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Electrodynamic Flight By Creating Magnetic Field Pressure For Future Aviation

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ABSTRACT

Aviation is always concerned with fuel efficiency which directly and indirectly affect various parameter and economy of the operators. One of the most preferred and the developing area is the flight using electric source. In this study the concept electrodynamic flight by creating magnetic field pressure for the future is demonstrated where the demands are met with desired range. This system of flight are highly economical, pollution free and produce no noise. The power source to operate the system is regenerated within the flight system. The electrodynamic flight system can be operated by the UAV systems and could make the commercial flight unmanned. Unlike the jet engines only few parameters are monitored by the control system thus making the entire system complex free. This flight system are most efficient for surveillance as it produce no noise while the other systems do so. The endurance and range of the system is too high when compared to other flight systems.

Keywords

Electrodynamic lift – Magnetic field pressure – Noise less flight – High range flight – Long endurance flying.

Nomenclature

1. B - Magnetic field produced by the mutual coordination of magnetic solenoid in Tesla
2. F - Magnetic field force on the superconductor disk in Newton
3. P - Magnetic field pressure on the superconductor disk Pascal
4. Tc - Critical temperature in Kelvin
5. H - Hydraulic actuator
6. S - Superconductor disk (High temperature superconductor)
7. M - Magnetic solenoid
8. d - Diamagnetic vanes
9. D - Diamagnetic fan
10. I_c - Induction coil
11. C - Conducting coils (EMF input coil to Induction coil)
12. Θ - Angle between superconductor disk and horizontal reference (relative to direction of motion).
13. B - Blow in door

1. INTRODUCTION

The electrodynamic flight system is broadly classified into four sections, the magnetic field source, the superconducting lift generator, the power regeneration and the control system. The magnetic field is produced by the superconducting solenoids cooled below their critical temperature by liquid nitrogen. The magnetic field pressure is directed upon the superconductor disk cooled by the liquid nitrogen taken from the liquid nitrogen tank placed in the flying body. The linear velocity is obtained by tilting the superconductor disk to angle θ relative to the direction of flight, thus two components of velocity are produced (Horizontal and Vertical components). The control system controls the angle to be which the superconductor disk should be tilted based on the altitude, velocity needed as indicated as an input parameter either by a pilot or UAV system. The temperature of the magnetic coils and the superconductor disk is monitored by control system and it sprays liquid nitrogen on the magnetic coils and the superconductor disk if the temperature of the magnetic coils and the superconductor disk tends to rise above the critical temperature. The overall schematic diagram of the flight system is shown in Fig 1.

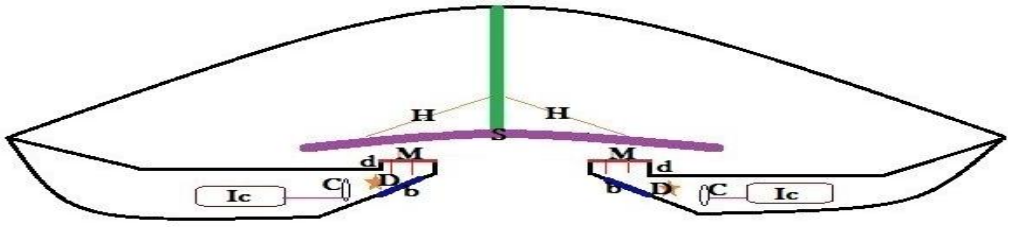

Fig 1: The overall schematic diagram of Electrodynamic flight by creating magnetic field pressure

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2. MAGNETIC FIELD SOURCE

Magnetic field is produced by even number of solenoid placed in the circular form with opposite poles placed adjacent to each other as shown in Fig 2, so the magnetic field is produced by the mutual coordination of the coils.

- The solenoids are made of Nb3Sn superconducting wire of n turns.
- The superconducting solenoids are cooled below its critical temperature (T_c = 18K) value after the passage of the current through it.
- The sequence of cooling and passage of current plays an important role, if the current is passed after cooling to its critical temperature the current do not persist and hence the current should be passed before cooling below its critical temperature value of the superconducting solenoid.
- The magnetic field is terminated by allowing the solenoid temperature to rise above the critical temperature by making the atmosphere to interact with the solenoids through blow in doors. Blow in doors are shown in Fig 1

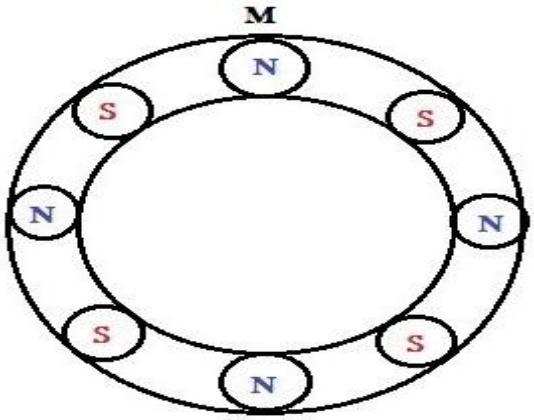

Fig 2: The arrangement of magnetic solenoid

3. SUPERCONDUCTING LIFT GENERATORS

A superconductor disk is used as lift generator by the applied magnetic field pressure from the solenoids by the phenomena "Meissner Effect". The position of the superconductor disk is determined by the hydraulic actuator to which the superconductor disk is fixed. The area of the superconductor disk is perpendicular to magnetic field pressure. The angle of the superconductor disk relative to the direction of flight is adjusted by the hydraulic actuators based on the command by the control system.

- The superconductor disk is of BSCCO (Bi-2212 a high temperature superconductor)
- The superconductor disk is cooled by liquid nitrogen below its critical temperature of 95k.
- The superconductor disk is covered by a layer of Kapton film which is highly stable at a temperature of -198^{0}C.

4. FORCE GENERATED FOR LIFT AND VELOCITY

The magnetic field lines from the magnetic solenoid is directed perpendicular to the surface area of the superconductor disk using diamagnetic vanes which are actuated relative to the inclination of the superconductor disk so the magnetic field pressure is perpendicular to the area of superconductor disk as shown in Fig 3.

The magnetic field pressure on the superconductor disk due to the magnetic field produced by the mutual coordination of the n number of the solenoids is,

(1). $P = \frac{B^2}{2\mu_0}$

The force on the superconductor disk due to the magnetic field pressure is

(2). $F = \frac{AB^2}{2\mu_0}$

For an angle of θ made by superconductor disk relative to the direction of flight, two components of force is produced on the superconductor disk.

(3). $F_{vertical} = \frac{AB^2}{2\mu_0} \sin\theta = F \sin\theta$

(4). $F_{Horizontal} = \frac{AB^2}{2\mu_0} A\cos\theta = F \cos\theta$

The vertical component produce lift and horizontal component of force produce acceleration to the flight in the direction of the horizontal component of force.

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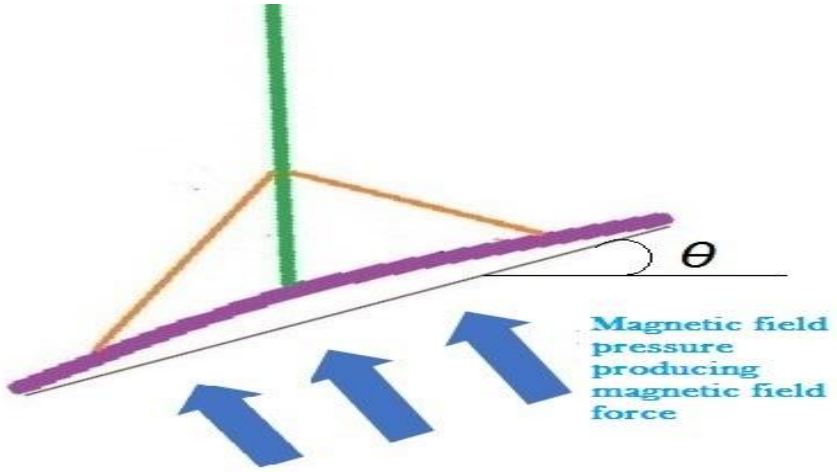

Fig 3: Representation of the actuation of superconductor disk

5. POWER REGENERATION

Power regeneration is of the great concern where the entire power needed to restart the magnetic coils for next flight and the control system is regenerated within the flying body during the flight itself. The power is regenerated by the principle of Electromagnetic induction using induction coil. A conducting coil is placed near the pole (opposite pole producing the magnetic field pressure to the superconductor disk) of the magnetic solenoid as shown in Fig 1. A diamagnetic fan is of thin plate is place between the poles and the conducting coil of all the magnetic solenoids, thus producing the change in magnetic flux associated with the conducting coil. Due to the change in magnetic flux an EMF is produced in the conducting coils. The EMF is taken to the induction coil, the induction coil produce very large EMF from the source of low EMF. The large EMF produced by the induction coil is stored as electric charge in the batteries and could be used to restart the magnetic solenoid for next flight. The power need for other flight components can be extracted from the EMF produced by the induction coil.

(5). The *EMF* produced in the conduction coil (*EMF* to the *induction coil* as input) is $\mathcal{E}_i = -\frac{d\phi}{dt}$

(6).Magnetic flux $\boldsymbol{\phi} = \int B\, ds$

(7).The *EMF* given as output by the *induction coil* is $\mathcal{E}_o = \int E\, ds = -L\frac{di}{dt}$

Where $\boldsymbol{i}$ is an alternating current which is lead to the rectifier circuit and converted to direct current, then stored as electric charge for the entire flight system.

6. CONTROL SYSTEM

A main computer coordinates all the working component thus forming a network and a feedback loop. The components of control system includes a main computer, interface between main computer and signal from the various components, sensors, Digital to analogue converter, Analogue to digital converter. The control system takes the control of the hydraulic actuators and the liquid nitrogen valve. The networks are formed as shown in Flowchart1.

- The sensors monitor the temperature of the magnetic solenoid and the superconductor disk, then send the signal to the main computer. If the temperature tends to rise above the respective critical temperatures, the main computer open the liquid nitrogen valve and thus the temperature of the magnetic solenoids are maintained below their critical temperature.
- The position of the superconductor disk is changed by the hydraulic actuator as per the command given by the pilot or auto pilot or UAV system through the main computer.

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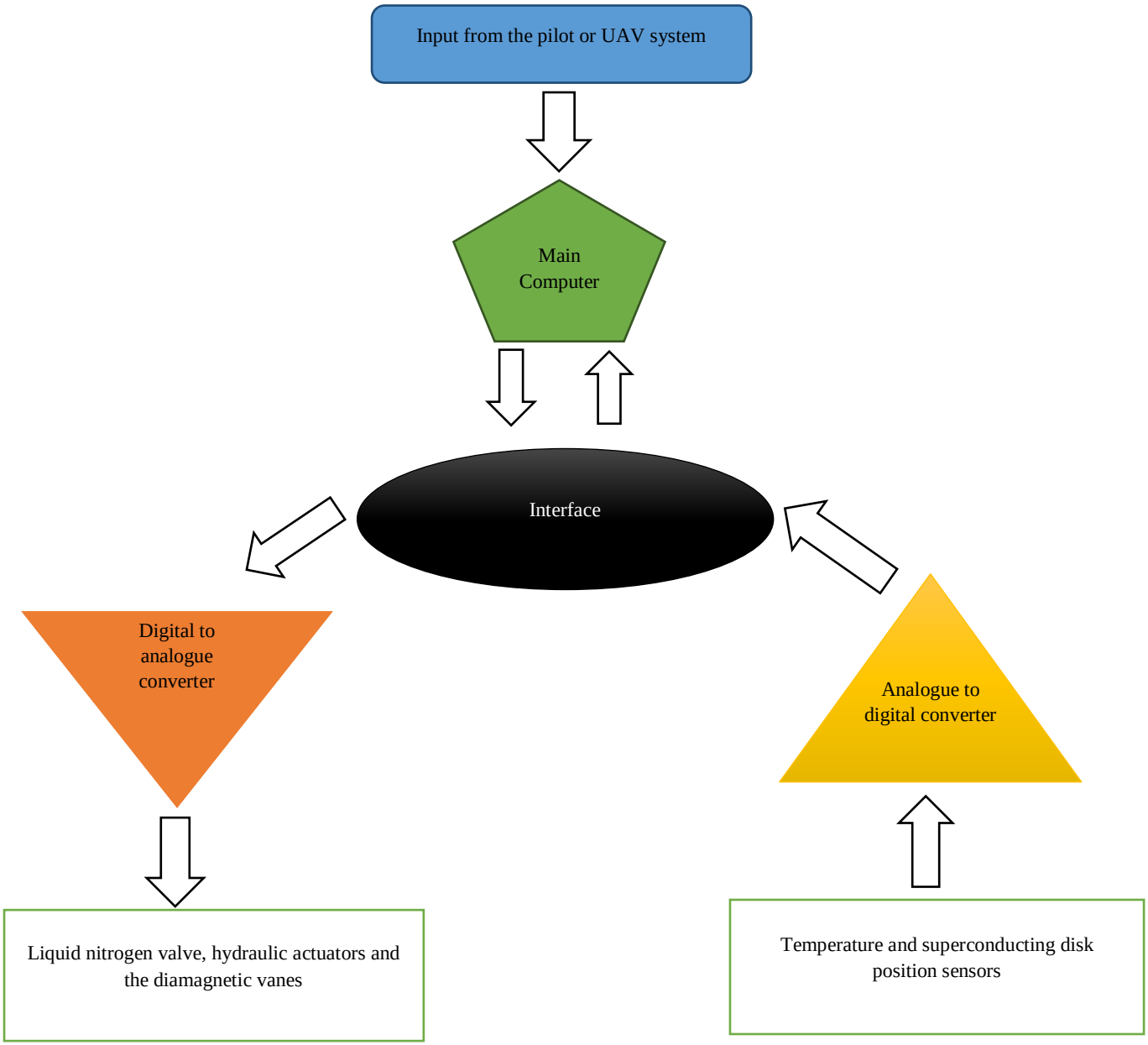
Flowchart – 1: The schematic representation of control system



7. CONCLUSION

The system of flying using the magnetic field pressure is demonstrates in this study. This system is highly economical and pollution free. This flight system produce no noise and can be used efficiently for surveillance, the system could be controlled either by a pilot or UAV system thus enabling the commercial flight to be pilot free. The power is regenerated within the flight module, no external supply is needed once the system is activated.

- The current in the magnetic solenoids persist as far as the temperature of the coils are below their critical temperature, hence by keeping the temperature of magnetic solenoid and superconductor disk below critical temperature, the flight system is kept operating.
- The endurance and range of flight are too high when compared to other flight systems. The time of flight and range continues as far as the temperature of magnetic solenoids and superconductor disk is below their respective critical temperature.
- The operators are free from thinking about fuel cost.

8. REFERENCES

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