

## DragonFly type Ornithopter Development History

YouTube 動画 <https://www.youtube.com/watch?v=IFPBcfo8epY>

YouTube Video List

<https://www.youtube.com/playlist?list=PLErVdRrwWuPpgaNLam--ZhGjSwbwl3px>

PDF file(English & Japanese) : <http://kakutaclinic.life.coocan.jp/DvlpHDFY.pdf>

トンボは複雑で卓越した飛行を行う。

2012年、トンボ型羽ばたき機 開発を開始した。

多くのトンボの飛行ビデオを見て、設計図を描いた。

Dragonflies perform complex and remarkable flight.

In 2012, I started developing a dragonfly-type ornithopter.

I watched many dragonfly flight videos and drew blueprints.

## Dragonfly21 (最初に製作したトンボ型羽ばたき機) 2012

Width 67cm Length 56cm Weight 186g

Gear を 2 対とし、それぞれで 4 枚の羽を羽ばたかせた

前羽の左右の羽の迎角の差でエルロン操作

前羽の左右の羽の上下動作でエレベーター操作

その後、

前羽の左右の羽ばたき振幅の差でエルロン操作

前羽の羽ばたき周期を後羽の周期より 1/4 遅らせることで

気流の流れの乱れを抑え、推力を得る

本物の羽ばたきに近い羽ばたきを創ることを心がけた。

様々な試行錯誤を行った。

うまく飛行ができるようになるまで 4 年を要した。

Two pairs of gears, each flapping four wings

Aileron operation by the difference in angle of attack between the left and right wings of the front wings

Elevator operation by vertical movement of left and right front wings  
after that,

Aileron operation by the difference in flapping amplitude between the left and right front wings

By delaying the flapping cycle of the front wings by 1/4 from the cycle of the rear wings,

Suppress turbulence in air currents and obtain thrust

I tried to create flapping that was close to real flapping.

I went through various trials and errors.

It took him four years to learn to fly well.



DragonFly 21- 4 : Action Test of the frame

<https://www.youtube.com/watch?v=AkGNjCbDjhc>

前羽の迎角の変更 エルロン、エレベーター

DragonFly21-11 with New Flight control system

<https://www.youtube.com/watch?v=EeE5IZWC5N0>

左右の羽ばたきの振幅を変えて左右に曲がるように操縦する

Dragonfly21-11 with Wing flapping amplitude change system: An effect to a roll axis

<https://www.youtube.com/watch?v=t0CyvUdrIIA>

Dragonfly21-12 : Flapping Phase setting for good Thrust for Flight

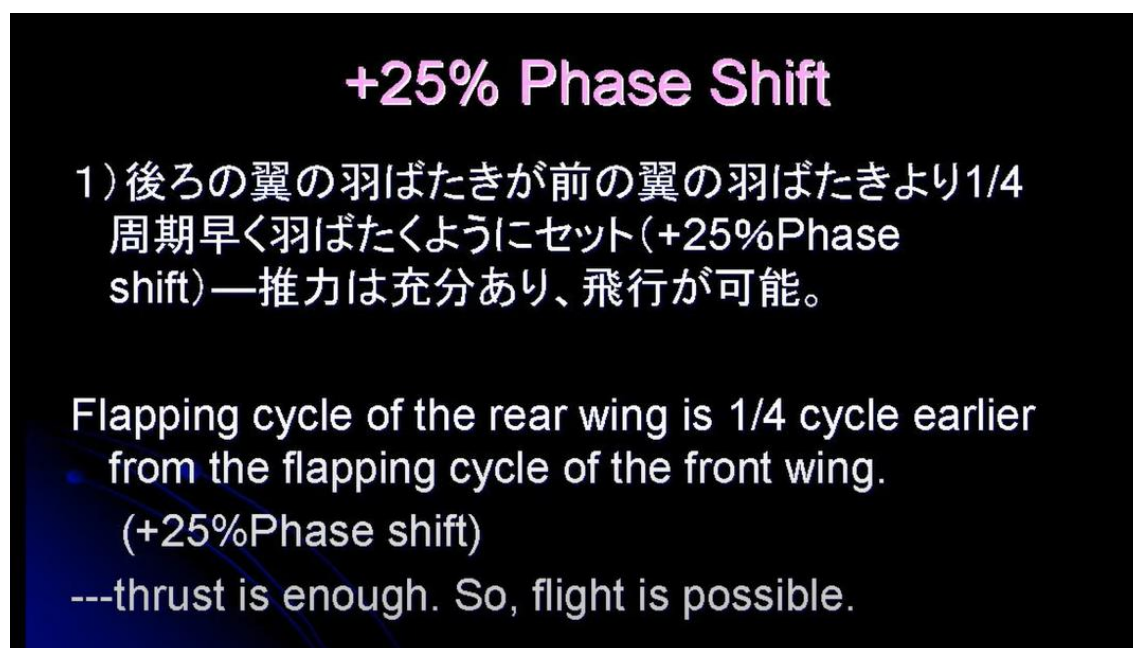
<https://www.youtube.com/watch?v=uFUIZm1mF6c>

前羽の羽ばたき周期を後羽の周期より 1/4 遅らせることで気流の流れの乱れを抑え、推力を得ることができる。

前羽の羽ばたき周期を後羽の周期より 1/2 遅らせると気流が流れ、推力を得ることができない。

By delaying the flapping period of the front wings by 1/4 from the period of the rear wings, it is possible to suppress the turbulence of the air current and obtain thrust.

If the flapping period of the front wings is delayed by 1/2 from the period of the rear wings, the air flow will flow and thrust cannot be obtained.



**+25% Phase Shift**

1) 後ろの翼の羽ばたきが前の翼の羽ばたきより1/4  
周期早く羽ばたくようにセット(+25%Phase  
shift) — 推力は充分あり、飛行が可能。

Flapping cycle of the rear wing is 1/4 cycle earlier  
from the flapping cycle of the front wing.  
(+25%Phase shift)  
---thrust is enough. So, flight is possible.

Dragonfly21-12 with Wing flapping amplitude change system: Elegant Good Flight

[https://www.youtube.com/watch?v=7whh1dk\\_Cp4](https://www.youtube.com/watch?v=7whh1dk_Cp4)

Dragonfly21-12 with Wing flapping amplitude change system: Elegant Good Flight2

<https://www.youtube.com/watch?v=vsuSiaCLhwI>

**Dragonfly48    width 74 cm length 51 cm weight 120 g    2015**

後羽が接合した前羽を羽ばたかせることで推力を生成。

Gear は 1 対

後羽は前羽より下方に 30 度ずれて固定-New Wing System

これにより、前羽から後羽に流れる気流の乱れを避ける。

後羽の迎角を変えることでエルロンとエレベーター操作を行う。

強い推力を得ることができ、操縦性も高く、アクロバティックな飛行が可能

Produces thrust by flapping the front wings to which the rear wings are joined.

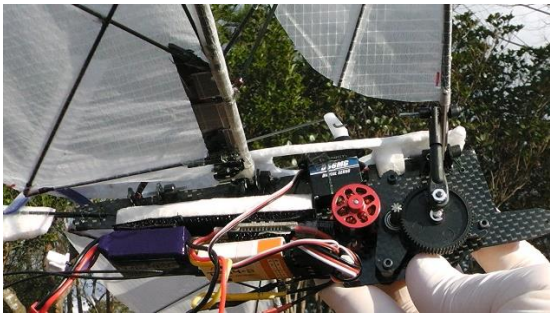
One pair of Gear

The rear wings are fixed 30 degrees below the front wings - New Wing System

This avoids turbulence in the airflow flowing from the front wings to the rear wings.

Ailerons and elevators are operated by changing the angle of attack of the rear wings.

It is possible to obtain strong thrust, high maneuverability, and acrobatic flight.



Dragonfly48: Second Flight Test : Splendid Flight !! Acrobatic flight-- Flip and Looping

<https://www.youtube.com/watch?v=fJulJHSdw1U>

Dragonfly48: Excellent Acrobatic Powerful Flight

<https://www.youtube.com/watch?v=5Al-RmUATbg>

Dragonfly48: Excellent Acrobatic Powerful Flight 2

<https://www.youtube.com/watch?v=RRfCgj8wXMw>

Dragonfly48: Excellent Acrobatic Powerful Flight 3

<https://www.youtube.com/watch?v=ZPsdK398i84>

Dragonfly48: Excellent Acrobatic Powerful Flight 4

<https://www.youtube.com/watch?v=KPIGMhxHGSI>

**DragonFly49 width 73 cm length 48 cm weight 113 g 2015**

Gear は 1 対

後羽は反対側の前羽と接合。

前羽は重心上部で羽ばたき、後羽は重心下部で羽ばたく

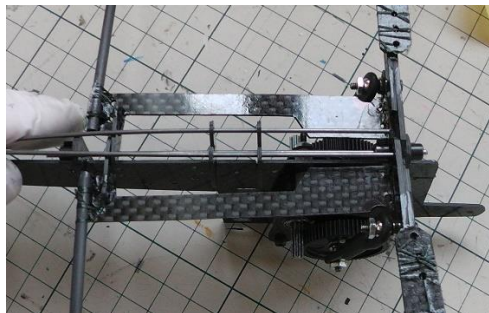
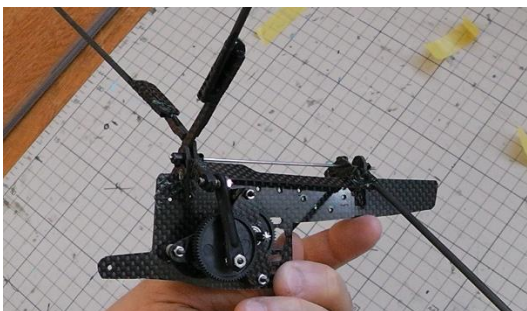
飛行は不安定

Gear is 1 pair

The rear wings are joined to the front wings on the opposite side.

Front wings flap above the center of gravity, rear wings flap below the center of gravity

The flight is unstable



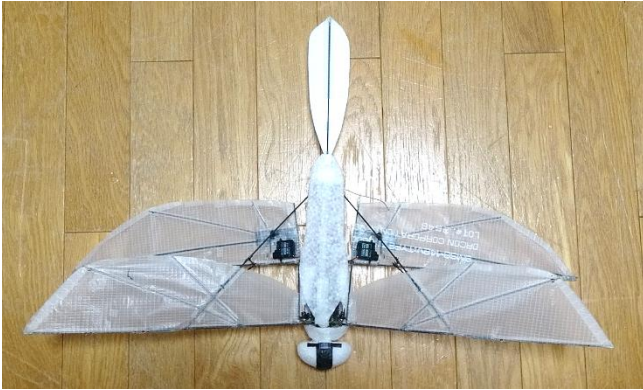
Dragonfly49: 7th Flight Test : Good Flight

[https://www.youtube.com/watch?v=J\\_AMfhXTNMg](https://www.youtube.com/watch?v=J_AMfhXTNMg)



**DoragonFly78      Wingspan:59cm length: 40cm Weight:101g      2020**

Dragonfly48 と同じ構造      やや小型  
Same structure as Dragonfly48      Slightly small



Ushiabu78 : Second Test Flight with Body of Dragonflu48 and Test Flight DragonFly78 with Body  
<https://www.youtube.com/watch?v=Fo0EMf-8AR8>

## サーボ駆動トンボ型羽ばたき機 試験飛行 7 SFODragonfly92 with Long Wings 7th Flight

### Test at Seaside 2021

Wingspan 820mm Length 430mm Weight 30g

<https://www.youtube.com/watch?v=bfMrL3YVpHw>

Servo Drive System の羽ばたき機

1つの Servo で接合した前羽と後羽を同時に羽ばたかせる

推力が上がらずよく飛ばなかった。

Flapping the front and rear wings joined by one Servo at the same time

The thrust did not increase and it did not fly well.



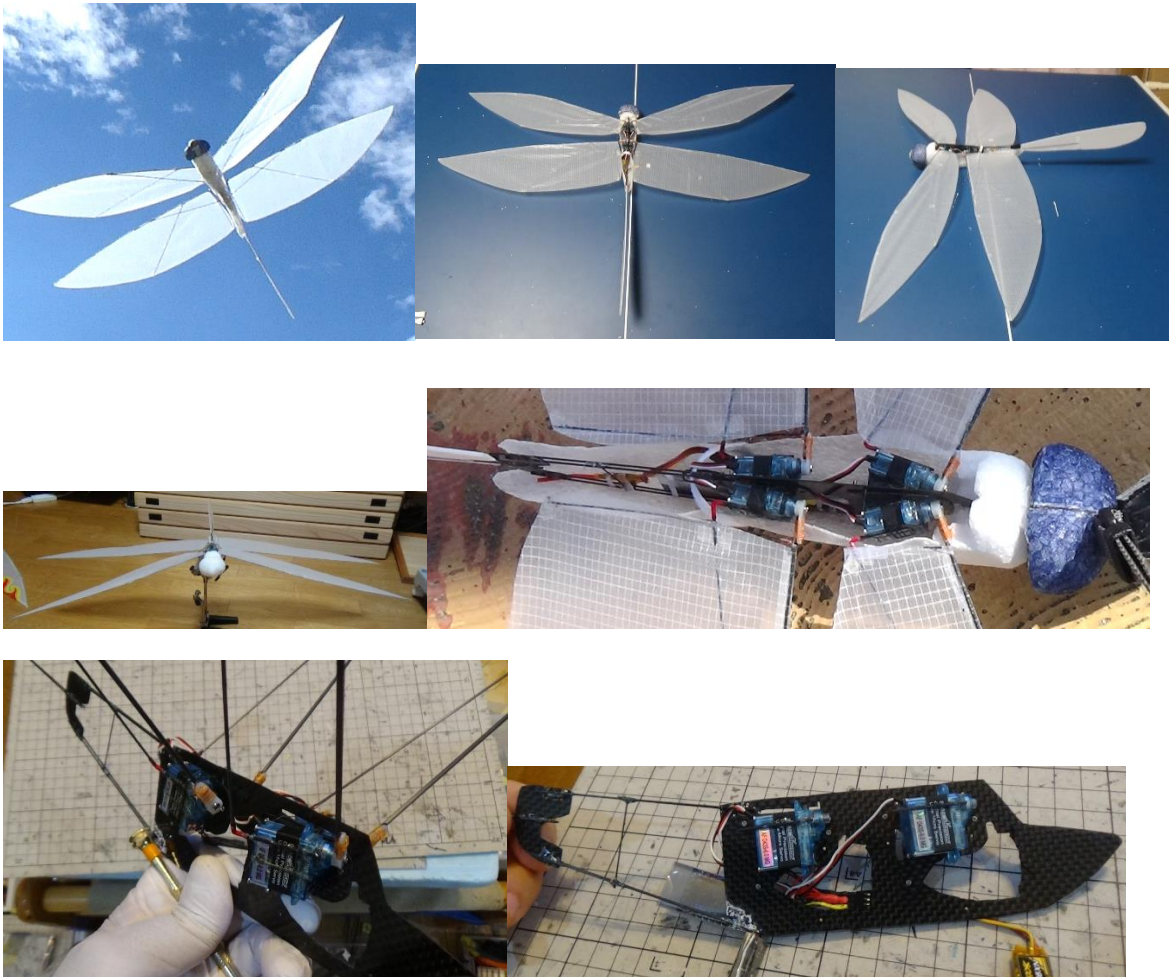
**SFODragonFly90-4Servo Wing Span 87cm Length 51cm Weight 52g 2021**

Arduino CODE による羽ばたきと羽の動作の制御

これにより、本物のトンボに近い羽ばたきができるようになった。

Controlling flapping and wing motion with Arduino CODE

As a result, it became possible to flap its wings close to that of a real dragonfly.



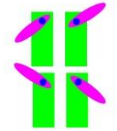
Arduino CODE for ServoFlapOrnithopter90-4S(4 Servo)

<http://kakutaclinic.life.cocan.jp/SFOsys4S.html>

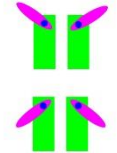
## Servo Flap system for Butterfly & DragonFly type Ornithopter



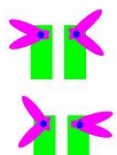
ch3 throttle Up --Flapping amplitude large thrust large  
Down-Flapping amplitude small thrust small



ch5 cycle time --large --Flapping cycle time long -- Flapping amplitude large  
small--Flapping cycle time short--Flapping amplitude small



ch1 Aileron stick left --Left servo horn down Right servo horn up -- Turn to Left  
stick right--Left servo horn up Right servo horn down -- Turn to Right  
**CG moves in the turning direction**



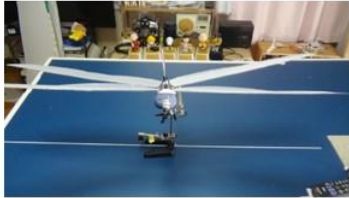
ch2 Elevator stick up --Left and Right servo horn up - ---Elevator Down  
stick down Left and Right servo horn down ----Elevator Up



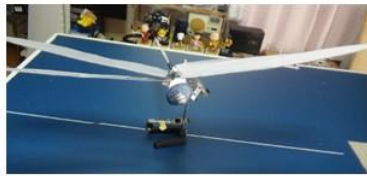
ch4 Rudder stick right --Left servo flapping angle large /Right servo flapping amplitude small ---turn to right  
stick left --Left servo flapping angle small /Right servo flapping amplitude large ---turn to left

## Aileron Flight control of Dragonfly type Servo Flap Ornithopter

SFODragonFly90-4Servo



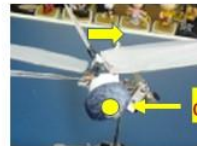
Straight Flight



Turn to Left

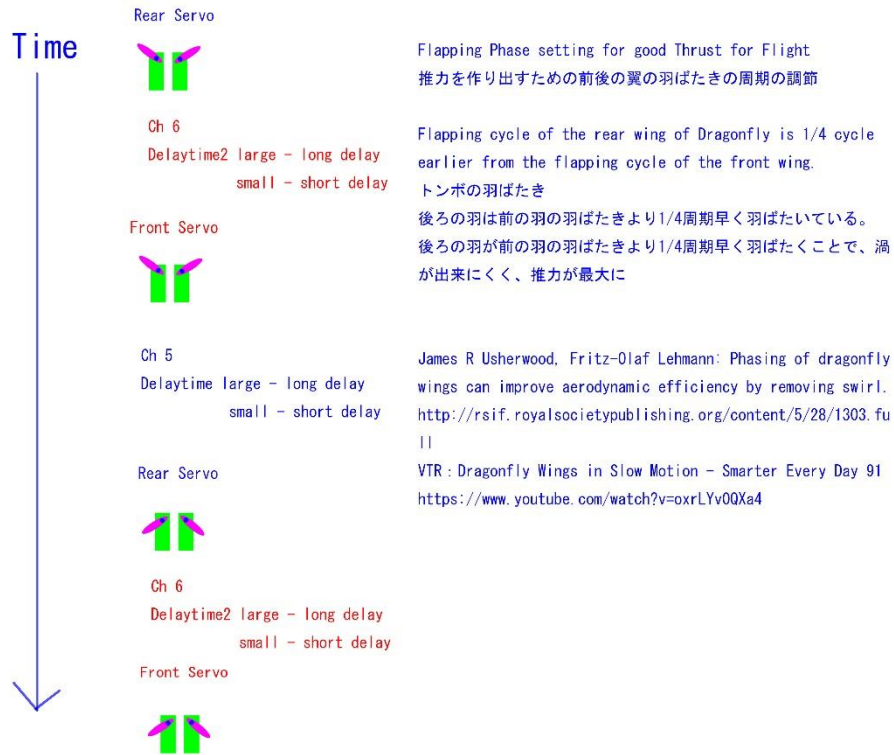


Turn to Right

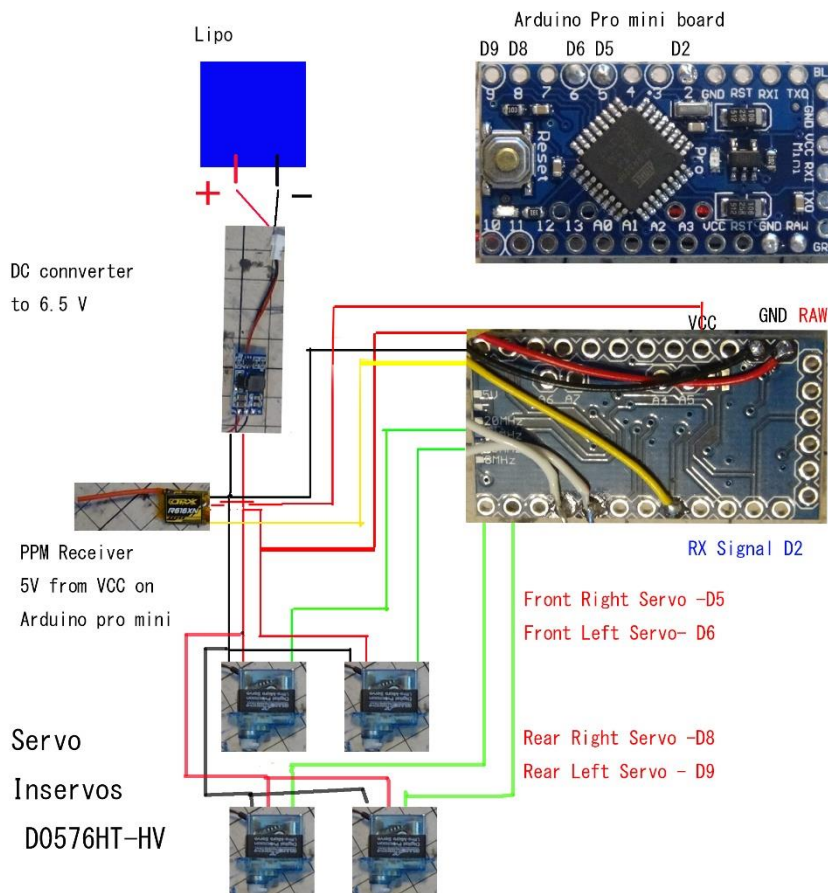


center of gravity

## ServoFlap system of 4 serevo



## ServoFlap system 4 servo Wiring



4 ServoFlap System : Flapping Phase setting for good Thrust for Flight 推力を作り出すための前後の翼の羽ばたきの周期の調節

<https://www.youtube.com/watch?v=C5wGLHqx9OA>

サーボ駆動トンボ型羽ばたき機 4サーボ SFODragonfly90 4servo 57g: Wing motion by New CODE

<https://www.youtube.com/watch?v=OnZWZERdAUQ>

サーボ駆動トンボ型羽ばたき機 4サーボ SFODragonfly90 4servo 57g: Good Flight

<https://www.youtube.com/watch?v=KGS-VylW6WU>

サーボ駆動トンボ型羽ばたき機 4サーボ SFODragonfly90 4servo 57g: Flight in Strong Wind

<https://www.youtube.com/watch?v=g1cLVK8xBgQ>

強風の中での飛行。ほぼホバリング状態。

Flying in strong winds. Almost hovering.