ARCHITECTURE AND APPLICATIONS OF FLYING ROBOT

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ABSTRACT

We are describing the Control System of a flying robot using Fuzzy logic. We can create a fuzzy logic controller to move a robotic fly through simple courses comprised of goal posts. We have to focus on the following points: To control our flying robot, our logic should be able to work in real time, receiving a video stream and outputting appropriate motor commands. A delay of split seconds can make a difference between successfully achieving goals and, crashing on the ground. Thus we require synchronization between video stream and movement of the robot. So we can use some fast processing techniques like SLAM(Simultaneous localization and mapping technique and parallel computing with graphics processors for execution of this idea. We also need to relay on defuzzification from the fuzzy inputs, we are getting from environment. We need amendments to the old design of flying robots that can be use for application like safety and rescue operations, crime and accident inspection, 3-d Photography of building, wildlife protection etc.

Keywords: Quad copters, Fuzzy logic, SLAM, Multimode robots, autonomous controller.

1. INTRODUCTION

The aim of our paper is create a small, light weighted and intelligent flying robot that work upon a frequency of 1 kHz. This 1 kHz frequency flying robots are contrast to other commercial and research platform. For providing flight to the robot we have to implement robot brain which can take decisions according to situations and react accordingly. Now we talk about the starting and stop of the flying robot. From start point the robot will start its flight for the destination. Destination image should be captured in the memory of the robot. By using some matching procedure (complex/approximate fuzzy logic) whichever is most efficient in implementation. The robot carries a laser sensor, camera, communication device, computer, and LED lamps among others. For power supply it will contain a battery reserve that allows it to fly non-stop for approximately 15-20 minutes. Our flying platform offers a 1 kHz control frequency and motor update rate, in combination with powerful brushless DC motors in a light-weight package. Having such a high control frequency allows us to create an extremely stable platform, even with payloads of up to 350g.

Fig 1: Intelligent Flying Robot

This Intelligent Flying robot also known as Quad copter. It uses the concept of Fuzzy logic and basic mechanism of Slam, Autonomous controller. The concept of fuzzy logic used is to solve the problems that are filled with ambiguous data. The fuzzy logic based control is mainly employed in the complex robot control applications which reduces design development phases, simple and faster design methodology, solution to
nonlinear control systems. Fuzzy logic control system can be used for both controlling robots as well as adding intelligence to application.

The purpose of using SLAM are used to determine a location within an environment and to depict an environment for planning and navigation; they support the assessment of actual location by recording information obtained from a form of perception and comparing it to a current set of perceptions.

These Quad Copter control the system by Autonomous controller which defined as a device that can initiate the sending of alarms and other data by embedded Web, FTP, and e-mail functions over an Intranet or the Internet. Autonomous controller have the power and ability for self governance in the performance of control function of flying robots.

In the previous study[1] of quad copter we have seen that four rotor flying robot operated by Commands or instruction given by PC. These commands are transfer to Quad copter using antennas. In this system decision making is not entertained by this quad copter.

![Old System Structure of Four Rotor Flying Robot](image)

In Contrast with the previous study this paper estimate the motion of each flying robot individually using onboard autonomous controller and technique of SLAM. This flying Robot equipped with Cameras, Sensors, GPS and audio sensor. This paper also introduced the various major applications in rescue operation, crime prevention, wildlife protection etc.

### 2. SYSTEM STRUCTURE OF INTELLIGENT FLYING ROBOT

![Complete architecture of the flying robot](image)

The robot generates the video and IMU data where former data of the slam are also preserved. Hence comparison of present slam data with the former data sensor, voice detector and autonomous controller are used to command the robot.
The main feature of the system is SLAM:

Simultaneous localization and mapping (SLAM) is a technique used by robots and autonomous vehicles to build up a map within an unknown environment (without a priori knowledge), or to update a map within a known environment (with a priori knowledge from a given map), while at the same time keeping track of their current location. Maps are used to determine a location within an environment and to depict an environment for planning and navigation; they support the assessment of actual location by recording information obtained from a form of perception and comparing it to a current set of perceptions.

Autonomous controller in flying robots can be defined as a device that can initiate the sending of alarms and other data by embedded Web, FTP, and e-mail functions over an Intranet or the Internet. Autonomous controller have the power and ability for self governance in the performance of control function of flying robots.

3. GENERAL DESIGN

![Diagram of the height controller](image)

**Fig 4: Controller Structure of the height controller**

The fig. shown that The transmitter we used is a standard model helicopter R/C. However, we had to modify the internal electronics using another AVR microcontroller to connect it to the laptop. This system has a user interface for developing the position controllers which enables debugging, testing and optimization step by step. An automatic controller compares the actual value of the plant output with reference input, it determines the deviation and produces control signal that will reduce the deviation to zero or to small value. After obtain of desired height this give negative feedback which pass through derivative controller which can be split into three different gain which are Kp called proportional gain, Kd called derivative gain, ki called integral gain. Here kp, the proportional controller is that it can bring the system to stability, in this a steady state error is always present with proportional controller. Ki stands for integral gain, the advantage of integral controller is that it minimizes the steady state error equal to zero, Kd is derivative gain, high differential gain causes of unstability that is compensate by negative feedback.

![Diagram of the X and Y position controllers](image)

**Fig 5: Controller structure of the X and Y position controllers**
The X-axis and Y-axis controllers are identical and were more challenging to derive. The system is harder to control in these degrees of freedom since there is no proportional behavior response. The inputs of the onboard controllers are proportional to the rotational velocity in pitch and roll, but they are not directly proportional to horizontal speed. The outer controller cascade is a PD-controller whose output is the desired speed for travel to the desired position.

4. WORKING OF QUAD COPTER

A quadcopter, also called a quadrotor helicopter, quadrocopter is a multicopter that is lifted and propelled by four rotors. Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of revolving narrow-chord airfoils. More recently quadcopter designs have become popular in unmanned aerial vehicle (UAV) research. These vehicles use an electronic control system and electronic sensors to stabilize the aircraft. With their small size these quadcopters can be flown indoors as well as outdoors.

There are several advantages to quadcopters over comparably-scaled helicopters. First, quadcopters do not require mechanical linkages to vary the rotor blade pitch angle as they spin. This simplifies the design and maintenance of the vehicle. Second, the use of four rotors allows each individual rotor to have a smaller diameter than the equivalent helicopter rotor, allowing them to possess less kinetic energy during flight. This reduces the damage caused should the rotors hit anything. For small-scale UAVs, this makes the vehicles safer for close interaction.

Fig 6: Quad copter having four rotators

Fig 7: Working of rotators in quad copter

5. SERVICES OF FLYING ROBOTS

Air-ground localisation and map augmentation generating 3-d environment:

In this application we consider a single flying robot that acts as a flying eye for a ground robot. This operates in close distance to the ground robot and offers the ability to move in the complex three dimensional environments.
and observe the scenario from a point which is inaccessible to the ground robot. The use of very small and lightweight flying robots reduces safety concerns, costs and increases the agility of the platform.

**Fig 8: Creating a scene where flying robot autonomously localized w.r.t. ground robots based on the structure of scene**

On the other hand the ground robot can carry more payloads such as active depth sensors, processors and may be equipped with a manipulator arm. Due to payload restrictions, the flying robot is equipped with a single downward-looking camera whereas the ground robot has a range sensor (either a laser or an RGDD camera) and further carries the main processing unit. Hence both ground robots and flying robots combined their captured pictures and make a 3-D picture of environments and that can be further analyzed for rescue purpose, building and bridges construction etc.

Flying robots equipped with modern cameras provide detailed aerial photographs of the crime or accident scene. Any trace or evidence can be documented in high-definition. Unlike traditional methods, data and evidence can be collected from the air so that traces are not destroyed and evidence is not altered.

**Fig 9: Evidence captured by flying robots**

Even during rescue operations, it becomes important to secure traces. Flying robots provide an overview of a particular rescue situation and allow for better planning in the rescue environment without entering the area. Compared to manned helicopters, flying robots do not create strong air turbulence. The copter can navigate over the site quietly and safely via remote control. Video goggles, displaying live images recorded by the robot, allow for the so-called FPV (first person view) flight in which the pilot can fly the copter from the perspective of the aircraft, just like a pilot in the cockpit. If the navigation fails during the flight, the flying robot returns automatically to its starting point.

**Fig 10: Overview of damaged Area**
During avalanches, earthquakes, landslides and other natural disasters, the conditions are often very confusing. Many areas are difficult to access, and cannot be viewed without the risk. At such moments, flying robots can help quickly: they provide detailed aerial photographs of destroyed buildings, landscapes and streets, help to track down missing people, and document damages.

After accidents, fires, earthquakes, landslides or flood damage, rapid action is required. Detailed knowledge of the facts and documentation becomes top priority. Highly advanced robots, cameras and sensors can be launched into the air in no time to collect images and to record findings – necessary for expert interpretation.

**Application of flying robot in tracking:** In this perspective of this application we focus on tracking and making plan for further operations.

One of the such application of tracker and planning focus on using air and ground vehicles to locate and rescue hostages being held in a remote building. Hence the along with navigation planning by the robot is entertain so that ground vehicles and air vehicles can reach to the remote where hostage are being held. Therefore a successful planning is required where using audio sensor, vision control etc. help in capturing the present scenario and ground and air vehicles can enter the location without being captured by opposite party. In such way rescue operation for these hostages can be performed.

These Audio and video sensors are also have necessity in wildlife protection. Because in protecting themselves from predators, fawns, hares, nesting birds and other animals seek tall grassland or crops. Often, this has a fatal outcome. It is estimated that 100,000 fawns are killed from agricultural machinery every year. In most cases, the driver cannot spot wildlife in the dense field from the cabin of his large machine. Flying robots, equipped with infrared cameras can detect these animals in pastures and fields from the air and rescue them in time. If they are
not visible even in cameras the sound detector or audio sensor can sense the voice of animal and can estimate the location of these creatures. Hence a planning can be done so that in which direction the vehicles should be diverted and in such a way these animals’ lives can be protected.

**Fig 14: Estimating the location of wild animals**

Accidents with wild life can become expensive: damage of tools and equipment, fines on hunting territory lessees, possible lawsuits and breaches of the Animal Welfare Act are often the result of wildlife accidents in agriculture and forestry. Undiscovered carcasses also lead to bacterial contamination of silage. If the silage is for livestock, botulism and other diseases may follow. Such aftereffects can be avoided successfully by the use of a flying robot which will track these animals and help in making documentation so that regular inspection become easy for the forest departments.

In case of chemical spills or fires, an investigation from the air has numerous advantages. Instead of rescue workers, flying robots can study the situation. Equipped with special sensors, they provide measurements of smoke and gas concentrations in the air.

Unmanned aerial robots fly programmed GPS routes independently, and deliver useful images. Alternatively, they can be manually controlled from a safe distance. Within a short time, areas that are difficult to access, can be studied. The obtained aerial photos offer information about the risk rescue teams may face and what precautions to take. Plus, the aerial robots can carry light goods, such as life jackets, water bottles and bandages.

6. CONCLUSION AND FUTURE SCOPE

In this paper we have presented a solution for an intelligent Flying robot which control its direction by its own. Our solution also contains a flying quad copter along with GPS system, camera and audio sensor. The key innovation is a platform capable of very high update rates and the development of simple, adaptive, and highly optimized controllers. Our goal is to improve the architecture so that it is beneficial for the human kind as well as wildlife. In this paper we have covered many applications such as hostage rescue, wild life protection. Our plans for the future include testing the platform in combination with acceleration sensors for dynamic and aerobatic maneuvers such that these flying robots can be used for day to day life such as newspaper distribution, jogging companion etc. We also plan to continue our work with a second generation platform offering even longer flight times and larger payload capabilities so that we do not require the ground robots and making ease in forming 3-D images. Ultimately, we wish to see this platform used as a mobile node in mobile sensor networks that use cameras for mapping, monitoring, and tracking. We also see future of robots in wireless network without GPS system. These preliminary experiments show promise for using our approach in the development of a practical aerial mobile sensor networks.

REFERENCES

