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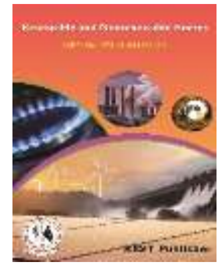

Power Management Stragies for a Grid Connected PV-Fc Hybrid System

***K Kalyani Radha, B Omprakash**

JNTUACEA, Ananthapuramu, Andhra Pradesh, India.

*Corresponding Author Email: *radha.mech@jntua.ac.in*

Abstract: *The Objective of this project is to develop the five bar mechanism for bird mimicking Entomopter. The objectives of the research would be realized through an elaborate research methodology consisting of dynamic simulation of the Five bar mechanism, choice of suitable actuation methods and deployment through dedicated design and fabrication of the propulsion unit. Recreation of the flight characteristics of insects has been the biggest challenge faced by researchers working on Entomopter. Using dynamic analysis in commercial software like MSC ADAMS to finding out the trajectories by optimization of the various parameters and to develop the optimized design to model using Rapid prototyping technology. This trajectory gives level of maneuverability exhibited by conventional Entomopter besides exhibiting distinct hover ability and dynamic simulation will be further used to explore the possibility of practical implementation of this data on Entomopter. By mathematical modelling of the mechanism, fabrication of near scale MAV and testing on a custom developed test rig for proof of concept studies, the aerodynamic characteristics would be evaluated for potential use in 10-gram class of Entomopter and it would enhance the aerodynamic capabilities.*

Keywords: *Five bar mechanism, MSC ADAMS, Rapid prototyping*

1. INTRODUCTION

In this Torque driven planar five bar mechanism is having two gears and these are fixed in the two end sides of the Five bar as shown in fig below. Gear A is rotating at clock wise direction and the gear E is rotating at counter clock wise direction. The twisting moment or rotary motion from the gear and it is transmitted to the fixed links. In each phase, a link adjacent to the fixed link of the mechanism is fixed temporarily and the remaining portion acts like a mechanism with single degree of freedom. In the next phase, the temporarily fixed link of first phase is released to move and another link to adjacent to the link of the mechanism is fixed temporarily and the remaining portion acts like a mechanism with suitable degree of freedom. Torque driven planar Five bar closed chain mechanism by variable topology ABCDE is shown fig.1. The proposed five bar mechanism consists of meshing discs that represent three linkages of the Five Bar mechanism. The two other linkages are effected as two connectors between the two discs connected through the revolute joint.

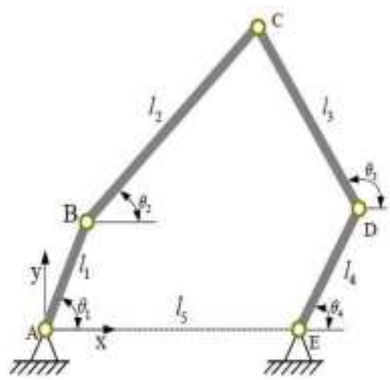

FIGURE 1. Five bar mechanism

With the proposed Five Bar mechanism, trajectories like A, B, C, D, E, F, G, H (Lopsided, milling and sad lemniscuses) N, O (Symmetric Lemniscuses) already been created to an extent, using dynamic simulation. Such data surpasses the level of maneuverability exhibited by conventional Entomopter besides exhibiting distinct and dynamic simulation will be further used to explore the possibility of practical implementation of this data on Entomopter, below is the hand drawn plot of the FIVE BAR MECHANISM implemented through meshing gears rotating with a phase difference of 90 degrees. One of the apex of the points are actuated with a motor it leads to corresponding motion of other linkages. End effector C is where the wing roots are based and to trace the trajectory path of the flapping wing at the time software simulation.
The trajectory of end effector determined by experimentally:

- Length of linkages
- Phase of primary linkages (ϴ1 & ϴ2)
- Distance between points A & E
- Direction of l1 and l4 rotation (CW/CCW)

And also the after the simulation of five bar mechanism the design of Entomopter is to fabricate by 3D printing and the aerodynamic characteristics of Entomopter is carried out the following parameters,

Thus the following are aerodynamic characteristics are further achieve:

- Optimum flexural stiffness for wing
- Optimum wing area
- Optimum wing weight
- Optimum RPM
- Optimum Torque
- Wing beat frequency Vs. Motor RPM
- Angle of attack Vs. Time
- Lift force Vs. Motor RPM

2. LITERATURE REVIEW

The recent research efforts that have examined MAVs.Micro Aerial Vehicles (MAVs) are a subset of Unmanned Aerial Vehicles (UAVs) characterized by their relatively small size MAVs are ideal for tasks that larger, less nimble, more expensive vehicles may not be able to perform. These vehicles also have the advantage of being portable. From a military point of view, a MAV is envisaged to be a small scale autonomous flying vehicle intended for reconnaissance over land, inside buildings and tunnels and in other confined spaces. These functions will be executed through carriage and operation of miniaturized sensors. However, as they get smaller and smaller, several factors start to hinder MAV performance. These include lack of understanding of aerodynamic, structural and propulsion physics at the micro-scale. The multidisciplinary aspect of MAVs makes it challenging for scientific and industrial communities of specific expertise's to master the numerous related scientific problems. Both design and system of MAVs are aimed at satisfying a distinct flight envelope associated with mission unachievable by UAV'S.

3. EXPERIMENTAL WORK

Experimental set up:

Proposed method: The basic working principle of this Torque Driven Planar Five Bar mechanism is five adjacent links and revolute joints. At the two end of the links such as A and E are having the rotation gears and this gears are plays a vital role to transmitting the motion for the corresponding linkages. Right side of the gear like A is rotating in clockwise direction and the Left side of the gear like E will rotating in counter clock wise direction. Due to this kind of rotation the motion is properly transmit to the corresponding linkages and it will act as Bird.

How does it fly: Most important thing to notice about the Entomopter is that it cannot land or Take-off to the ground directly, so support must be provided during this crucial Times. Now to fly an Entomopter we trigger the motion of it by providing it support through our hands. For initiating the motion, we switch on the power supply for Motor and servos by simulator (transmitter) and then the whole dynamics of the Aircraft is controlled by simulator. Directions or throttle should be controlled appropriately for smooth and stable flight.

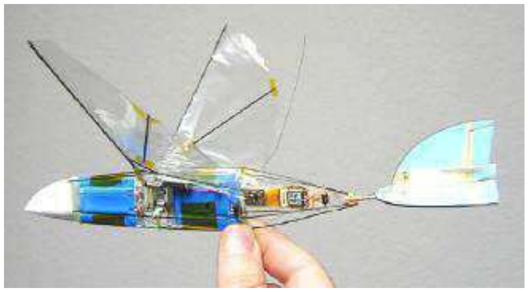

FIGURE 2. Flapping wing mad

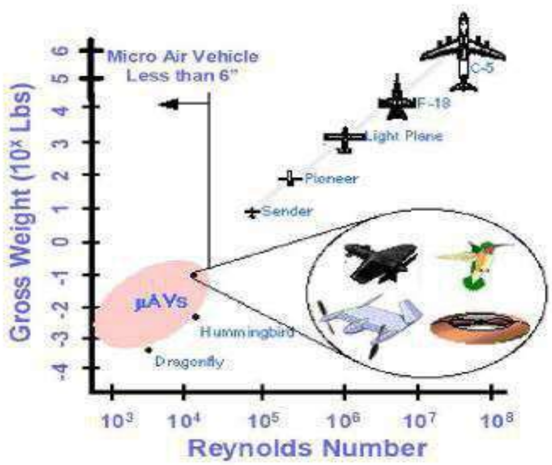

FIGURE 3. MAV Flight Regime

Definition of Entomopter:

The mechanical insect, known as an "Entomopter" is based around a new development called a Reciprocating Chemical Muscle (RCM) which is capable of generating autonomic wing beating from a chemical energy source. Through direct conversion, the RCM also provides small amounts of electricity for on-board systems and further provides differential lift enhancement on the wings to achieve roll and hence, steered flight. A large tested for the RCM technique has been constructed and demonstrated, a reduced version of the Reciprocating Chemical Muscle was used to obtain empirical data to validate the concept's ability to develop the power necessary to fly at a reasonable weight. This second generation unit has since been further reduced in sized to produce a muscle capable of reciprocation rates in excess of 60 Hz. This latter unit will be reduced by a factor of 2.5 for the actual terrestrial Entomopter to be constructed. Entomopter was defined for a particular mission space. A simulation was constructed to model aerodynamics, thermodynamics, and muscle chemistry to the first order, and was used to predict performance as a function of variables such as weight, wing parameters, and dynamics. A CAD model allowed a full-scale stereo lithographic 3D model to be constructed. Methods for in-flight stability and control, navigation, altimetry, and obstacle avoidance were designed and demonstrated in hardware. A rubber band-driven no resonant flying model was also constructed using wing flapping kinematics of the actual MAR, a second and third generation reciprocating chemical muscle were designed, built, and demonstrated. Although the third generation muscle actuator is still 2X larger than necessary for the operational MAR, its internal porting and components are at about the correct scale, thereby establishing the fact that it can produce the proper power, motion, and frequency to allow MAR flight as predicted by our models. Beyond the obvious military uses for an Entomopter, several NASA Research Centers have noted its unique ability to fly on the planet Mars. Fixed wing aerial Mars rovers would have to fly at over 250 MPH just to stay aloft in the rarefied Mars atmosphere. This makes landing on the rocky surface almost impossible, thereby precluding sample inspection/gathering. Also, the high speed flight means that dwell time on any particular area will be difficult-- a negative feature that is compounded by the fact that turns in the thin atmosphere will require enormous radii.

4. RESULTS & DISCUSION

In this Torque Driven Planar Five Bar mechanism for an entomopter is carrying the following approach as shown in below,

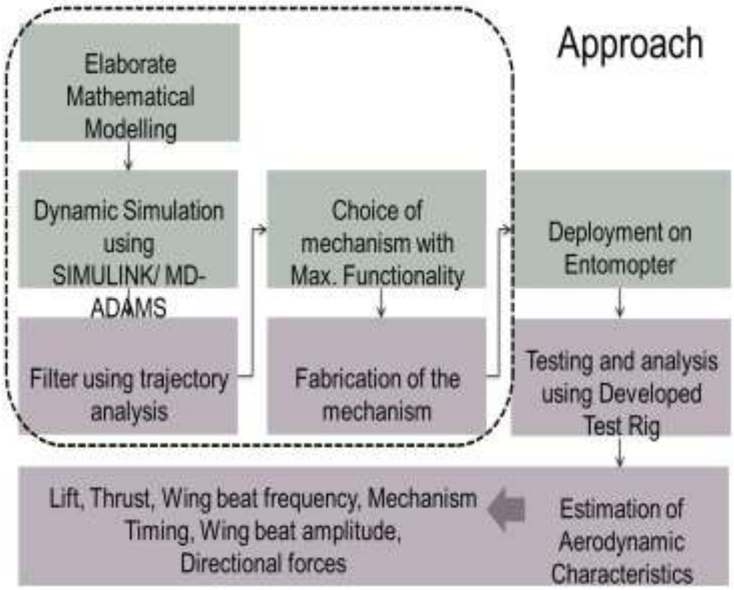

FIGURE 4. Approach of torque driven planar five bar mechanism for an Entomopter

Approach in MSC ADAMS: By using the mathematical derived values and substituting in the MSC ADAMS the simulation of the Five Bar Mechanism is achieved successfully and required parameters to obtain such as length of linkages, primary phase linkages (ϴ1 & ϴ2).

Due to this dynamic simulation the following parameters are determined, Such as

- Gear diameters
- Length of connectors
- Phase of discs
- Distance between the discs
- Driving torque for the discs
- Direction of rotation for maximum permutations of lemniscuses

TABLE 1.

parameters	ϴ1	ϴ2	L1	L2	L3	L4	L5
Units	Degree	Degree	Mm	mm	mm	mm	mm
Values	109.38	43.32	15	7.5	7.5	15	15

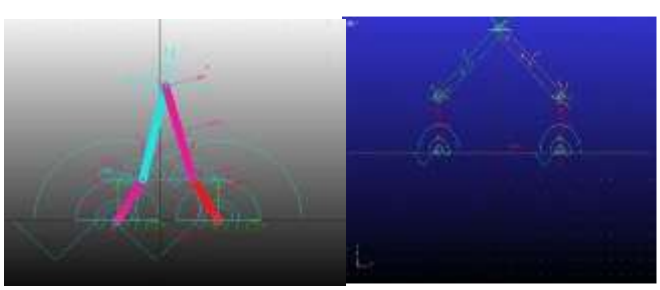

FIGURE 5. Five bar mechanism in MSC ADAMS

ADAMS simulation: By various iterations finally we get the exact simulation of the Five Bar mechanism and to found out the required trajectory path exactly in infinity curve in horizontally at trajectory point C.

TABLE 2.

Values	142.10	226.86	10	5	5	10 Expected trajectory

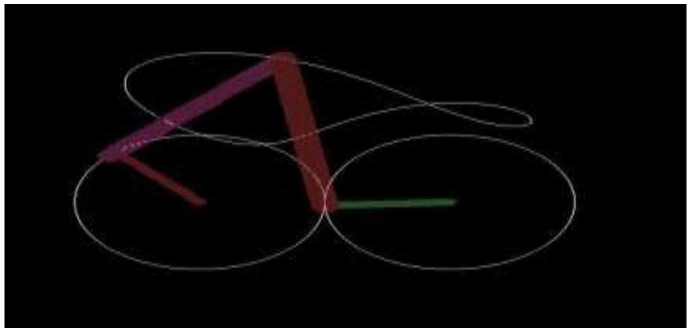

FIGURE 6. Angle of 30 degrees each, gear rotation in counter clockwise direction

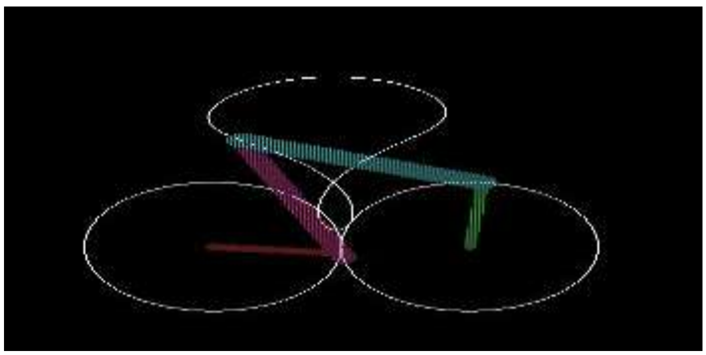

FIGURE 7. Angle of 45 degrees each, gear rotation in clockwise direction

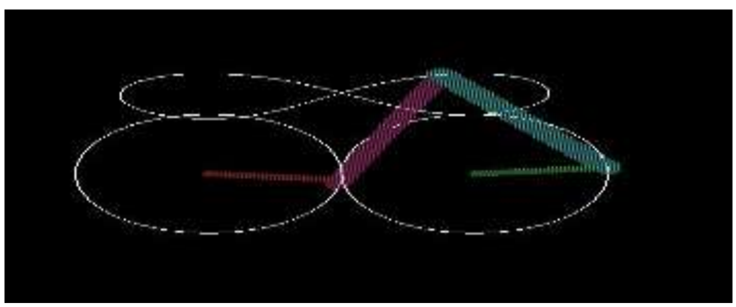

FIGURE 8. Angle of 45 degrees each, gear rotation in counter clockwise direction

5. CONCLUSION

The five bar mechanism reduces the synthesis of link, two degree of freedom mechanism to the synthesis of a 4 moving parts, 5 revolute joints and two motions, zero degree of freedom linkage mechanism in two phases. This method is simple and straightforward. We have an infinite number of possible solutions and it is depending upon the choice of mechanism. After the fabrication of design, the mechanism will further be testing in experimentally and the aerodynamic characteristics of the Entomopter is achieve.

Thus the following are aerodynamic characteristics are further achieving experimentally:

- Optimum flexural stiffness for wing

- Optimum wing area
- Optimum wing weight
- Optimum RPM
- Optimum Torque
- Wing beat frequency Vs. Motor RPM
- Angle of attack Vs. Time
- Lift force Vs. Motor RPM

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