CHAPTER 9

SCOPE FOR FUTURE WORK

The scope for the further research, in respect to develop full fledged flapping wing MAV with payload is discussed. To improve the vehicle the various work to be carried out in respect with mechanism, wing, instrumentation, battery, navigation and flight-testing were explained in this chapter.

9.1 FLAPPING MECHANISM

The fabricated mechanisms developed during the present research can be able to produce flapping in the vertical direction only. It can be modified to have small pitching during flapping, which will result in good aerodynamic efficiency. Use of lightweight motor can do the mechanism optimization; the parts of the mechanism can be made with the materials having high strength to weight ratio. Employing piezoelectric actuators can further reduce the weight of the vehicle. And it is possible to mimic the insect with lower flap angle and higher flapping frequency. Reciprocating chemical muscle can be used in the place of conventional material to have more feasible flapping motion.

Wing resonance concept can be used for the control of the flapping and also to save energy/power requirement of the MAV. Flap and Glide concept also be adapted to save power required.
9.2 WING PLANFORM

Unlike the fixed wing conventional aircraft, flapping wing differs by its dual function, which cause the lift as well propulsion. More work has to be carried out in perspective to have good aerodynamic efficiency. By combining aeroelasticity and MEMS technology better wings have to be designed and developed to give positive lift in both upstroke and down stroke. The small increase in efficiency in the given size will be useful in terms of increase its payload and communication system.

9.3 INSTRUMENTATION

It was found difficult, while testing the vehicle since it has lightweight and the order of force produced is less, the unsteady nature of the airflow and dynamic stability characteristics etc., affected the reading considerably and hence more work can be carried out to improve the design aspect of load cell to measure lift and thrust forces. A data acquisition system with very high sampling rate has to be employed for precise measurement of forces during each stroke.

9.4 COMPUTATIONAL WORK

The available CFD packages like CFX and Fluent are not fulfilling the exact requirement of the unsteady aerodynamics, where the flow is at low Reynolds Number regime. Build and Pre-Processor is not much easy to obtain or simulate the flapping motion in the available packages. Separate coding has to be written to analyze the flapping wing meticulously.
9.5 FLOW VISUALIZATION

Flow Visualization is another tool for determining the vortex pattern in the flow, and this is to be carried out in the smoke tunnel using high-speed CCD cameras. This flow visualization will give the pattern thereby empirical relation.

9.6 STABILTY ANALYSIS

Since the flapping wing MAV fly at low Reynolds Number, unsteady regime the stability analysis is an important to have a stable flight. More work has to be carried out through calculating overall C.G and individual components C.G of the vehicle. Dynamic analysis has to carry out to study its stalling characteristics due to its delayed stall and spiral vortices.

9.7 DEVELOPMENT OF NAVIGATION AND CONTROL SYSTEM FOR MAV

- The initial study has to start with validation of autonomous flight in the available MAV platforms.

- Navigation and autonomous control procedures have to be studied and evaluated based on MEMS gyroscope, MEMS accelerometer.

- Identification of all the imaging and sensor payload configurations, actual components and PCB schematics to be made. Fabrication and testing of (a) Accelerometer (b) Gyroscope (c) imaging system,(d) wireless data link
(e) rechargeable batteries plus regulator configuration
(f) Ground Control system.

- Miniaturized electric equipment will be designed and fabricated/procured from the market for receiving and processing the command from the ground station. Also very high-resolution miniature camera and suitable transmission devices will be procured/developed for capturing the video images and transmit the captured video images to the ground station.

- Lightweight battery and battery charger have to be procured. Bread Board design completion of all individual payload and OBC subsystems. Experimentation on image processing and ground station.

9.8 INTEGRATION AND FLIGHT TESTING

- Integration of the miniaturized flapping wing MAV with the control and navigation parts towards the development of Autonomous Flight.

- Integration of lift and thrust mechanisms of the wing with miniaturized DC motor, the electronic components for receiving and processing the commands from the ground, miniature camera and transmission device to the vehicle structure appropriately in order to minimize the size.

- Receiving and processing of commands from the ground control station for the vehicle movement and transmitting the video image captured by the vehicle to the ground station.
• Continuous flight-testing and refinement with payload and ground station towards the miniaturization, stabled autonomous flight.

9.9 CONCLUDING REMARKS

The different work to be carried out towards development of autonomous MAV with payload has been discussed. Improvement needed in the development of mechanism, wing planform, instrumentation, testing techniques were also discussed. Since the MAV sized unsteady aerodynamics is not fully explored, lot more research can be done towards obtaining formulae and empirical relations like conventional steady state aerodynamics.