I.M.A.V(Insect like Miniature Aerial Vehicle)

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***Abstract*-This work focuses on incorporating a novel technology in the field of drone operation. The inspiration came from an unlikely place, in the movie *Harry Potter and the Philosopher's Stone*. Whether it is for covert or recon operations drones are set to play a major role in the near future. Drones are even being used during combat for air support. Drones are more formally known as Unmanned Aerial Vehicles (UAV). They can either be autonomous or remote controlled. The simple reason for the ascension of drone technology is that it minimizes the involvement of humans thereby ensuring their safety. The proposed model involves the usage of artificial muscle as 'wings' for the drone. These are materials which can reversibly contract, expand or rotate within one component on the application of an external stimulus (Voltage). Tiny, lightweight sensors can also be integrated to detect the presence of hazardous chemicals which could endanger human life .The advantage of the proposed work is its appearance; possessing wings and being small in size it possess the much vaunted stealth capability since it is not too dissimilar from the appearance of an insect making it incredibly difficult to identify and detect.**

***Index terms* - Piezo-electric actuators, drone technology.**

I. INTRODUCTION

An effective flying design a safe bet is to study the mechanism being used by a dragonfly. One reason for it is because it's a comparatively simple flying creature it doesn't change the shape of its body or wings when flying taking off or gliding as a bird does. The dragonfly's method of flying is completely different from the smooth flight of airplanes and soaring of birds. Its mode called "unsteady aerodynamics" which means there is constant turbulence around its wings. There is a significant variation in the flight kinematics of a dragonfly because of the usage of two pairs of wings which can be controlled independently. Effective mimicking of this kinematics allows for excellent maneuverability which potentially enhances the flight performances. Harnessing turbulence applying this principle to aerodynamic design is still a bit complicated with today's technology because execution must be simple and predictable. There has been significant research into the creation and characterization of flexure-based micromechanical devices [1]. More immediate application of what is being learnt; dragonfly's flight could be to modify existing airplane wings to give extra lift when needed. In this age of advanced warfare where stealth get top priority and the increased usage of drone technology for the purpose of surveillance and espionage, drones which resemble creatures of nature are unlikely to be noticed easily.
However there is a certain level of difficulty involved in quantification of the flight motion of small insects due to their high wing beat frequencies [2]. Artificial muscles as known as piezoelectric actuators are used for the wings of the drone. Piezoelectric actuators exhibit a change in size or shape when stimulated by an electric field.These piezoelectric polymers undergo a large amount of deformation while sustaining large forces. The piezoelectric actuator is a thin ceramic strip which contracts when an electric field is run across it. The actuators are created with the SCM process: First, individual lamina [PbZrTiO3(PZT)-5H and M60J carbonfiber/cyanate ester resin] are laser-micro-machined into desired shapes.

II. EXISTING MODEL

A team of research students of Harvard led by Prof. Robert J.Hood worked on a Robo-bee project where they developed a miniature drone which mimics the flying mechanism of an insect. The drone had two wafer- thin wings that flap at 120 times per second. These wings were controlled by piezoelectric actuators. Thin hinges of plastic embedded within the carbon fiber body frame serve as joints, and a delicately balanced control system commands the rotational motions in the flapping wing robot. Each of the wings is controlled independently in real-time. This was the first major attempt in which a drone employing insect-like flying mechanism was able to hover above the ground for a limited period of time. This miniature drone was tethered by a wire to the power supply thus limiting its flying range. The commands which are required for the drone to fly were sent from an external controller and not from an on-board chip. This model consists of two wings which might be adequate when flying in a less turbulent atmosphere. In a more turbulent atmosphere two wings might not be sufficient for a drone which weighs negligibly low.

III. Literature Survey

[3] Christopher Dileo and Xinyan Deng, 2007 has developed an insect inspired robot which uses gear based mechanism which has many moving parts which are not concealed hence compromising on the stealth factor.
[4] Mr.Kalpesh N.Shah, 2014 et al has proposed a drone model resembling a quadcopter which may produce excessive noise because of the involvement of rotors.
[5]Henri Eisenbeiss, 2011 has developed an autonomous aerial vehicle used for image acquisition which is large in size and can be detected easily.

IV. Proposed Model

The objectives of this paper are as follows,

- To make a drone model that is small enough to fly unnoticed deep inside enemy territory and yet be able to respond and execute each of our commands could be either stored inside the onboard chip or sent wirelessly.
- By adopting the flying mechanism of dragon fly-which has four wings. It would be able to handle more turbulent conditions while maintaining its stability, which is essential for perfect execution of the task which has been assigned to it.
- The high generative forces, low power requirements and fast electromechanical response of piezoelectric polymers makes it a vital component of our proposed model.[6]

V. Components

On-board Components

- Camera:TCM8230MD module
  Size: 6x6x4.5mm
  Operating voltage: 2.6V
  Frames per second (FPS): 30
- Microcontroller: ARM cortex TMPM37AFSQG
  Size: 15x15mm
  Operating voltage: 4.5-5V
- The TCM8230MD is a small, high quality 640x480 CMOS camera from Toshiba with a standard data + 12C interface. It includes RGB color filter along with Auto Shutter Control (AEC), Auto Gain Control (AGC), Auto White Balance (AWB) and night vision capability.
- The TMPM37AFSQG high performance microcontroller which incorporates processing hardware “vector engine” for motor vector control and pre-driver for three phase complementary sine wave drive, in spite of its compact size.
- A Boscam 5.8G 400mW A/V Transmitter module is attached along with the Tx5826 FPV 5.8 GHz micro A/V CL Transmitter antenna which is used to transmit live images and also enables the live streaming of videos.
- A Hubsan H107L X4 Receiver H107-A34 does the receiving part of the commands sent to control the drone.
- An 800mAH 4.7V Lithium Polymer battery is used to provide the required voltage.
- The total weight of the on-board components does not exceed 40 grams.

VI. Ground Station Component

- A Boscom 5.8GHZ 8CH Wireless RC805 Receiver is used in the ground-station to receive the signals sent from the drone. This signal is used to display live feed in an LCD monitor.
- It features two AV outputs which are handy if you want to plug-in video goggles and a video monitor at the same time.

VII. Materials And Working

The fibers used in drones are usually glass or carbon although other fibers such as paper or wood or asbestos have been used. The polymer is usually an epoxy, vinyl-ester or polyester thermosetting plastic. FRP’S are commonly used in the aerospace, automotive, marine construction industries [7].

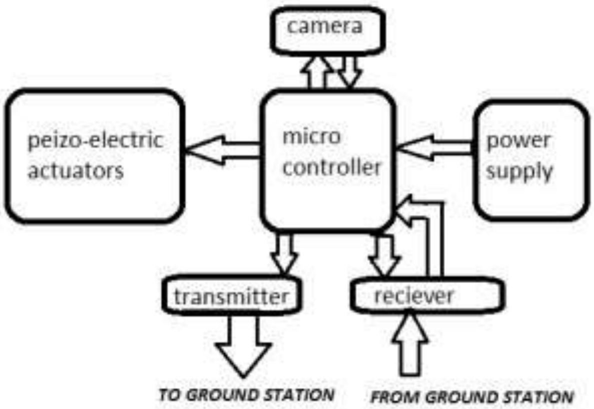

figure1: block diagram of the system

The piezoelectric actuators are controlled by the microcontroller which decides the time interval between the switching of the power supply to the piezoelectric actuators. Wing rotation is accomplished by smaller muscles that directly apply torque to the part connected to the wing hinge [4].Since this is done at a rapid rate they act like the flapping wings of a dragonfly which generates the necessary lift for the vertical takeoff and landing of the MAV (Miniature Aerial Vehicle). The on-board components are interfaced with ARM M3 cortex series microcontroller which acts as the brain sending commands which have been programmed in it. This microcontroller is compatible with high end programming languages like Python, Java and Embedded C. The piezoelectric actuators are controlled by the microcontroller which decides the time interval between the switching of the power supply to the piezoelectric actuators. Rapid application and removal of this stimulus will lead to these materials to act like the wings of an insect, flapping at 30 flaps per second. Four piezoelectric actuators are connected to artificial muscles and they act as the four wings of the IMAV. Wing rotation is accomplished by smaller muscles that directly apply torque to the part connected to the wing hinge [8]. The live video streaming and images taken by the camera are transmitted through the 2.4 GHz A/V Transmitter in real time. The three movements (yaw, pitch and roll) are controlled by the inputs given from wireless controller which has 4 channels.

figure2: model structure of i.m.a.v

Basically Yaw is the directional sideways movement which is controlled by giving commands to the right front and left back wings to beat faster to change direction to the left side. To change direction to the right side the commands are given make the left front and right back wings to best faster. Roll is the tilting movement on both the sides which is controlled by giving commands to make either the right side or left side wings to flap faster. Pitch is the up-down movement which is controlled by making the front two or the rear two wings to beat faster. These commands are received by the receiver and sent to the microcontroller which adjusts the delay time for the flapping of the four wings by programming.

VIII. Conclusion

Thus using artificial muscle and piezo-electric actuators we have presented a unique model which is less noticeable because of its appearance and lack of noise from the actuators making a viable concept to be considered for building the drones in future. This drone can operate in both short where it is controlled via a remote, and if required for long ranges where it surveys the area, the co-ordinates of which can be stored in the onboard GPS which can be added when required.

This work has tremendous future scope, some of which are given below

- It is very much possible to develop an aquatic version of this drone by tweaking the flapping mechanism of the wings and streamlining the overall design to allow the machine to scythe through the water more efficiently. The flapping speed must also be reduced to avoid damage to the wings and the actuators since the density of water is higher when compared to air.
- The drone also can be configured in a manner such that it is compatible to virtual reality device like oculus rift. This will enable the pilot to control the drone more effectively through tight spaces.
- The drone can also be modified in such a way that it can be controlled via voice command within a short distance.

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