Design and Fabrication of Flying Saucer Utilizing Coanda Effect

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Abstract. Coanda effect is used in several engineering applications with distinctive designs and structures. It is also applied in aircrafts flying at low speeds for a comfortable ride. In this paper, we have designed and modelled Coanda effect in terms of a flying saucer. The fabrication was done by means of structural and electronic components. Electrical motor was used as a propeller to take off and land vertically (VTOL) along with hovering capability. The rotor disc diameter is smaller than the bulbous body unlike a helicopter which makes to fly very stable. Control flaps were used to regulate the path by altering the flow over the streamlined body. The model was then tested with a remote control. Numerical Simulation of the tesla turbine was done using ANSYS 14.5 software and displacements were obtained by applying different forces on designed model. CATIA V5 was used to analyse the shaft of the model to get minimum value of torque at which the shaft starts to deform. **Keywords:** AMB, PMB, RPM, Regular Ball Bearing, VTOL, STOL, VSTOL, USAF, UAV.

1. Introduction

An un-conventional design was patented by Nikola Tesla in 1913 with the objective to develop a turbine with lower complexity, cost, and maintenance requirements than conventional mechanisms. Within the literature, the Tesla turbine has been commonly referred as a boundary layer, multiple-disk, friction, or shear force turbine [1]. The design consists of several, closely-spaced rigid disks set in parallel on a shaft. The co-rotating disks are centred and locked to the shaft. Located near the centre of the disks are orifices that allow for fluid exhaust in the axial direction. The disk-shaft assembly is set on bearings and enclosed within a cylindrical casing. An inlet into the casing is directed approximately tangentially [2].

The idea of the magnetic bearing and its applications has been conceptualized over the years. Today, magnetic bearing technology has become viable because of advances in microprocessing controllers that allow for confident and robust active control. It is advance in following areas: rotor and stator materials and designs which maximize flux, minimize energy losses, and minimize stress limitations; wire materials and coatings for high temperature operation; high-speed micro processing for advanced controller designs and extremely robust capabilities; back-up bearing technology for providing a viable touchdown surface; and precision sensor technology; have put magnetic bearings on the forefront of advanced, lubrication free support systems and The magnetic bearing technology is distant from young, didn't become practical application and the high-speed micro processing enables active magnetic bearing with stable control and dynamic stiffness and damping such application is the most of one gas turbine engine [3]. Turbomachines are machines that transfer energy between a rotor and a fluid, including both turbines and compressors. While a turbine transfers energy from a fluid to a rotor, a compressor transfers energy from a rotor to a fluid. A Tesla turbomachine utilizes the viscous shear forces of a fluid (boundary layer effect) passing near a disk on an axle to transmit torque to and from the fluid. It can be designed to efficiently pump highly viscous fluids as well as low viscous fluids [4].

Once aircraft flying on air, at high Mach number, the thin layer of air that sticks to the wing. This layer of air energies the same speed as the aircraft. Then, shear action or shear plane between that boundary layer and the close inactive air around the aircraft. In aerodynamics, boundary layer drag is completely unwanted precept. But, Tesla could turn that precept, it supposed that boundary layer drag used to do something useful in its applications [5]. Conventional turbines are mostly reaction and impulse type or both. Often technical challenge faced by conventional turbines. Financial feasibility of power plants is depended upon innovations to prevent erosion of mechanical equipment's or alternatives which better handle these conditions. Tesla turbine is an unconventional turbine that uses fluid properties such as boundary layer and adhesion of fluid on series of smooth disks keyed to a shaft [6]. A preliminary design of a Tesla turbine for pico hydro applications has been undertaken employing Rice's analytical method. The efficiency of the preliminary turbine design was near 80% but it is believed that the bulk of efficiency losses will be found in inlet and exhaust flows, which are not considered in this analysis. Challenges remain for the application of Tesla turbines to pico hydro generation [7].

Powered lift rotary wing, vertical takeoff and landing (VTOL), and short takeoff and landing (STOL) aircraft, and aircraft capable of both vertical and short field operations (VSTOL) are the different designed implemented in the literature. The concentration is on the USAF (X-designated), US Army (VZ-designated), and European experimental VSTOL aircraft, some research aircraft supposed to be prototypes for production aircraft into their mission [8].

Unmanned Aerial Vehicles (UAVs) play a prime role in the modern-day warfare where emphasis on surveillance, intelligence-gathering and dissemination of information. Some have a fixed wing design, which bear a resemblance to the one of outmoded achieving plane and require runway to take off and land. Others are using rotors just as helicopter, thus better result as far as hovering is concerned. This is important because the Vertical Take Off and Landing (VTOL) capability plays also a key part for UAV. It may come to the idea of searching for a modern design based on Coanda Effect (Coanda UAV). These have been evolved to generate lift and maneuverability force in a more efficient manner, which have rudder just as air plane, and have two types of flap. It can Take-Off and Land just like helicopter but move faster than helicopter [9], [10], figure 1 shows the designed and fabricated model.

Some more advanced flying saucer's capable of spaceflight have been proposed, often as black projects by aeronautics companies. The Lenticular Reentry Vehicle was a secret project run by Convair for a saucer device which could carry both astronauts and nuclear weapons into orbit; the nuclear-powered system was planned in depth, but is not believed to have ever flown. More exotically, British Rail worked on plans for the British Rail "Space Vehicle" a proposed, saucer-shaped craft based on so far undiscovered technologies such as nuclear fusion and superconductivity, which was supposed to have been able to transport multiple passenger between planets, but never went beyond the patent stage [11].

2. Design Process

From the literature, to fabricate the flying saucer it begins with the assortment of apparatus's and their quantities according to the existing model. Selection of components based on the range and endurance of the flying saucer and it is very important to observe the weight because of payload should be in the certain limit. Choice of Styrofoam is based on the its weight and strength, the selected Styrofoam is similar to a sheet form. Then, Styrofoam was brake into some fragments based on design dimensions to build an assembly of model by using adhesive bond into carbon fiber roads. Later, electronic components enhanced to operate the fabricated model. While assembling several attempts it was performed due to inherent in adhesive bond, the quantity of adhesive is very important to glue into the Styrofoam to reinforced to provide structural strength. The below figure 1 shows that fabricated model after all the components enhanced in to the flying saucer and developed with slightly change of design and dimensions to improve the performance of the existing model.

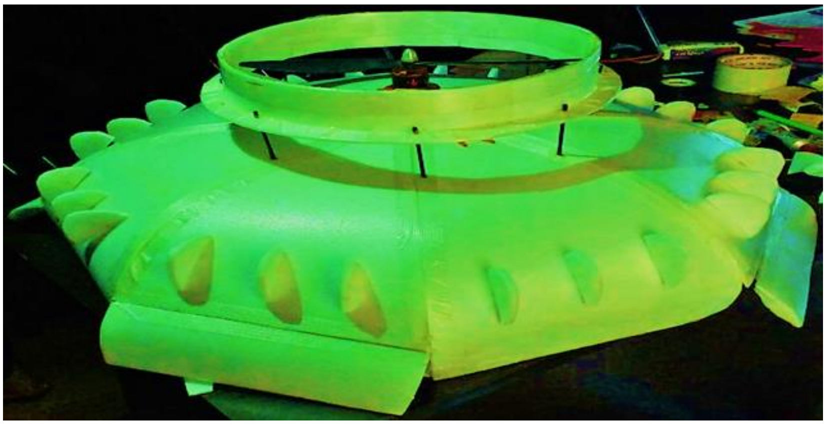

Figure 1. Fabricated model

The description is used for the design as listed below to fabricate the model. Following approach is performed to construct the design and accomplish the Coanda effect flying saucer as shown in figure 2.

Table 1. Description (From existing model)

Specification	
Size	50.5mmx50.5mmx12mm
Wight	21 grams (Inc Piezo buzzer)
IC	Atmega664 PA
Gyro	6050MPU InvenSense Inc.
Auto level	Yes
Input Voltage	4.8-6.0 V
AVR Interface	Standard 6 pin.
Signal from Receiver	1520us (5 channel)
Signal to ESC	1520us

Figure 2. Methodology

3. Components

The consideration of components is hired by the two-major discipline and enhanced for making flying saucer Coanda effect. These components are selected from the literature of existing model and to improve its performance to some extent by changing components.

3.1 Structural Components

The selected materials for the fabrication of the body is Styrofoam, along with which Carbon fibre rods are used as reinforcement to provide structural strength.

- Styrofoam
- Carbon fiber rods
- Electronic Components

3.2 Electronic Components

The electronic components consist of the whole entity from the power supplying battery to the flap actuating serve. The listed below shows all the electronic components used for model.

- Transmitter
- The Receiver
- Motors
- Electronic Speed Controller (ESC)
- Battery
- Flight Control Board

4. Result and Analysis

4.1 Analysis

Analysis of Tesla Turbine: The turbine disc was analysed using ANSYS 14.5 software. The disc structural analysed by applying the force in the direction at which the viscous force act on the disc. The analysis showed the displacement of the disc at an increasing rate from the centre of disc to the edge. The displacement proves that the force acting on the disc will provide the necessary torque to drive the turbine.

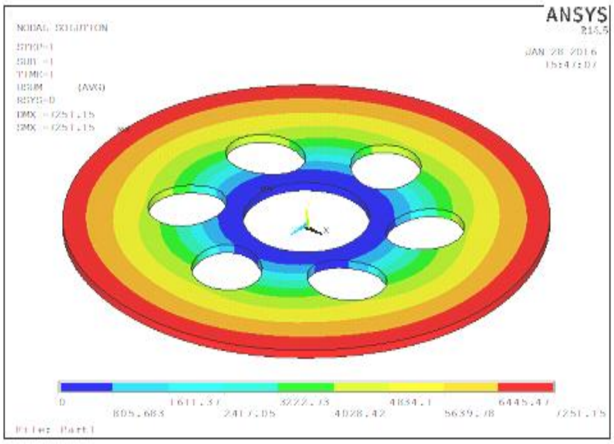

Figure 3. Displacement plot of turbine disc

Furthermore, the shaft was analysed using CATIA v5. The structural analysis of the shaft was done by fixing the pointed end of the shaft and applying the torque where the disc will be fitted. Then we checked for the min torque value at which the shaft started to deform. The value was found to be around 0.225 Nm when the shaft started to deform.

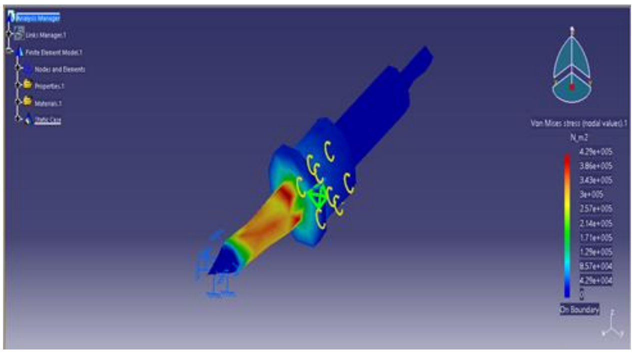

Figure 4. Von-Misses Stress plot of Turbine shaft

MATLAB analysis of AMB: The MATLAB simulation of the AMB system provided the following graph showing the stability and working of the proposed model for the following values of parameters.

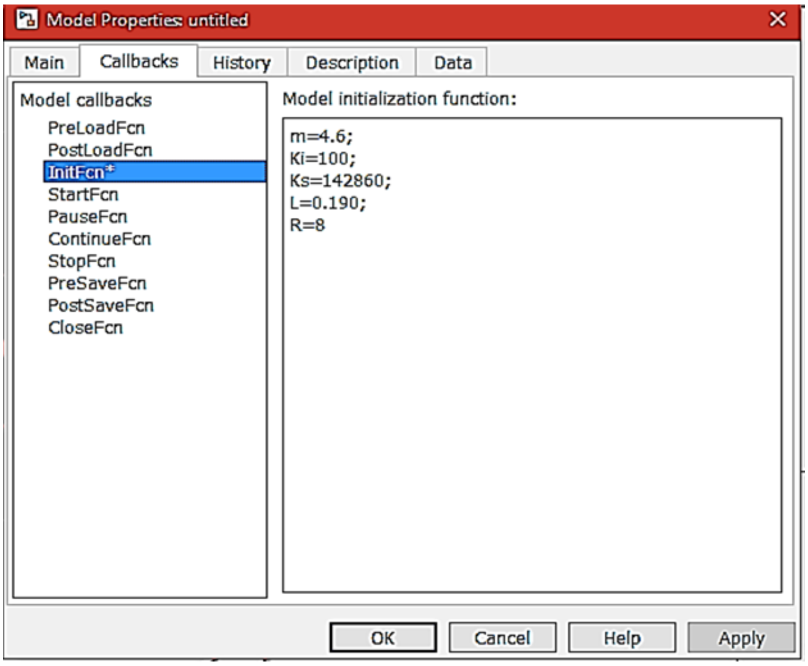

Figure 5. Parameters assigned to linearized AMB and feedback system

From the above input data, the following graphs were obtained. The below graph is gives us the displacement vs. time plot of magnetic bearing. At the start of the setup there will be no displacement as the surface of the rotor does not have an eddy current created on it. As the rotor rotates the eddy currents are formed on the surface and hence Lorentz force starts to act on the surface hence we find a gradual increase in x i.e., the position of the rotor with respect to the coil. After few seconds, the system is stabilized and a constant displacement t line is obtained.

When an external force is introduced to the system the disturbance caused by the force will displace the position of the rotor such vibrations will be dampened and the system will be stabilized by the forces acting on the rotor by the electromagnetic coils. The below graph shows the stabilization of the system for external excitation.

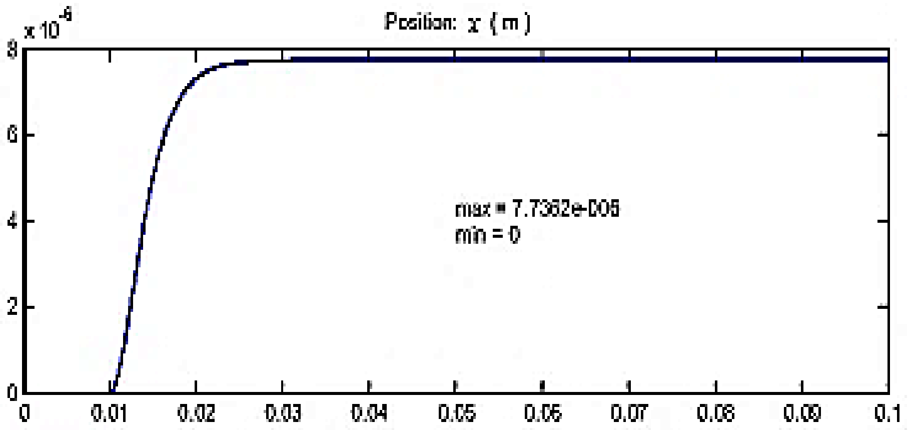

Figure 6. Displacement vs. time plot for AMB feedback system without external force

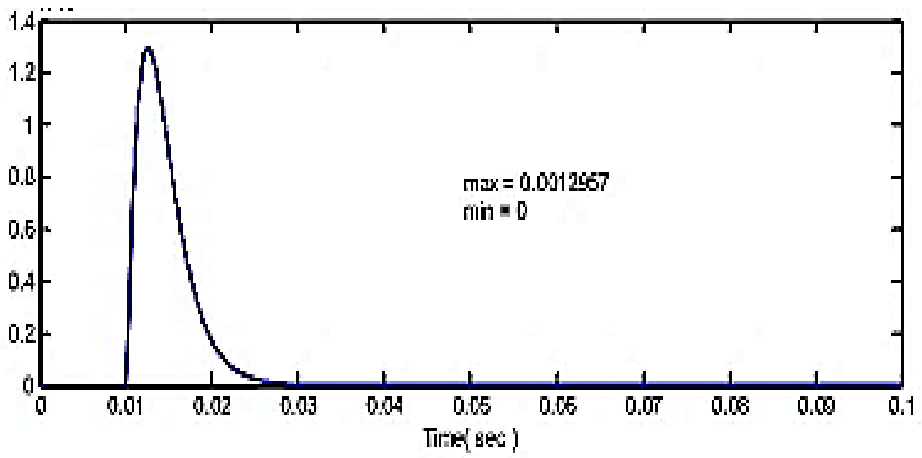

Figure 7. Displacement vs. time plot for AMB feedback system when an external force is applied.

4.2 Experimental Result

After the fabrication and assembly of the model, it was tested for performance parameters by using two different bearings i.e., regular ball bearing and PMB. The results obtained by those tests are listed below.

The first test was to check the max. RPM attained for different pressure of compressed air passed into the turbine. Air pressure was measured using a pressure gauge near the inlet and RPM was found using an RPM meter. As expected the PMB had higher RPM value compared to ball bearing as shown in to the below figure 8.

The setup was made to attain the max. RPM and then passing of compressed air through the inlet was stopped. The RPM was noted at regular intervals of time till the step stopped to run. This process was first conducted using PMB and then with ball bearing. The noted results are as follows.

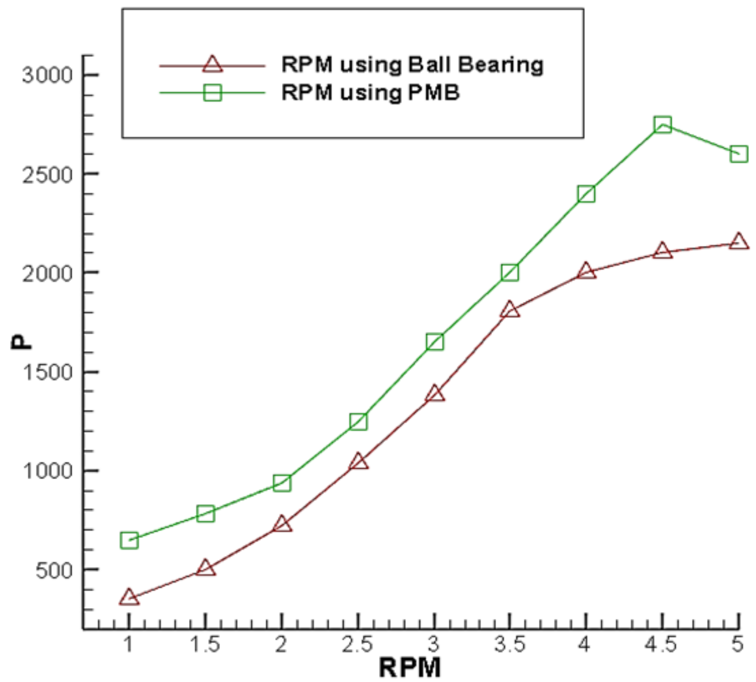

Figure 8. Graphical Representation of Pressure vs. RPM

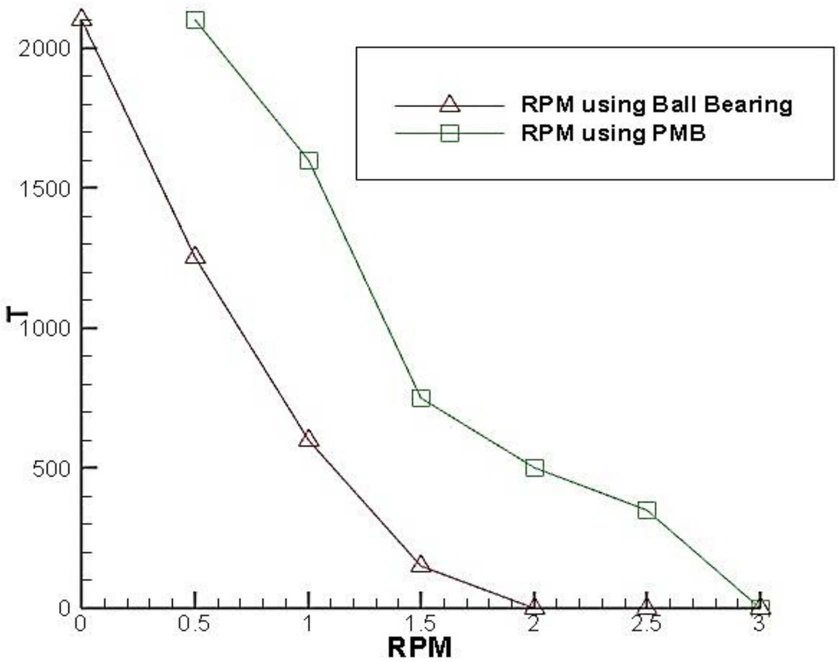

Figure 9. Graphical Representation of Time vs. RPM

5. Conclusion

Flying saucer using Coanda effect was fabricated by using structural and electronic components. The dimensions of the model were selected from the existing literature. Sorties were performed with the help of remote control.

- The results of the ball bearing and PMB comparisons were plotted. Result shows that PMB had higher RPM value compared to ball bearing.

- ANSYS simulation shows that displacement proves the force acting on the disc will provide the necessary torque to drive the turbine.
- CATIA V5 simulation shows that shaft starts to deform at 0.225 Nm.

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