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The bionic flapping-wing drive mechanism analysis and design

XuYang[1,a], Xiaolei Zhou[1]
1(College of Mechanical Engineering, Shanghai University of Engineering Science, Shanghai 201620, China)
Xiaoyi Jin *(Department of Mechanical design, Shanghai University of Engineering Science, P.O. Box: 201620, Shanghai, China; Tel/Fax: 021-67874119)*

Abstract: *By comparing the advantages and disadvantages of the current drive mechanism, using Solid works modeling technology, selected by the DC motor driven crank rocker mechanism, as this paper flapping wing aircraft for the drive mechanism, select and calculate the motor to match the two cylindrical parameters gear reducer. Drive mechanism will be established in Solid works model and the simulation results are analyzed in order to obtain the optimal parameter solution.*
Keywords: *MAV, flexible wing, flight mechanism, drive mechanism, flapping flight*

I. INTRODUCTION

The core content of the bionic flapping wing flight vehicle research is to use what way to make the craft to produce enough lift and thrust balance its own gravity and air resistance, in order to realize the maneuvering flight in the air.Which one of the most core structure is the drive mechanism[1].Driving mechanism is the purpose of the operation of the actuator n regulated into wings flapping motion of low frequency, driving mechanism drives the wings flapping, resulting in a spacecraft required lift and thrust[2].

For the flapping wing flight mode, providing the lift and thrust required in the process of flight are heavily dependent on from wings flapping up and down, while wings flapping up and down is driven by the flapping wing flight vehicle driving mechanism to implement, so requires driving mechanism motion process can realize various aircraft flight movements[3].So the drive system is the core part of the bionic flapping wing flight robot, driven by driving system periodically low frequency, large flapping wings, is the key in the process of the flapping wing flight vehicle research.Traditional flapping-wing drive system is general by rack, input parts, fittings, and left and right sides of two wings bar, in this paper, the design of the driving mechanism of the need for two of the most basic requirements: (1) can be driven to periodic large amplitude of high frequency flapping wings to generate the aerodynamic as large as possible;(2) the size of the as small as possible and as far as possible light material and simple structure of the final purpose is to reduce friction and energy consumption[4].

The goal of the flapping-wing drive system design is the execution of the original movement into low frequency flapping wings, drive mechanism drives the wings, air power required to produce aircraft.At the moment, the wings of the insects in the nature joints is present in motion is three-dimensional complex motion, and the research process, by the low degree of miniaturization, large friction loss, impact vibration is strong, the structure is relatively complex, implement multiple degrees of freedom of movement is more difficult, and other limitations, the driving mechanism of the flapping wing mainly adopts unidimensional drive way[5].

II. THE FLAPPING WING DRIVE MECHANISM MODELING AND DESIGN

In this article, the basic principles of a four-bar mechanism is based on the following insect flapping kinematics are discussed.Four-bar linkage design output can be a variety of insect wings movement.Four-bar linkage has been widely applied to drive the flapping wing platform, the four-bar linkage can be a rotation motion, flap is converted into linear movement[6].However, can only simulate the single degree of freedom of four bar linkage wings flapping motion.In this chapter, we put forward a kind of double difference to simulate the insect wings flapping motion of four bar linkage.By using the double difference transformation of four bar linkage mechanism can accurately simulate the insect wings.Followed in previous studies of the driving mechanism of insect wing movement is very complex, and mainly for the setting of test bench.Therefore, this article is the main research goal is to develop a simple driving mechanism to accurately mimic the insect wings, so that it improve the efficiency of the flapping wing flight vehicle the flapping wing flight[7].

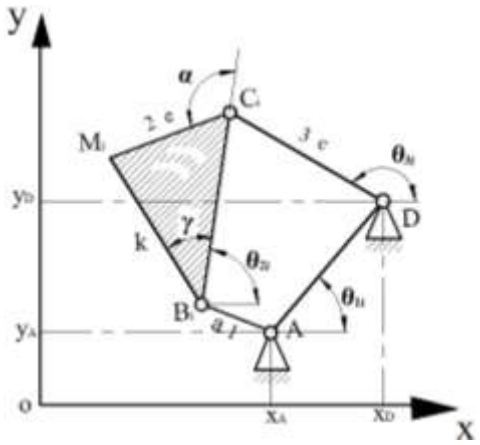


Fig.2-1 Four Bodies Schematic

As shown in figure 3-4, moving because of the connecting rod, can be used in connecting rod choose a point on the coordinates of M (x_M, y_M) ,The connecting rod bearing θ_2 connecting rod position, Therefore, according to a predetermined position of connecting rod design can be expressed as the M (x_M, y_M) point on the connecting rod to a series of predetermined position and the design of the connecting rod with appropriate Angle θ_{2i} .

Establish a coordinate system as shown Oxy , the four-bar linkage is divided into left and right sides two double pole group discussion.Building on the left side of the double pole vector relation, available:

$$\vec{OA} + \vec{AB_i} + \vec{B_iM_i} - \vec{OM_i} = 0 \tag{2-1}$$

Projection on its axis x, y:

$$x_A + a\cos\theta_{1i} + k\cos(\gamma + \theta_{2i}) - x_{Mi} = 0 \tag{2-2}$$

$$y_A + a\sin\theta_{1i} + k\sin(\gamma + \theta_{2i}) - y_{Mi} = 0 \tag{2-3}$$

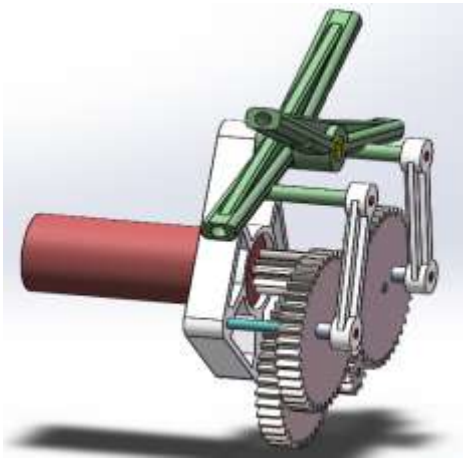
The type of elimination, and finishing available:

$$\begin{aligned}(x_{Mi}-x_A)^2 + (y_{Mi}-y_A)^2 + k^2 - a^2 - 2\left[(x_{Mi}-x_A)k\cos\gamma + (y_{Mi}-y_A)k\sin\gamma\right]\cos\theta_{2i} \\ + 2\left[(x_{Mi}-x_A)k\sin\gamma - (y_{Mi}-y_A)k\cos\gamma\right]\sin\theta_{2i} = 0\end{aligned} \tag{2-4}$$

In the same way, by the right side of his double pole group:

$$\begin{aligned}(x_{Mi}-x_D)^2 + (y_{Mi}-y_D)^2 + e^2 - c^2 - 2\left[(y_{Mi}-y_D)e\sin\alpha - (x_{Mi}-x_D)e\cos\alpha\right]\cos\theta_{2i} \\ + 2\left[(x_{Mi}-x_D)e\sin\alpha + (y_{Mi}-y_D)e\cos\alpha\right]\sin\theta_{2i} = 0\end{aligned} \tag{2-5}$$

And for the movement rule of the flapping wing flight rocker $\alpha = \alpha_0 + \frac{4}{5\pi}(\theta - \theta_i)$, According to the five connecting rod reserve position calculated precisely, After the integer to AB=3.2mm,BC=10.3mm, CD=6.2mm, DA=13.8mm, Initial installation $\theta_1 = \theta_2 = 35^0$ On the basis of the calculation results, the design of bionic flapping wing flight vehicle driver and transmission mechanism 3d model diagram below



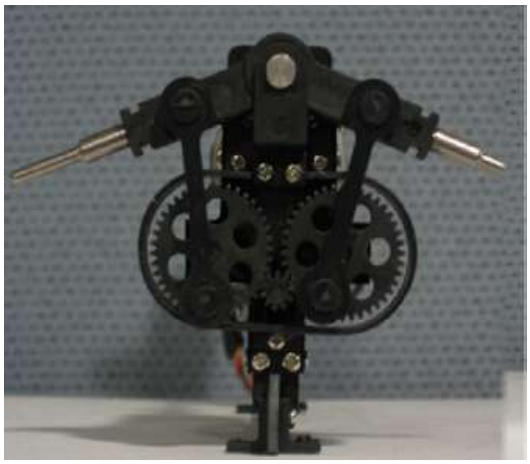


Fig.2-2Drive mechanism modeling Fig.2-3 Drive mechanism drawingentity

III. DRIVE THE OUTPUT RESPONSE ANALYSIS

Driving mechanism were the major influencing output response, reduction ratio, the size of the motor output frequency and other factors[8].At this point, this article hope to form a experimental platform, through the measurement to determine the output of the actuators are designed response characteristic curve.The following are the three schemes for analysis are as follows:

(1) To change from the first way

By changing the length of the crank connected with gear drive directly, the agency movement condition be clear at a glance, it is relatively easy to make.To explore the relations for the size of the flapping wing Angle as shown.Only change driving mechanism in figure ABCD length, and the length of the change in external reducer, convenient disassembling operations.The experimental purpose is very strong, easy to analysis[9].

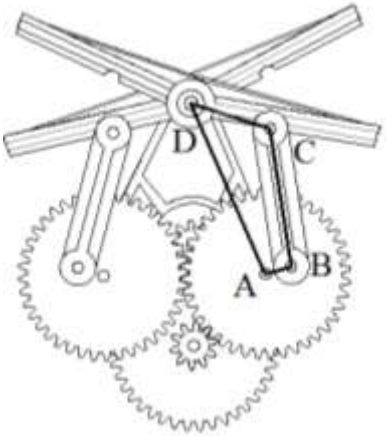


Fig.2-4 Drive mechanism sketch

(2) To change from the second way

Change the motor power, so as to achieve the flapping wing Angle frequency change[10].On the experiment platform operation is difficult, need whole transfer including retarding mechanism, the whole box.This experiment platform has not been reflected, the present stage can only be achieved by 3D simulation.

(3) To change from the third way

Change gear modulus, tooth number of corresponding parameters, such as to achieve the flapping wing Angle change.This experimental platform, a preliminary to replace the whole reducer, by providing different speed ratios observed output difference.This experiment platform designed measurable mechanism of input and output shaft speed sensor device, real time control of the input and output rotational speed can change, after the

observation and record data, data analysis and comparison[11].By changing the experiment of different schemes, analyzing the change of the data, to understand the characteristics of the agencies in the experimental platform.

IV. CONCLUSION

Bionic flapping wing flight vehicle driving mechanism is the aircraft actuator, is one of the key components of the core, so its very important to design and analysis of the dc motor was established based on Solidworks and crank rocker flapping wing kinematics simulation model of driving mechanism, and according to the needs of the flapping wing flight vehicle to overcome the weight of this simple fact, the simulation model was established, constitute a driving mechanism are an integral part of the simulation system, put forward the formation of experimental platform to test the ideaofthe system, and is verified[12].

Through the drive mechanism in the present existing flapping wing flight vehicle, and the research condition and chose usually adopt the basis of plane four-bar linkage, driving force is provided by the motor drive way.Determine the through the adoption of the crank rocker mechanism to realize the wings flapping, miniature dc motor drive is used to drive.

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