May-June 2020
ISSN: 0193-4120 Page No. 3766-3771

Smart Unmanned Aircraft Vehicles for Border Surveillance: A Model

Younus Mehraj[1], Rajeev Ranjan[2]

[1,2]School of CSA, REVA University Bangalore, India
[1]younusmehraj38@gmail.com, [2]rajeevranjan@reva.edu.in

Article Info
Volume 83
Page Number: 3766-3771
Publication Issue:
May-June 2020

Article History
Article Received:*19 November 2019*
Revised: *27 January 2020*
Accepted: *24 February 2020*
Publication: *12 May 2020*

Abstract
In this work, a border surveillance solution, composed of a unmanned aircraft vehicles (UAVs) has been proposed to enhance the border security. The work is also focus on the detection and study of any node or network failures, the working of the sensor nodes which have been used to track of any trespasser, the sense and transmit to the base-station of real-time movement and location. Together with the design of the electrical, and software architecture of the UAV, Multiple Sensors techniques have been proposed to accurately localize terrestrial sensors technology. The development of this UAV prototype is tested to provide suitable and exact values of parameter to reduce Line of Control (LOC) disputes, prevents illegal entries and helps in risk-free border surveillance of a country.

Keywords: *Unmanned Aircraft Vehicles (UAVs); border surveillance; Sensors; Model*

1. Introduction

The UAV is an assistive device which has a high demand in the surveillance sector [1]. As the technology has matured and become more important, a number of practical and very interesting uses of UAV technology have emerged [2, 3]. The most common application (fig: 1) of UAV is event or node detection [4, 5]. Zhang & Kovacs [6] has developed an application for farmers to monitor and analyse the crop behaviour in the field with camera sensors. This system will either use a motion sensor [7] camera and radars for identification of object based on the data gathered. Apart of this, UAVs have been used in many applications like environmental monitoring [8], coastal surveillance [9], Path finding and planning [10, 11], Fire detection and monitoring [12], 3D modelling[13], intelligent transportation systems[14], air and water pollution detection[15],post-disaster assessment[16] and many more.

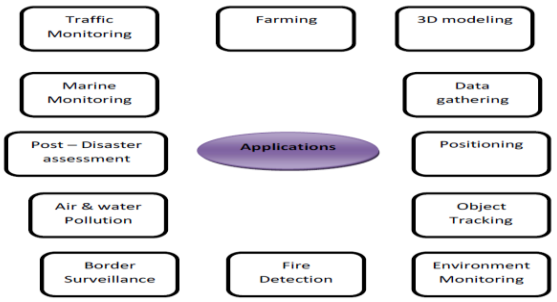

Figure 1: Applications of UAVs

The present work includes the design and development of the UAV using KK 2.1 Multi-Rotor Control Board [17]. This system will be controlled by a remote system or a transmitter by sitting inside our Camp, office or any place within its transmitter range. This concept will thus facilitate surveillance activities. The UAV is useful for in many situations. From the scope of the UAV, it's used for aerial photography, security and rescue, LOC security inspection and much more [18-19]. The result of this work will help reduces LOC disputes, prevents illegal entries and helps in risk-free border surveillance of country practice, the UAV is being used for object detection

May-June 2020
ISSN: 0193-4120 Page No. 3766-3771

through image processing in border security of the nation.

Rest of the paper is organized as follows: In Section II, we list some related works towards the different UAV based approach. In Section III, we describe the system design and other details of the proposed model. Section IV discusses the results obtained, with the conclusion in the last section.

2. Related Work

Existing System

Earlier day's LOC border surveillance was managed manually [20]. It required a large number of armed forces on surveillance to detect intruders or any type of intruders crossing the Line of control. The armed persons while patrolling must perform their duty very carefully. Even a single mistake would be dangerous for them. To cop up this, the researchers have developed the UAVs to automate the border surveillance. In recent times, UAVs have gone through a rapid development because they made possible to access and monitor the area where human intervention is least possible. Recent developments focus not only the military applications but also the civil applications. It has been referred in the various works under various names as UAVs, quadcopters, aerial drones and aerial robots etc. The section discusses the most recent and prominent non- military as well as working international borders monitoring and surveillance systems. Table 1 shows the development of UAVs in the recent times for different applications.

To supervise the LOC in real-time with high accurateness and minimize the need for human support, numerous surveillance technologies, which complement each other, are proposed. Nonetheless, a minor hindrance of the existing systems include insufficient performing potential , node -connectivity, visceral lethargy of territory agents, and insufficiency of quick-acknowledge circumstantial alertness competence. There exists a large number and variety of potential problem. Surveillance operations parameters may be different during peace and war conditions. The UAVs and WSN should work together. In this scenario, many environment parameters will play a major role and cause distraction. Threat recognition and identification can be made more complex using secret technologies. The area under surveillance is typically vast and requires significant network and hardware resources to provide complete coverage.

Table 1: Background of the proposed work

Work	Details of work	Pros	Cons
Yi & Yoon [21]	Proposed a technique to improve the network connectivity and the data collection quantity in WSNs by using a mobile sink with wireless power transfer capabilities	Improved network connectivity	Node size is less
Bhadwal *et al.* [23]	Border surveillance system with pyro-electric infrared sensors (PIR) and video cameras	Improve the basic security at border areas.	Advanced features like automated drones have not implemented
Yanmaz *et al.* [24]	Proposed architecture for aerial drone system consisting with laser-scanners, ultrasonic sensors and camera sensors and embedded processing and networking capabilities.	Suitable for monitoring, traffic and disaster management	Not suitable for border surveillance due to communication challenges
Gharibi *et al.* [25]	Proposed layer architecture for drone networks which works in a zone with cloud	Layered approach provides flexibility, maintainability, and scalability	It will increase the network overhead with WSN
Algabri *et al.* [26]	Proposed a fuzzy logic based moving object tracking system to monitor the crowds participating in Hajj ceremony	Can detect a object of different colour and different size and shape which is moving in front of the camera of the drone.	The system can track the object within 8m
Berrahal *et al.* [27]	A border surveillance technique is proposed which uses unmanned aircraft vehicles (UAV) as mobile sink to detect and investigate of WSN failures, and the maintain potential for the deployed network	A scheduling algorithm has been proposed to optimize the monitoring task by increasing the level of detected intruders seen by the drone.	UAVs as mobile sink have limited energy

May-June 2020
ISSN: 0193-4120 Page No. 3766-3771

Küçükkeçeci *et al.* [28]	Proposed a big data based object surveillance technique. The technique is based on graphs and a multilevel fusion.	Unsupervised learning based object tracking approach, developed using the data model based on graph theory.	Cannot work with heterogeneous sensor nodes
Laouira *et al.* [29]	A multi layer WSN based solution for surveillance and monitoring borders against trespassers.	The proposed work combines multidirectional cameras, sensors , Radars and Quadcopter to trim down the deployment and maintenance costs of the surveillance task.	Connectivity due to node failure is a concern
Benzerbadj *et al.* [30]	Proposed a border surveillance system for sensitive and tensed areas using WSN with asymmetric links.	Provided a MAC protocol with WSN that is based on algorithms which rely about radio to path packets to the sink node	The proposed work has not taken into the account of the case of security lapses, non uniformity on the sensing quality as well as the lifetime.

3. System Development

This proposed model is designed to monitor the border areas and find and trace intruders (using motion sensors), to guide military troops, and to sense the object of the occurred events from a long distance. The collected data will be received by the processor and transmitted to the controller via Node MCU (Esp8266). The data is transmitted via Node MCU to be analyzed. These data are displayed on IoT system using Wia application. The controller monitors the UAV device via remote communication and controls its movement of the system. The designed UAV would facilitate the intervention in unreachable areas to minimize the threat of losing human lives, building and save the border areas from intruders.

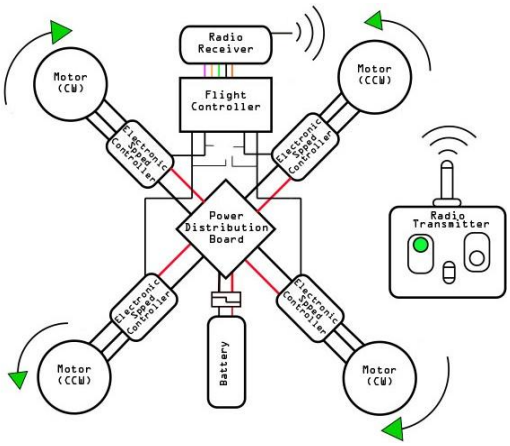

Figure 2: System Architecture

Module Description

UAV: The UAV subsist of a four-fixed DC motors settled at the ends of a bisect-fashion frame. Figure 1 shows a simplified of a proposed UAV helping to understand how it works. The two motors 1 and 3 (front and back) rotate directional generating a force, while two motors number 2 and 4 (right and left) rotate bi-directional. These motors produce an antagonistic force which results in a equitable to force across the UAVs. The four motors would generate equal core when rotating in the same acceleration drive the UAV in the skyward angle.

Figure 3: Schematic diagram of the four rotors on a UAV.

Brushless DC (BLDC) Motors: Brushless DC Motors have certain gain over brushed motors and are high-caliber choice overdue to the dearth of hardware parts and the hooky of brushes, as mentioned before, the BLDC motors are more efficient (converting power-driven to machine-drive energy) than brushed DC motors since attendant are no agitation losses due to the brushes. The motors selected to actuate the Quad-copter are the BLDC outriggers type 1400KV. Weighing each 78 g, these motors are capable of 1400 rpm/Volt, maximum efficiency of 80%, and a maximum current of 30A. Each motor can produce a maximum thrust up to 1000 g +.

May-June 2020
ISSN: 0193-4120 Page No. 3766-3771

Figure 4: A Brushless DC Outrunner Motor.

Electronic Speed Controller (ESC)

Characteristics ECS's are required to run the BLDC motors in the UAV. The required ESC needed to run the motor is 30 A, the Mystery cloud are capable to deliver up to 30 A, which is quite enough and safe. Weighing about 25 g and with a lot of features such as; superior current endurance, protection features, different operating modes depending on the aerial platform used, and a throttle range that can be programmed and compatible with all transmitters.

Figure 5: Electronic Speed Controller (ESC)

Microcontroller Unit (MCU)

The proposed model uses the Hobby King KK2.1 Multi-Rotor controller [17, 32]. It manages the flight of (most) multi-rotor UAVs (Tricopters, Quad copters, Hex copters, octocopters etc). The purpose of these controllers to stabilize the UAVs during the take –off and to do this, it takes signals from onboard gyroscopes. The microcontroller selected for the work is based on certain criteria like, speed of operation, price, memory, number of I/O ports, resources required, and working environments. The micro-controller used with Lithium Polymer batteries.

Figure 6: Microcontroller Unit (MCU)

Transmitter and Receiver

The transmitter used in the work is the same one used in most remote-control (RC) toys. Having multiple channels and user-defined channel mixing makes it a suitable choice. As for the receiver, the R16SCAN is selected. Featuring SCAN technology which enables the receiver to auto-detect the optimum frequency needed without any extra steps. It weighs only 17g.

Figure 7: Transmitter and Receiver

4. Results And Discussion

The Wia Platform with android and Pc applications have been used that controls Arduino and Raspberry Pi Boards over the web. It is computer based dashboard that can be used to build a graphic interface (GUI) for the data by simply using sensors. It collects data through devices using the interface of the app and maintains the graph of condition of motion and sense the compatibility and ability of respond with sensors in every condition. Moreover, it stores the information in server. The sever (i.e Wia server), is an open source based on Java Programming. This is used for sending messages between Wia Mobile App and Wia Dashboard and Boards of different microcontrollers and single board computers (SBCs) (i.e. Arduino, ESP8266 etc.). It stores the data collected by the Wia app which is provided by Motion sensor or any other sensor networks.

May-June 2020
ISSN: 0193-4120 Page No. 3766-3771

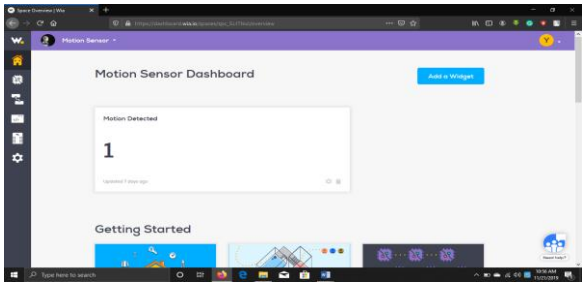

Figure 8: Front Page of Wia APP

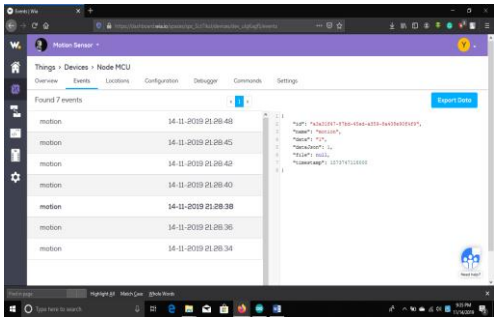

Figure 9: Dashboard of Motion sensor

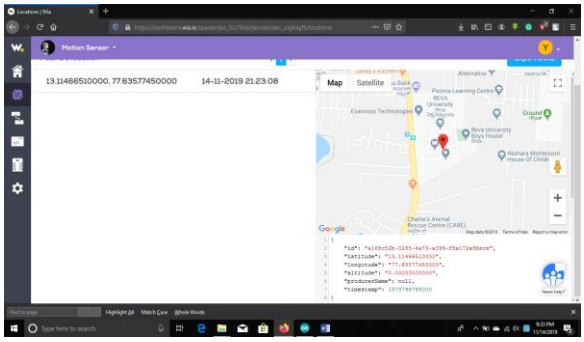

Figure 10: Events

5. Conclusion and Future Scope

There is a concern of organized crime, illegal immigrants and terrorist movement of LoC. The work proposes a model of UAV with WSN for the purpose of border surveillance. The model detects the object/ trespasser and sends the information on the app. The designed UAV detects and covers the network in-connectivity, node and network failures. However, there is a much scope of research in UAVs with WSN as follows:

- Most of the work follows the layered approach which is not suitable with WSN and IoT applications [33].
- The quadcopters or UAVs used in border or marine surveillance need more security.
- The system should alarm early to react on potential threats rather than only sending the information after the event.
- Much scope of research is there in designing the architecture of UAVs for different military and civil application.
- The Internet of Drones (IoD) has become demand of the time for such applications. The IoD can make the network of the drones and UAVs controlled by central or distributed controller.
- There is a need of small, noiseless, resource optimized device that can work in diverse environment like on LoC without much need of line-of-sight for communications.
- The sensor used in drones can perform sensor-fog or sensor-cloud computing which will help in the development of ubiquitous systems in heterogonous environment.

References

[1] Vijayanandh, R., et al. "Design and fabrication of solar powered unmanned aerial vehicle for border surveillance." Proceedings of International Conference on Remote Sensing for Disaster Management. Springer, Cham, 2019.

[2] Navia, Jose, et al. "Multispectral mapping in agriculture: Terrain mosaic using an autonomous quadcopter UAV." 2016 International Conference on Unmanned Aircraft Systems (ICUAS). IEEE, 2016.

[3] Akatyev, Nikolay, and Joshua I. James. "Evidence identification in IoT networks based on threat assessment." Future Generation Computer Systems 93 (2019): 814-821.

[4] Tisdale, John, et al. "A multiple UAV system for vision-based search and localization." 2008 American Control Conference. IEEE, 2008.

[5] Chmaj, Grzegorz, and Henry Selvaraj. "Distributed processing applications for UAV/drones: a survey." Progress in Systems Engineering. Springer, Cham, 2015. 449-454.

[6] Zhang, Chunhua, and John M. Kovacs. "The application of small unmanned aerial systems for precision agriculture: a review." Precision agriculture 13.6 (2012): 693-712.

[7] Dueckman, Leonard Rudy. "Method and an apparatus for controlling a machine using motion based signals and inputs." U.S. Patent No. 9,199,825. 1 Dec. 2015.

[8] Manfreda, Salvatore, et al. "On the use of unmanned aerial systems for environmental monitoring." Remote sensing 10.4 (2018): 641.

[9] Green, David R., et al. "Using low-cost UAVs for environmental monitoring, mapping, and modelling: Examples from the coastal zone." Coastal Management. Academic Press, 2019. 465-501.

[10] Sujit, P. B., and Randy Beard. "Multiple UAV path planning using anytime algorithms." 2009 American control conference. IEEE, 2009.

May-June 2020
ISSN: 0193-4120 Page No. 3766-3771

[11] Cabreira, Tauã M., et al. "Grid-Based Coverage Path Planning With Minimum Energy Over Irregular-Shaped Areas With Uavs." 2019 International Conference on Unmanned Aircraft Systems (ICUAS). IEEE, 2019.

[12] Sudhakar, S., et al. "Unmanned Aerial Vehicle (UAV) based Forest Fire Detection and monitoring for reducing false alarms in forest-fires." Computer Communications 149 (2020): 1-16.

[13] Iglesias, Luis, et al. "Using Small Unmanned Aerial Vehicle in 3D Modeling of Highways with Tree-Covered Roadsides to Estimate Sight Distance." Remote Sensing 11.22 (2019): 2625.

[14] Menouar, Hamid, et al. "UAV-enabled intelligent transportation systems for the smart city: Applications and challenges." IEEE Communications Magazine 55.3 (2017): 22-28.

[15] Lu, Yi, et al. "A UAV-mounted whole cell biosensor system for environmental monitoring applications." IEEE transactions on nanobioscience 14.8 (2015): 811-817.

[16] Ezequiel, Carlos Alphonso F., et al. "UAV aerial imaging applications for post-disaster assessment, environmental management and infrastructure development." 2014 International Conference on Unmanned Aircraft Systems (ICUAS). IEEE, 2014.

[17] Hernandez-Martinez, E. G., et al. "Trajectory tracking of a quadcopter UAV with optimal translational control." IFAC-PapersOnLine 48.19 (2015): 226-231.

[18] Hanafi, Dirman, et al. "Simple GUI wireless controller of quadcopter." (2013).

[19] Zaheer, Zainab, et al. "Aerial surveillance system using UAV." 2016 Thirteenth International Conference on Wireless and Optical Communications Networks (WOCN). IEEE, 2016.

[20] Berrahal, Sarra, et al. "Border surveillance monitoring using quadcopter UAV-aided wireless sensor networks." (2016): 67-82.

[21] Yi, Jun Min, and Ikjune Yoon. "Efficient Energy Supply Using Mobile Charger for Solar-Powered Wireless Sensor Networks." Sensors 19.12 (2019): 2679.

[22] Rizwan, Raffay, Muhammad Naeem Shehzad, and Muhammad Naeem Awais. "Quadcopter-Based Rapid Response First-Aid Unit with Live Video Monitoring." Drones 3.2 (2019): 37.

[23] Bhadwal, Neha, et al. "Smart Border Surveillance System using Wireless Sensor Network and Computer Vision." 2019 International Conference on Automation, Computational and Technology Management (ICACTM). IEEE, 2019.

[24] Yanmaz, Evşen, et al. "Drone networks: Communications, coordination, and sensing." Ad Hoc Networks 68 (2018): 1-15.

[25] Gharibi, Mirmojtaba, Raouf Boutaba, and Steven L. Waslander. "Internet of drones." IEEE Access 4 (2016): 1148-1162.

[26] Algabri, Mohammed, et al. "Wireless vision-based fuzzy controllers for moving object tracking using a quadcopter." International Journal of Distributed Sensor Networks 13.4 (2017): 1550147717705549.

[27] Berrahal, Sarra, et al. "Border surveillance monitoring using quadcopter UAV-aided wireless sensor networks." (2016): 67-82.

[28] Küçükkeçeci, Cihan, and Adnan Yazici. "Multilevel object tracking in wireless multimedia sensor networks for surveillance applications using graph-based big data." IEEE Access 7 (2019): 67818-67832.

[29] Laouira, Mohammed Lamine, et al. "An efficient WSN based solution for border surveillance." IEEE Transactions on Sustainable Computing (2019).

[30] Al Fayez, Fayez, et al. "Assessing the effectiveness of flying ad hoc networks for international border surveillance." International Journal of Distributed Sensor Networks 15.7 (2019): 1550147719860406.

[31] Bappy, A. M., et al. Design and development of unmanned aerial vehicle (Drone) for civil applications. Diss. BRAC University, 2015.

[32] Ranjan, Rajeev, and Shirshu Varma. "Challenges and implementation on cross layer design for wireless sensor networks." Wireless personal communications 86.2 (2016): 1037-1060.