Queen Mary
University of London
Science and Engineering

QMUL-BUPT Joint Programme
JP Student Innovation Centre
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Leonardo Project

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What is an ornithopter

A heavier-than-air aircraft with wings that flap up and down like those of a bird

Project introduction

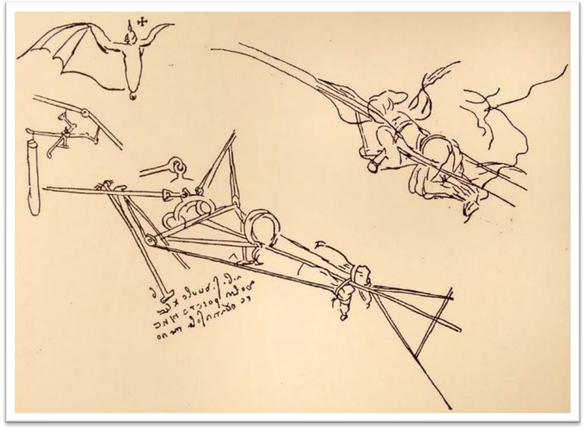
Realizing Da Vinci's idea of ornithopter

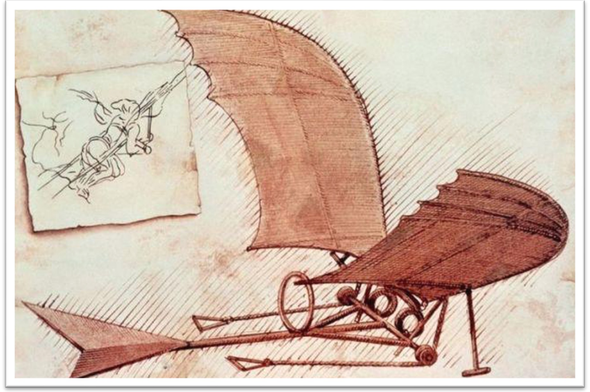
The bird is a machine which works on mathematical principles, and man is capable of imitating this machine including all its movements.

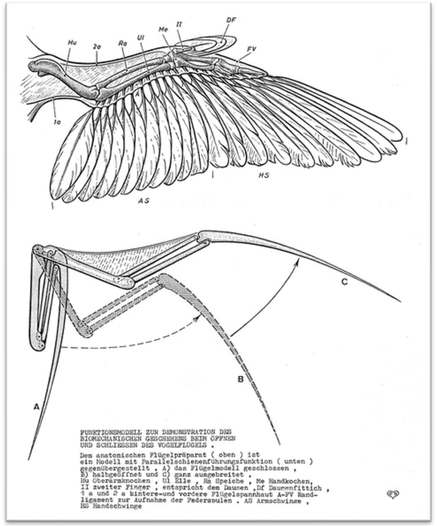
-Leonardo da Vinci

Da Vinci

Research and Draft







The study of Da Vinci

- 《Volo Degli Ucelli》
  - flight posture of bird
  - wing structure of birds
- Ornithopter design
  - Material
  - Power
  - Pneumatic

The core of ornithopter

TIME LINE

Our project process

Da Vinci’s manuscript study

Knowledge of ornithopter design

preliminary design with SolidWorks

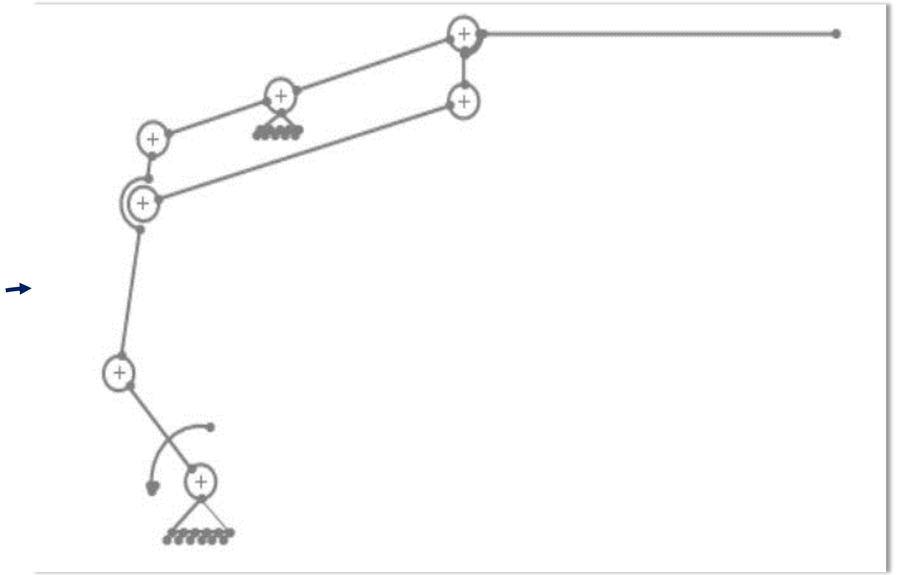
Validate different approaches to design

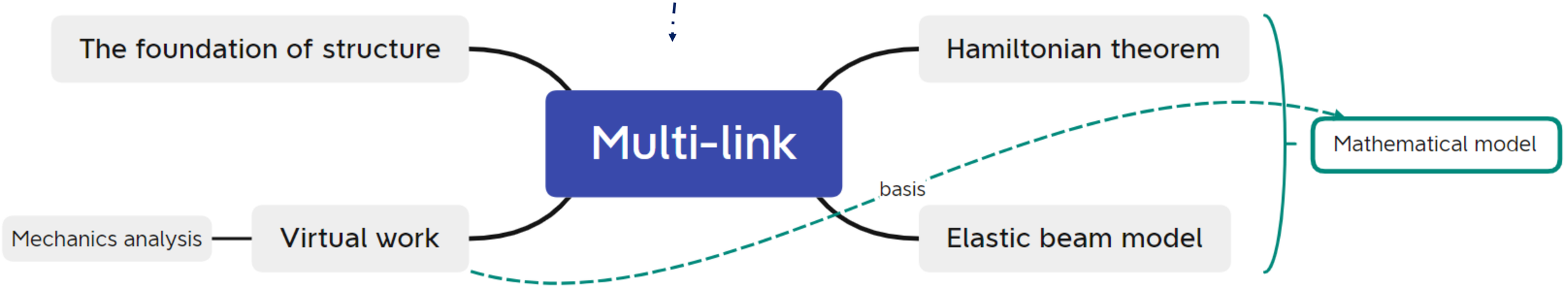
Experiment preparation

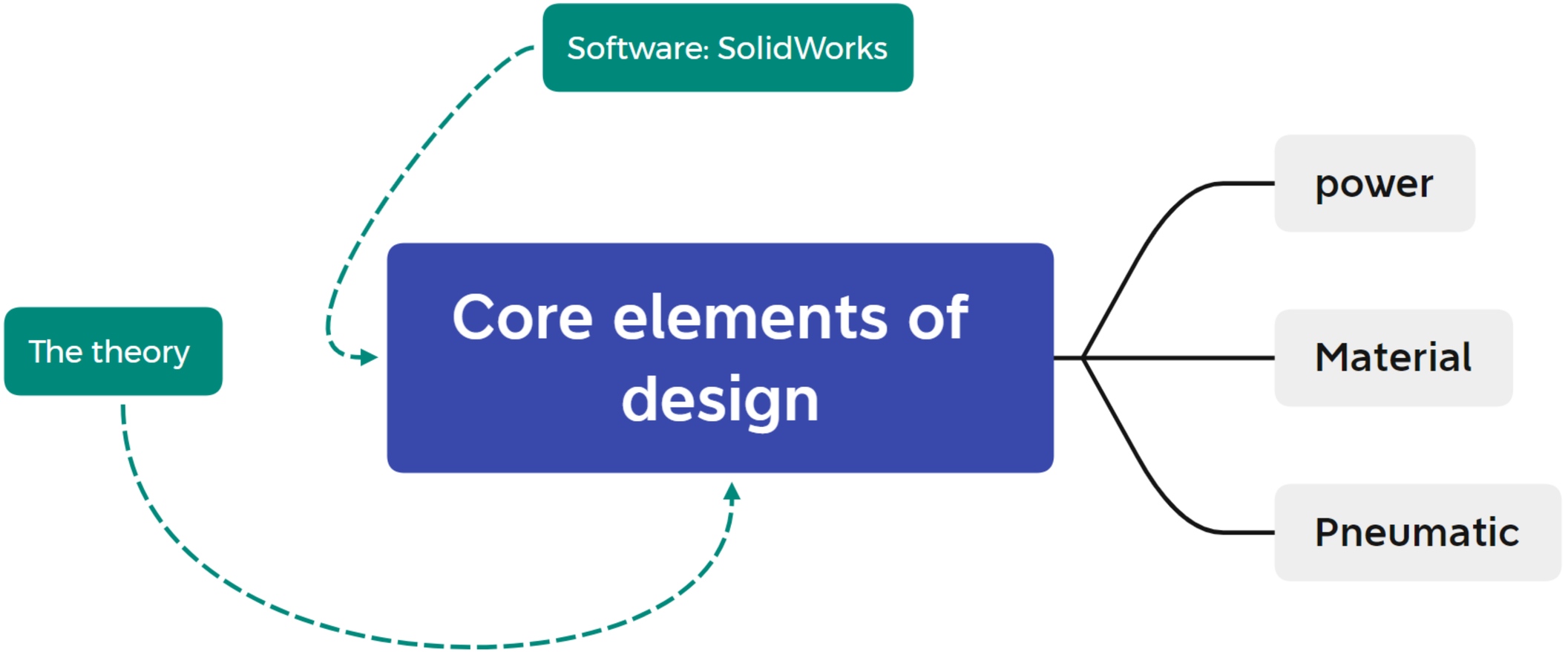
Experiment reflection

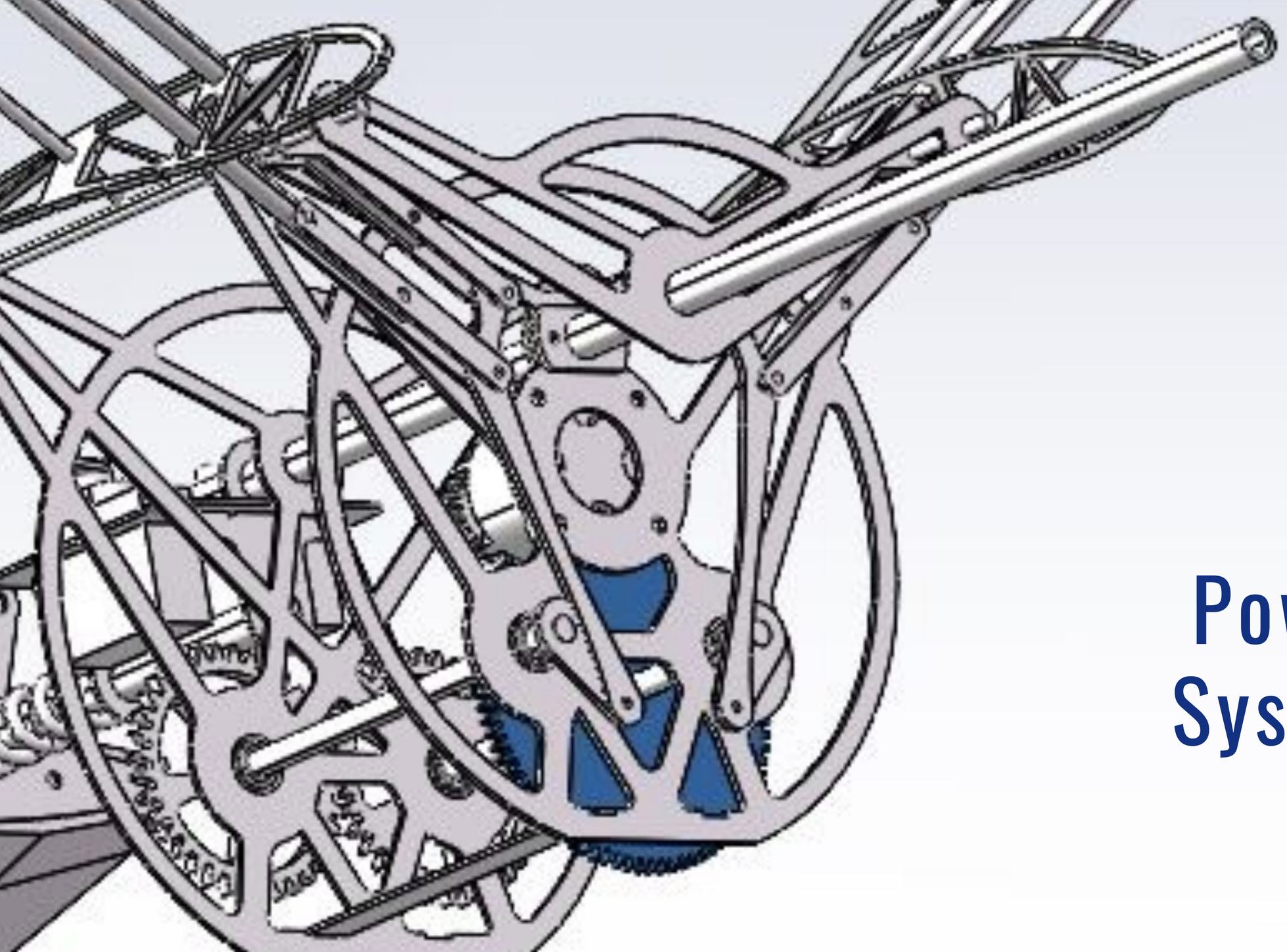
Multi—link

Mechanical analysis and vibration model of Multi—link






Software: SolidWorks
The theory
Core elements of design
power
Material
Pneumatic



Power System

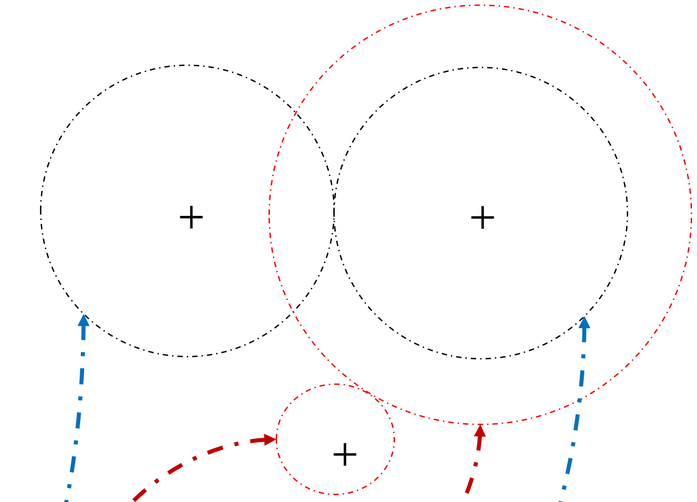
power system

flying frequency of dove

Design frequency of the aircraft: 2Hz

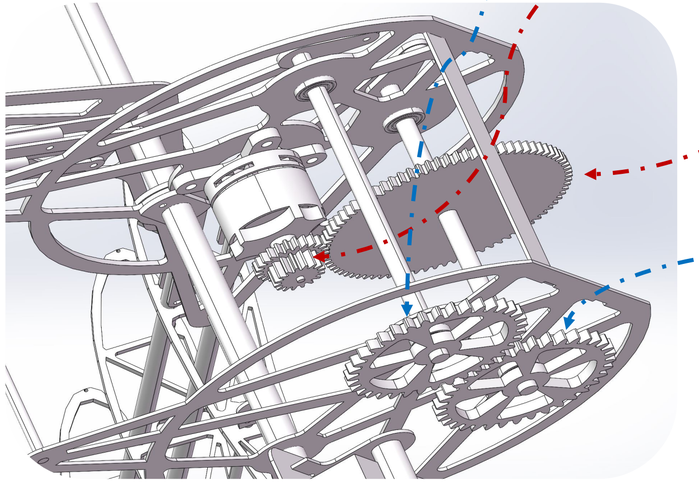
The gear parameters

- Blue drive gear module 0.5, Z1=36
- Red drive gear module 0.5, Z2=80

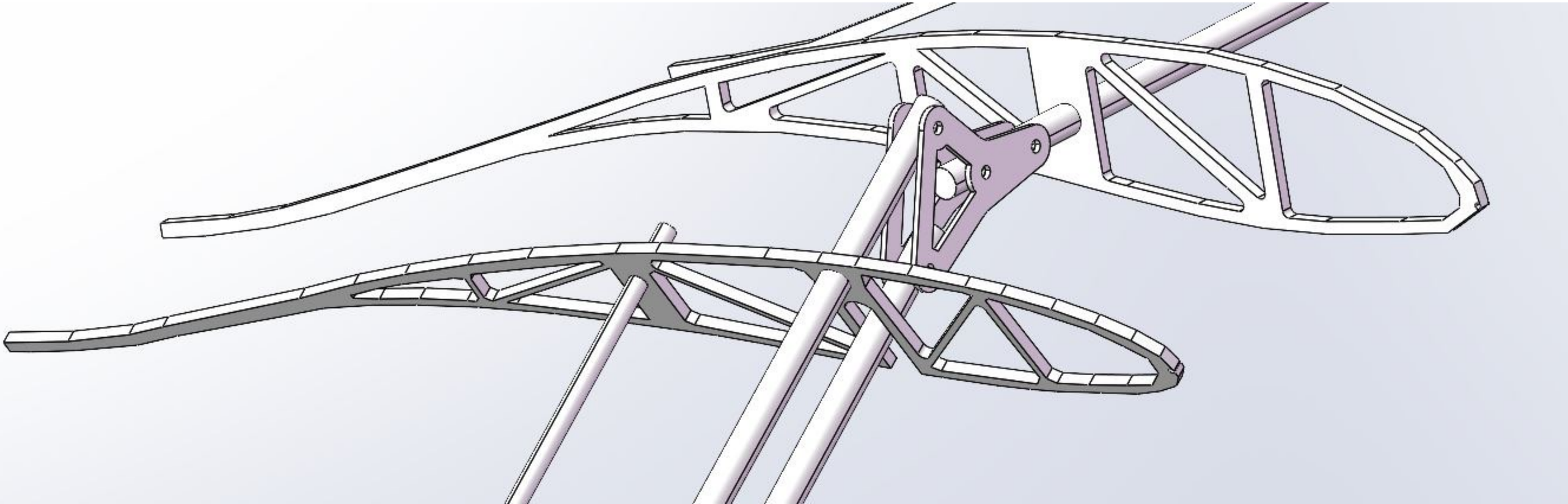


The transmission ratio is 47.6.

The motor speed: n=5712r/min



Pneumatic & Material



Wing surfaces

- The main wing — Provides the main lift
- The lateral wing — Stable airflow

Location and size are different

Material

- structure — PA、PPS
- Wing surface — Flexible material

KRY POINT

The experimental design

✓ Background and Target

There is a mature ornithopter, relevant sensors...

Get a lot of data, build models

✓ The data collection

Load core sensors and collect the rest by ground equipment

Use Bluetooth and data line, Python climb, MATLAB analysis

Pre condition

Sequence	Pre condition
1	Keep no wind, standard temperature and humidity environment
2	Fixed different wind speed, keep wind direction and standard temperature and humidity environment
3	Fixed different wind speed, keep wind direction and standard temperature and humidity environment
4	Keep no wind, standard temperature and humidity environment, fixed different brightness
5	Fixed wind speed, switch wind direction and standard temperature and humidity environment
6	Switch wind direction, wind speed and standard temperature and humidity environment
7	Keep calm in icy conditions

Purchasing items

The equipment number	items	Attachment methods
1	Hanwang ornithopter	/
2	Six-axis Bluetooth accelerometer	belly
3	anemometer	ground
4	Light sensitive switch	ground
5	Tension meter	ground
6	farmar	belly

The experiment plan

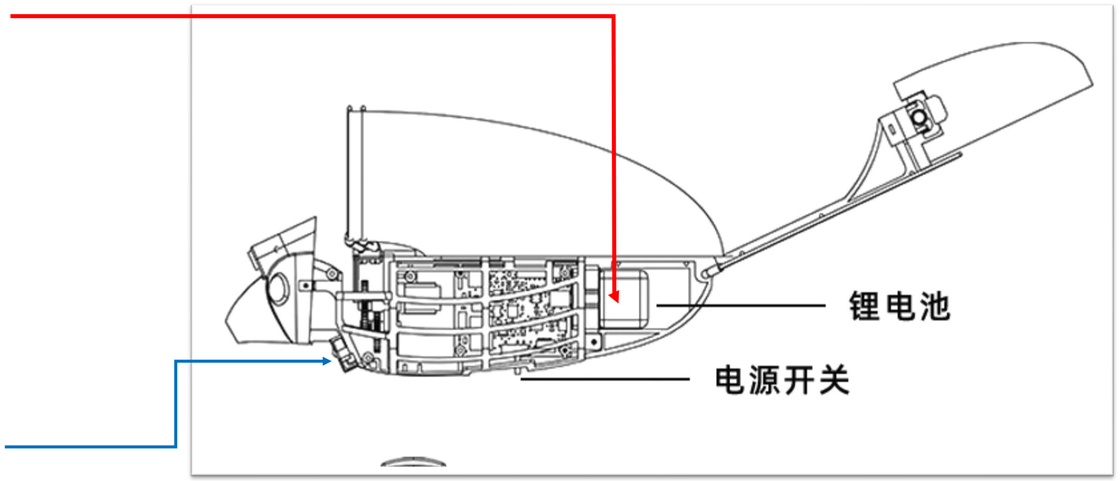
Senoral number	pre condition		The equipment number	Constant in this case	independent variable	dependent variable	independent variable	dependent variable	independent variable	dependent variable	independent variable	dependent variable
1	1/2 /3/4 /5/6 /7	Measure the lift generated by the vehicle under full power operation	1、5	lift	/	/	/	/	/	/	/	/
2		Measure the lift force generated by the aircraft under full power operation (with acceleration sensor)	1、2、5	lift	/	/	/	/	/	/	/	/
3		Measure the influence of different angles (three gears) of the aircraft tail on flight speed and acceleration under full power operation	1、2	lift	Wing Angle 1	Velocity	Wing Angle 2	Velocity	Wing Angle 3	Velocity	Wing Angle 3	Velocity
						v1		v2		v3		v4
						v11222		v22		v33		v44
						acceleration		acceleration		acceleration		acceleration
						a1		a2		a3		a4
						a11		a22		a33		a44
4		By increasing the load (small mass weight) and fixing the Angle of the aircraft tail (third gear) under full power operation, the flight speed and acceleration are measured	1、5、6	lift	Wing Angle 1 / load 1	Velocity, acceleration	Wing Angle 2 / load 1		Wing Angle 3 / load 1		Wing Angle 1 / load 2	Velocity
						v1						
						acceleration		acceleration		acceleration		acceleration

Experiment（trial）

The ornithopter can't keep the sensors flying

The core acceleration and axis Angle cannot be obtained, so it is difficult to build a model based on the remaining data

Attempted to replace the battery but could not determine circuit load

A lighter equivalent sensor could not be found

It is difficult to increase the load by breaking the existing structure