HARDWARE FOR GRIFFIN

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Objectives and Needs

Design of the complete electronic system

- High computing capacity for control and perception
- Real time control for automatic and manual control
- General power supply
- Possibility of integrating different sensors and actuators
- Lowest possible weight
- Suitable shape to integrate with ornithopter design
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Computers

Why do we need a computer?

- WiFi network capability
- Allows remote connection from ground station
- High computing performance for different algorithms
- Use of different library
  - Optitrack
  - Perception libraries
- Easy to use
Computers

Two Options

**KHADAS VIM 3:**
- More powerful, heavier
- Essential when using perception
- Size: 82 x 58 mm
- Weight: 28.5g

**NanoPi Neo AIR:**
- Less powerful, lighter
- For simpler algorithms
- Size: 40 x 40 mm
- Weight: 7.5g (WITHOUT Pin-headers)
Computers

Before Perching Integration

**KHADAS VIM 3**
- Event and imagen processing
- Event-based line detection and tracking
- IMU processing
- Visual servoing in quadrotors
- Dataset collection

➢ Papers submitted:
  - IROS 2019
  - RA-L 2020

**NanoPi Neo Air**
- Adaptative longitudinal Control
- Lateral Control
- Frequency Control
- Robust Control
- Trayectory Control
- Loggin datasets
- Experiments of capability

➢ Papers submitted:
  - IROS 2019
  - RA-L 2020
Computers

After Perching Integration

**KHADAS VIM 3**
- Event and image processing
- Event-based line detection and tracking
- IMU processing
- Visual servoing in ornithopter
- Dataset collection
- Control techniques
- **Closing loop with Control and Perception**

**NanoPi Neo Air**
- Improve current control algorithms
- Testing new controls
- Testing new design of ornithopter
- Testing new actuators and sensors

**Computer**
- Both computers work well
- Depending on task, you must choose a computer
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Carriers

Why do we need a carrier?

- Microprocessor for real time
- General power supply for all components
- Radio Control Capability
- To Read Sensors
- Sending control signals
- Connection between Computer and ornithopter
Carriers

Two Options

Catec’s Carrier for KHADAS VIM 3:
- Similar microcontroller, more general.
- Including additional connectors for manipulation servo motors and 2S battery connector
- Size: 82 x 58 x 1.6 mm
- Weight: 31.74g (without wires)

E-Flap Carrier for NanoPi Neo AIR:
- Similar microcontroller, more specific.
- For more simple algorithms
- Size: 50 x 50 x 0.6 mm
- Weight: 14.27g (with some wires)
Carriers

Catec’s Carrier for KHADAS VIM 3

Characteristics
- STM32F303 High-performance → ARM Cortex M4 core at 72 MHz
- Two DC/DC regulators
- Optocoupler to 7 PWM for servo motors
- ESC, RC Receiver, programmer, analog inputs, VN200, battery and 5V output connectors

Advantage:
Customized Carrier for design and control. Oversized PWM for more actuators. Small and light. Without bugs

Disadvantages:
Not connectors for manipulation servo motors.
Carriers

Catec’s Carrier for KHADAS VIM 3

Characteristics
- STM32F446 High-performance → ARM Cortex M4 core at 180 MHz
- Two DC/DC regulators
- Optocoupler to 7 PWM for servo motors
- 4 UARTs for manipulation servo motors
- ESC, RC Receiver, programmer, analog inputs, VN200, batteries and 5V output connectors

Advantage:
General Carrier for all tasks. Oversized microcontroller (with a lot of pins) and connectors.

Disadvantages:
Not optimized. Too many GPIOs. Some bugs (e.g. a capacitor is missing and a PWM not found)
Computer + Carrier

After Perching Integration

Due to delays in the fabrication of Catec's PCB, we have used a E-Flap Carrier for integration.

**Advantage:**
- Robust and functional carrier
- Make us, we can repair and make new PCBs
- Lighter and cheaper

**Disadvantages:**
- Do not have a manipulation servo motors

**Conclusions:**

- ✓ The power supply is correct
- ✓ Device compatibility is correct
- ✓ Communication software works independently of the devices used
- ✓ A solid foundation for future development
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Next Steps

Currently

We have two independent computers and carriers (tested only one)

Advantage:
- Robust and functional electronic system
- Easy to fix

Disadvantages:
- Electronics adapted to the shape of the computer but not the shape of the ornithopter
- Not measure Flapping speed

Future

- Only one electronics for all computers
- PCB will be the body of the ornithopter

Advantage:
- More integration and sensors, fewer wires
- Everything has its place, cleaner, cooler and lighter

Disadvantages:
- More difficult to fix
Next Steps

What is the idea?

PCB in one of the ornithopter framework
Possibility of expanding with more sensors and actuators in the other framework

Problems to solve:

- Simultaneous mechanical and electronic design
- Structural problems in crashes
- Possibility of using composite materials for the framework
- Currently, a new board is being designed to serve as the basis for PCB design.
To end...
Launcher

Hardware for Launcher

- ESC Odrive to control
- Rotative encoder sensor
- Brushless motor
- Arduino for interface
Launcher