ISSN No: 2349-059X
Peer Reviewed & Refereed Journal
National Research Journal

COLLISION DRONE TRAFFIC CONTROL SYSTEM USING SWARM TECHNOLOGY

[1]Poonam Navale

[1]Student, Department of E&TC Engineering, Sinhgad Institute of Technology, Kusgaon, Pune, Maharashtra

[2]Sanskruti Choudhari

[2]Student, Department of E&TC Engineering, Sinhgad Institute of Technology, Kusgaon, Pune, Maharashtra

[3]Ashwini Dandekar

[3]Student, Department of E&TC Engineering, Sinhgad Institute of Technology, Kusgaon, Pune, Maharashtra

[4]V.D Raskar

[4]Department of E&TC Engineering, Sinhgad Institute of Technology, Kusgaon, Pune, Maharashtra

ABSTRACT

Drones are popular not only as recreation for enthusiasts but also as a tool with huge potential to achieve a superior, efficient and accurate method of surveillance, sought after by different security agencies. Commonly, the word "Drone", in its most basic technical sense, means an unmanned aircraft i.e., a flying robot with a remote controller. They can be further augmented with GPS, cameras, various sensors, and specialized programs such as autopilot, etc. for increasing their usefulness in data collection and aerial monitoring.

Swarm technology, inspired by the collective behaviour of social organisms like ants, bees, and birds, is employed to enable drones to autonomously coordinate their movements in real-time, ensuring safe and efficient air traffic management. By using decentralized, communication-based interactions, drones within the swarm can dynamically adjust their positions, speeds, and trajectories to avoid collisions and adapt to changes in their environment, all while minimizing human intervention.

The CDTCS utilizes advanced algorithms based on swarm intelligence, including consensus protocols and real-time data exchange between drones. Each drone in the system is equipped with sensors (e.g., LIDAR, cameras, radar) and communication modules, enabling it to detect nearby drones, assess potential collision risks, and share this information with other drones in the swarm. The drones collectively make decisions to alter their paths, avoiding congestion and dangerous encounters without the need for centralized control, thus increasing scalability and flexibility.

The system also integrates with existing airspace management protocols, such as geofencing, no-fly zones, and communication with air traffic control (ATC), to ensure compliance with aviation regulations and safe integration with manned aircraft. The swarm-based approach allows for real-time collision prediction, dynamic route optimization, and seamless drone traffic flow, particularly in urban or high-density environments.

This project demonstrates that swarm technology can significantly improve the safety, scalability, and efficiency of drone operations in congested airspaces, making it an essential component of future drone traffic control systems and urban air mobility solutions.

Keywords:

- Drone Traffic Control
- Swarm Technology
- Collision Avoidance
- UAV Coordination
- Real-time Traffic Management
- Autonomous Flight Paths
- Swarm Intelligence
- Decentralized Algorithms
- Trajectory Optimization
- Machine Learning

INTRODUCTION

This project aims to develop a compact Micro Drone with integrated **"Collision Drone Traffic Control System Using Swarm Technology".** The primary objective is to create a small, agile drone capable of navigating confined or densely populated spaces by detecting nearby obstacles, which reduces the risk of collision and enhances operational safety.

This project addresses these limitations by introducing the near future the world is going to be surrounded by innumerable Drone for different conventional and non - conventional applications and hence it is an ultimate problem to be solved to avoid maximum number of accidents that can happen with the growing number of drones in the open air.

The main purpose of implementation of this project is to increase human safety by reducing the accidents due to drones. Swarm robotics is implementation of Swarm intelligence. Swarm Intelligence (SI) is an artificial intelligence technique based around the study of collective behavior in decentralized, self- organized systems.

In summary, this project aims to develop a versatile and practical drone solution for environments where larger drones cannot safely operate. By integrating Swarm technology, the micro drone can navigate safely, reducing the risk of collisions and expanding its usability. This approach emerged on the field of artificial Swarm

OBJECTIVE - COLLISION DRONE TRAFFIC CONTROL SYSTEM:-

This project aims to **"Collision Drone Traffic Control System using Swarm Technology"** project is to design and implement a system that enables a fleet of drones to safely and efficiently navigate shared airspace. The primary goals of such a project include:

Collision Avoidance: Use swarm intelligence algorithms to ensure drones avoid collisions with each other and other obstacles (e.g., buildings, trees, or other flying objects) in real-time.

Autonomous Navigation: Implement autonomous decision-making capabilities that allow drones to adapt to changing environments, optimize flight paths, and respond to dynamic obstacles without human intervention.

Cooperative Behaviour: Leverage swarm technology to facilitate cooperation between drones, allowing them to share information and adjust their trajectories in real-time, optimizing overall system efficiency and safety.

Scalability: Ensure the system can handle large fleets of drones, coordinating traffic across different regions or urban airspaces, while maintaining safety and optimal operational performance.

PROJECT STATEMENT :-

The integration of **Swarm Technology** with micro drones has the potential to revolutionize environmental mapping, surveying, and infrastructure inspection. Drones, operating autonomously, must navigate through dense urban environments or vast rural areas without colliding with other drones, obstacles, or restricted airspace. Traditional air traffic control systems are not designed to handle the dynamic and high-density nature of drone traffic.

Furthermore, ensuring the safety, efficiency, and scalability of drone operations in such environments poses a significant challenge. The core problem is the **lack of an intelligent, scalable, and autonomous traffic control system** that can coordinate large fleets of drones, prevent collisions, optimize flight paths, and ensure safe operation in real-time.

There is a need to develop a **swarm-based drone traffic control system** that incorporates **distributed decision-making, cooperative behaviour, and collision avoidance algorithms.** This system must allow drones to self-organize and adapt to dynamic environments while ensuring safe and efficient operation in real-time.

BLOCK DIAGRAM :-

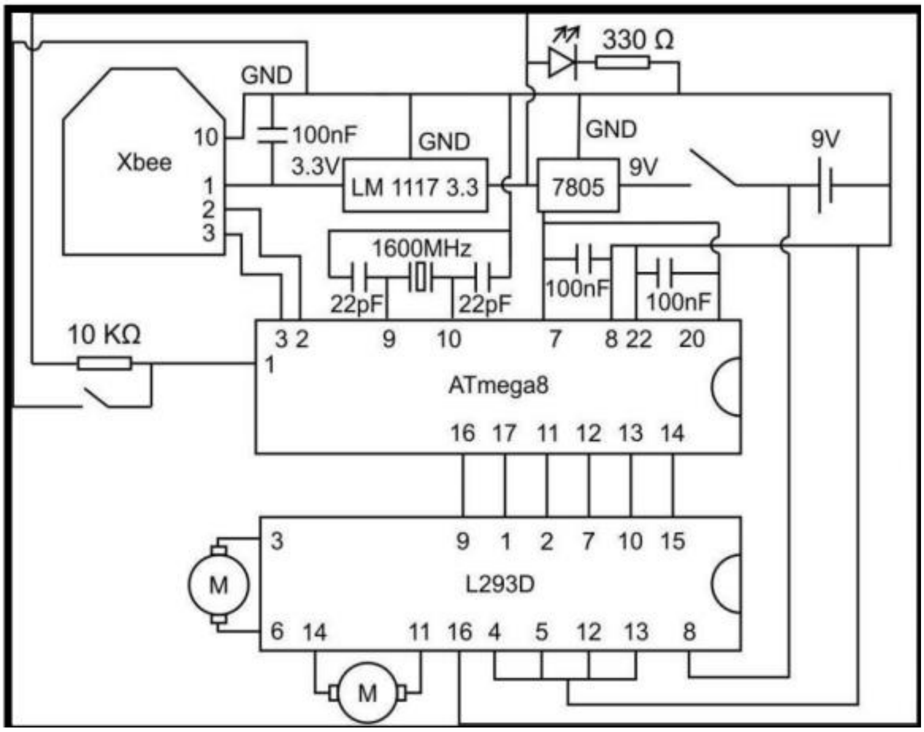

Fig.1

METHODOLOGY, DESIGN AND IMPLEMENTATION

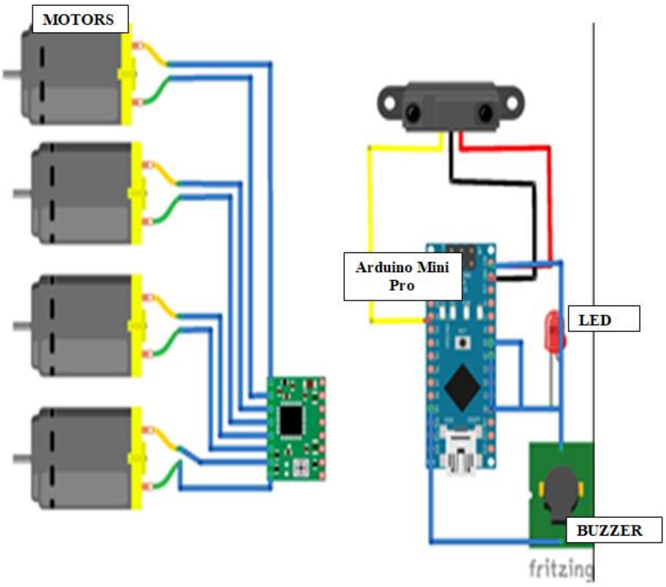

Fig.2

HARDWARE SPECIFICATIONS ;-

MCU - Tensilica Extensa LX 106

802.11 b/g/n Wi-Fi - Xtensa Dual-Core 32-bit

Bluetooth - Yes, HT40

Typical Frequency - Bluetooth 4.2 and below

SRAM - 160MHz

Flash - 512 kbytes

GPIO - SPI Flash,up to 16 MBytes

Hardware/Software PWM - 36

SPI/12C/12S/UART - 4/2/2/2

AD - 1/16 Channel

CAN - 12-bit

Ethernet MAC Interface- 1

Touch Sensor - Yes

Temperature Sensor - Yes

Working Temperature - -40c

Software Specifications ;-

- Development in Embedded C
- Implementation of BLE using RTOS
- Use of Arduino IDE
- Blynk Cloud IoT Platform for App Development

CONCLUSION AND FUTURE ENHANCEMENTS

This concept has various applications in huge industries like Automobile Industry and Warehousing. At present, while performing a particular task as one robot is performing its work the rest of the robots are idle waiting for the first robot to complete its work which results in slow processing of the assigned task. Using the concept of 'Swarm Robotics' less number of robots can complete the assigned task collectively in less amount of time which also in turn increases the efficiency and the output at same time reducing the cost.

The turn cost plays a vital role in the functioning of the client robot. Efficient use of the Zigbee buffer must be done. Collision avoidance is the most important task that must be worked upon.

ACKNOWLEDGMENT ;-

We take this opportunity to thank our project guide prof. V. D. Raskar and head of the department prof. Dr. D. S. Mantri for there valuable guidance and for providing all the necessary facilities, which were indispensable in the completion of this project report. We are also thank full to all the staff members of the department electronics and tele. communication of sinhgad institute of technology for their valuable time, support, comments, suggestions and persuasion. The authors are grateful to the Sinhgad Institute Of Technology Lonavala, Pune, for giving facilities during the preparation of this research paper.

REFERENCES

1. [1] A Review of Studies in Swarm Robotics, L. Bayindir and E. Sahin, Turkish Journal of Electrical Engineering and Computer Sciences, VOL. 15, NO.2 2007.
2. [2] Bio-Inspired Sensor Swarms to Detect Leaks in Pressurized Systems, Fronczek, J.W.; Prasad, N.R., Man and Cybernetics, 2005 IEEE International Conference on Volume 2, 10-12 Oct. 2005 Page(s): 1967 - 1972 Vol. 2 Digital Object Identifier 10.1109/IC- SMC.2005.1571435.
3. [3] Autonomous Underwater Explorers, J. Jaffe, C. Schurgers, WUWNet '06: Proceedings of the 1st ACM international workshop on Underwater Net-works September 2006 Publisher: ACM.
4. [4] Distributed Surveillance Sensor Network (DSSN), http://www.nosc.mil/robots/undersea/dssn/dssn.html SPAWAR Systems Center, San Diego, June 2006.
5. [5] A Survey of Practical Issuesin Underwater Networks, J. Partan, J. Kurose, B. N. Levine, ACM SIGMOBILE Mobile Computing and Communications Review, Volume 11 Issue 4 October 2007 Publisher: ACM