai (Tamil nadu) India. E-mail: sithukky@gmail.com

K. R. Devabalaji*, Department of Electrical and Electronics Engineering, Hindustan Institute of Technology and Science, Padur, Chennai (Tamil nadu) India. E-mail: eeedevabalaji@gmail.com

A. Literature Survey

The in-vehicle device is composed of a microcontroller and GPS/GSM/GPRS module to acquire the vehicle's location information and transmit it to a server through GSM/GPRS network[1]. The independent and continuous gesture recognition system using IMU and EMG sensors were performed [2]. The design and implementation of a low-cost system monitoring based on Raspberry Pi, a single board computer which follows Motion Detection algorithm written in Python as a default programming environment. In addition, the system uses the motion detection algorithm to significantly decrease storage usage and save investment costs [3]. The drawback of these works was found that they have not used it on an aerial vehicle and have not used for the purpose of surveillance. The Bluetooth wireless transmission and GPS positioning technologies to design and develop a GPS information sharing system, named GISS [4].

The main contribution of our proposed work is that development of novel method to use of IMU and GPS sensors in an aerial vehicle for surveillance purpose. We used Arduino as a microcontroller and interfacing it with the GPS and IMU sensors, for displaying the location, position, temperature and pressure information's to the user in an understandable way. The surveillance wireless camera is mounted onto the servo motor for sweep action of the camera. LabVIEW is used for the user understandable display of information's. Proteus and Arduino IDE software's are used to simulate and program the models respectively. The live streaming video is recorded and image is captured in Ulead video studio software.

The purpose of this paper is to perform the innovation design of cam-controlled planetary gear trains with one degree of freedom. The atlas of new designs with 4 and 5 links will be generated. The feasibility of new designs will be illustrated with an example, and verified by kinematic simulation.

II. PROBLEM FORMULATION

The aircraft is necessary to be monitored at every instant of flight for guiding pilot. In the case of UAVs it becomes even more important for monitoring the position and status of it during its flight since it is unmanned, the need of surveillance becomes essential as it is very difficult to monitor the UAV in the case of misadventures. The combined model of surveillance includes a GPS locator in it which is officially banned in India and has to be imported and costs around 60,000 rupees [5] in Indian money. The IMU module used in fighter aircrafts are nearly half of the weight of aircraft. This will add on to the cost of the aircraft and even the weight. In order to overcome this problem, a surveillance model is developed to monitor the basic parameters of aircraft which can be used to track the flight in a cost-effective as well as efficient manner. Even if the camera fails to capture, the GPS module will enable us to locate the current position of the UAV [6-8]. The use of Arduino as a microcontroller in order to design and implement this has been a major interest of work.

III. METHODOLOGY

The main blocks of this project are:

- Microcontroller (Arduino)
- Wireless pinhole camera transmitter and receiver kit
- Wireless medium (Bluetooth - HC 05)
- GPS module (2828U7G5LF)
- IMU module (GY-85 6DOF 9DOF)
- Ground station setup to view and monitor the flight

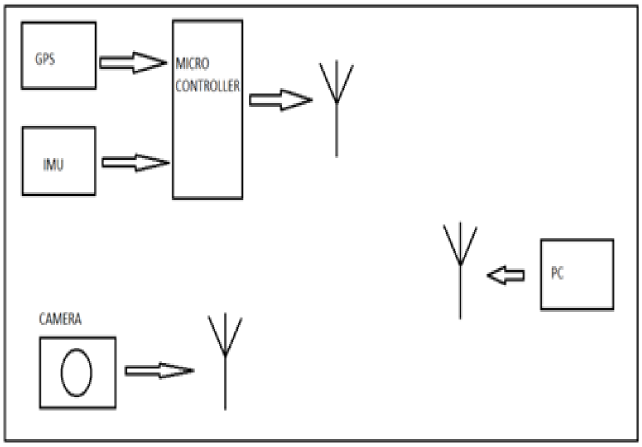

Fig 1. Block diagram

The microcontroller is chosen as Arduino because of compact size, low cost, high processing speed and open-source prototyping platform based on easy-to-use hardware and software. The GPS device is capable of receiving information from the GPS satellites and then to accurately calculates its geographical location [9-11]. GPS modules typically put out a series of standard strings of information, under something called the National Marine Electronics Association (NMEA) protocol. The Inertial Measurement Unit (IMU) is a self-contained system of the triad of gyroscopes and triad of accelerometers that measures linear and angular motion [12-14]. We selected VC0706 camera module for capturing and transmitting but unfortunately, the camera failed to work with Arduino's communication protocol. Thus we choose 208CA CMOS Colour Wireless Micro Camera and Matching Receiver kit that provides high quality wireless video transmission. We chose wireless medium as Bluetooth for a prototype model. Wifi or Zig bee modules can be replaced depending on the preferred range.

At the ground station, LabVIEW software is used to view the information of GPS, position, pressure and temperature in real time. The camera output is view through the Easy Cap drivers in the Ulead software. The Ulead software helps in recording and capturing the image. This image can be further processed in Matlab.

IV. SIMULATION RESULT

For simulation Arduino IDE and proteus software has been used. Firstly, the Arduino code for the display of GPS details according to the NMEA specifications. NMEA 0183 is a combined electrical and data specification for communication between marine electronics such as echo sounder, sonar, anemometer, gyrocompass, autopilot, GPS receivers and many other types of instruments. The GPS module which we use follows the NMEA protocol. According to table 1, any option can be chosen depending on the description needed. We chose the required output messages of the GPS display according to the following NMEA protocol as RMC.

Secondly, in proteus we uploaded this code as a hex file to Arduino mega board and interfaced it with the GPS module. Output of which is obtained in the virtual terminal through the serial port [15-16].

For the simulation of navigation system, An Arduino program was framed for IMU details.

Symbol	Description
GGA	Time, position and fix type data.
GLL	Longitude, Latitude, UTC time of position fix and status.
GSA	GPS receiver operating mode, satellites used in the position solution and DOP values.
GSV	Number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.
MSS	Signal-to-noise ratio, signal strength, frequency, and bit rate from a radio beacon receiver.
RMC	Time, date, position, course and speed data.
VTG	Course, speed information relative to the ground.
ZDA	PPS timing message (synchronized to PPS).

A. NMEA Data

We uploaded pressure and temperature formulas in the IMU navigation program to convert the sensors output into degree celsius and Pascal valve.For altitude simulation the IMU block is not readily available in proteus. So, we interfaced Arduino UNO board with three servo motors. This can provide us information about the roll, pitch, yaw movements. Arduino UNO unit is connected to Arduino MEGA with the help of potentiometers which helps in varying the angular positions of the aircraft. Further, temperature and pressure sensors are connected to the MEGA Arduino board where the combined outputs of all the sensors are displayed through a physical interface block output is displayed.

Similarly, a servo motor and Arduino was interfaced in proteus. An Arduino program to perform sweep operation (i.e. -180º to +180º) is programmed and uploaded into the Arduino block of proteus.

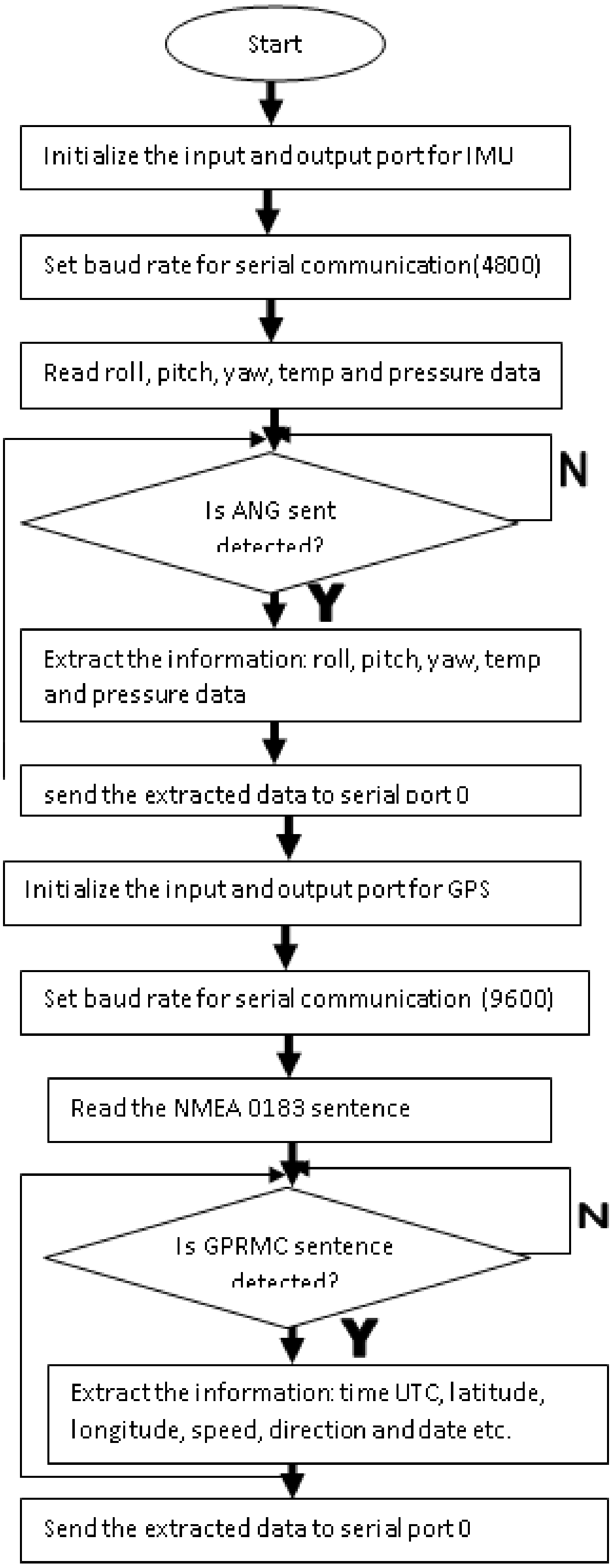

Fig. 2. Flow chart of combined GPS and IMU program

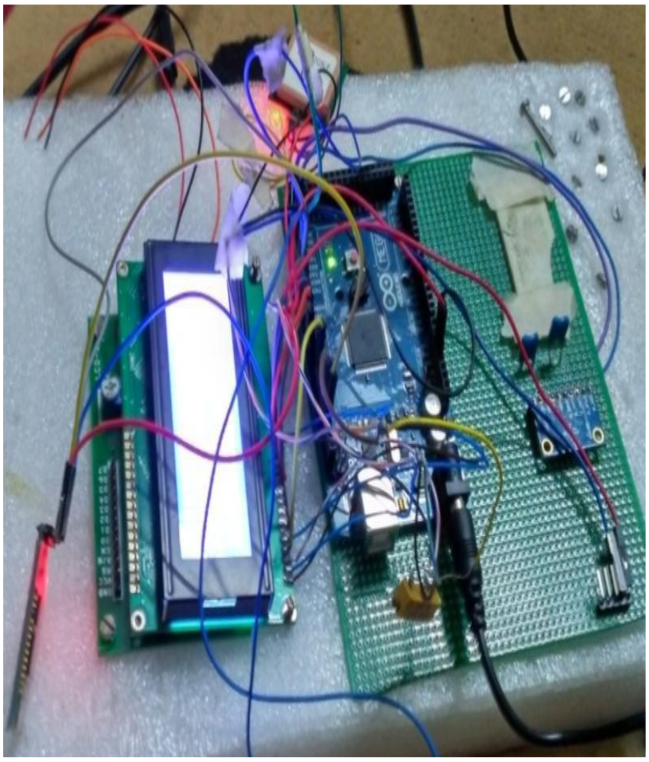

Fig 4. GPS and IMU connected to Bluetooth through Arduino

Fig 5. Camera mounted on servo motor

Retrieval Number: B4241129219/2019©BEIESP
DOI: 10.35940/ijeat.B4241.129219
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

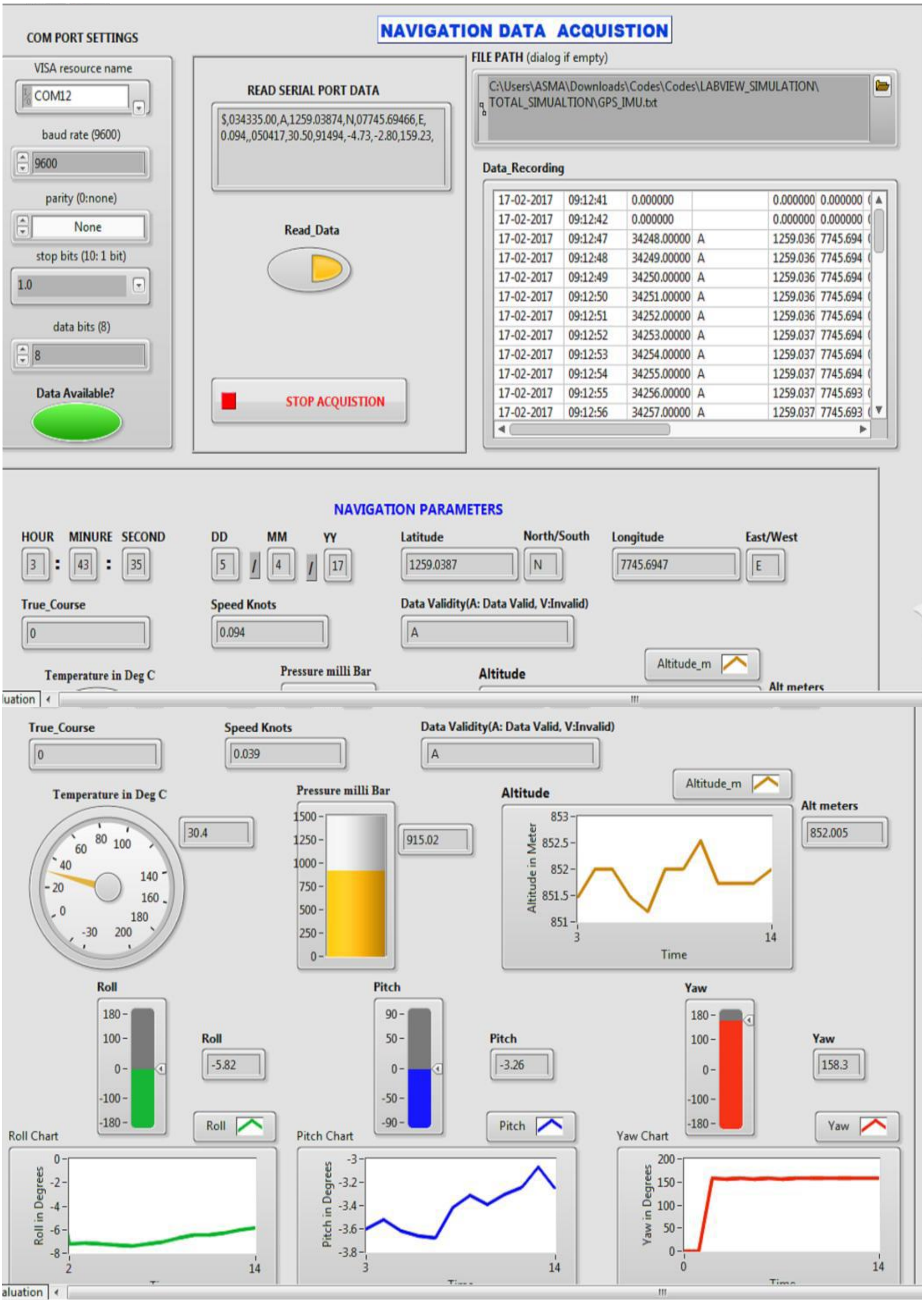

Fig. 6. Combined output of navigation system through bluetooth in LabVIEW.

V. HARDWARE RESULTS

The Arduino mega board is interfaced with GPS and IMU sensor. Firstly, the codes for GPS and IMU separately were uploaded into the Arduino mega board as shown in figure 3. Outputs were observed on the serial monitor.

Now, LabVIEW is an integrated development environment designed specifically for building measurement and control systems. Its back panel configurations and blocks were laid according to the display needs and program flow. To check the LabVIEW output, proteus is run with outputs on the virtual terminal. Using VSPE (Virtual Serial Port Emulator), the serial ports are paired and the LabVIEW is run through the paired port. Output was observed successfully for both GPS and IMU navigation individually.

Now, the Arduino boards are loaded with GPS and IMU navigation programs and the LabVIEW is run on the same port as that of the Arduino board and outputs are observed successfully. Then, the camera is mounted onto the programmed servomotor for sweep control as shown in figure 5. The receiver end of the camera module is connected through the Easy Cap driver which enables it to be connected to the ground station. The live video streaming is captured and recorded in Ulead video studio.For image processing, Matlab can be used to do so.

The camera output is observed on the Ulead video studio as shown in figure 7, where the live streaming video is getting recorded.

VI. OVERALL ANALYSIS

The combination of Arduino programs and models allowed us to frame the total navigation data acquisition system in proteus. Now, the transmitting and receiving port of the Arduino board is connected to the bluetooth module. Now the bluetooth is connected to the pc and paired. LabVIEW is run on the same port as the port connecting the bluetooth device. The combined GPS and IMU navigation system output is shown in figure 6.

VII. CONCLUSION

The surveillance is carried out by mounting the camera, GPS, and IMU on the UAV or Quad copter module which monitors a particular area. The wireless camera captures video and simultaneously transfers it to the ground stationwhile the GPS locates the exact position and gives the latitude, longitude, and time etc according to NMEA protocol. The GPS is programmed through Arduino such that it displays the parameters on the LED 20*4 display according to NMEA protocol.IMU gives the position information such as roll, yaw and pitch of the aerial vehicle. Along with this the pressure and temperature sensors inbuilt in IMU give pressure and temperature details.The Arduino is programmed in such a way that it receives IMU signals and displays it based on the movement of vehicle. All these parameters are simulated and viewed on single screen. In case of emergency situation we can capture the snap shot and can be transmitted to any other system connected to the base station. The GPS and IMU modules are been simulated using proteus as well as LabVIEW. From the above designed project we can able to transmit the video from remote areas by using this transmission technology. The objective of this project was to build a low power low cost, reliable surveillance system. This module used in this project is used for local surveillance having transmission range of 100 meters. The scope of the project can be extended by replacing the bluetooth transmission to WiFi module for higher range and ease of availability of data.

REFERENCE

1. S. Lee, G. Tewolde and J. Kwon, "Design and implementation of vehicle tracking system using GPS/GSM/GPRS technology and smart phone application," 2014 IEEE World Forum on Internet of Things (WF-IoT), Seoul, 2014, pp. 353-358.
2. S. O. Shin, D. Kim and Y. H. Seo, "Controlling Mobile Robot Using IMU and EMG Sensor-Based Gesture Recognition," 2014 Ninth International Conference on Broadband and Wireless Computing, Communication and Applications, Guangdong, 2014, pp. 554-557.
3. Huu-Quoc Nguyen, Ton Thi Kim Loan, Bui Dinh Mao and Eui-Nam Huh, "Low cost real-time system monitoring using Raspberry Pi," 2015 Seventh International Conference on Ubiquitous and Future Networks, Sapporo, 2015, pp. 857-859.
4. C. Liu, C. Zhang, H. Yao, D. Zeng, Q. Liang and C. Hu, "A GPS Information Sharing System Based on Bluetooth Technology," 2014 International Conference on IT Convergence and Security (ICITCS), Beijing, 2014, pp. 1-2.
5. M. Borg; D. Thirde; J. Ferryman; F. Fusier; V. Valentin; F. Bremond; M. Thonnat, " Video surveillance for aircraft activity monitoring", IEEE Conference on Advanced Video and Signal Based Surveillance, Pages: 16 – 21 2005.
6. D. Thirde; M. Borg; J. Ferryman; V. Valentin; F. Fusier; F. Bremond; M. Thonnat; J. Aguilera; M. Kampel, "Visual Surveillance for Aircraft Activity Monitoring", IEEE International Workshop on Visual Surveillance and Performance Evaluation of Tracking and Surveillance, pp: 255-262.
7. I. V. Svyd; I. I. Obod; G. E. Zavolodko; O. S. Maltsev, "Interference immunity of aircraft responders in secondary surveillance radars" , 14th International Conference on Advanced Trends in Radioelecrtronics, Telecommunications and Computer Engineering (TCSET), pp: 1174-1178.
8. Mohamed El-Ghoboushi; Atef Ghuniem; Abdel-Hamid Gaafar; Hossam El-Din Abou-Bakr, "Multiple aircrafts tracking in clutter for multilateration air traffic surveillance system" , International Conference on Innovative Trends in Computer Engineering (ITCE), pp: 225-230.
9. Gregory L. Orrell; Angela Chen; Christopher J. Reynolds ," Small unmanned aircraft system (SUAS) automatic dependent surveillance-broadcast (ADS-B) like surveillance concept of operations: A path forward for small UAS surveillance" , IEEE/AIAA 36th Digital Avionics Systems Conference (DASC), pp: 1-10