Universitatea Politehnica București

Facultatea de Automatică și Calculatoare

Catedra de Calculatoare

Formation Flight for Unmanned Aerial Vehicles

Bachelor Thesis: July 13th 2013

Author:

Alexandru George Burghelea

aburghelea@rosedu.org

Scientific Adivisers:

Prof. Adina Magda Florea

Ing. Mihai Trăscău

Ș.l. Cătălin Leordeanu

Index

UAV (*Unmanned Aerial Vehicle*)

- no pilot **on board**
- remote controlled or
- completely autonomous
- envisioned by N. Tesla in 1915
- used in military and civil missions
- rotor based or fixed-winged

Figure: http://http://aerosdb.com/uav-drone/

About:

- in collaboration with *Teamnet International S.A.*
- aims to build a management platform for a fleet of UAVs

Scope:

- development of autonomous flight modules for the Hirrus drone
- development of a software platform for programming, tracking and remote controlling of the drones

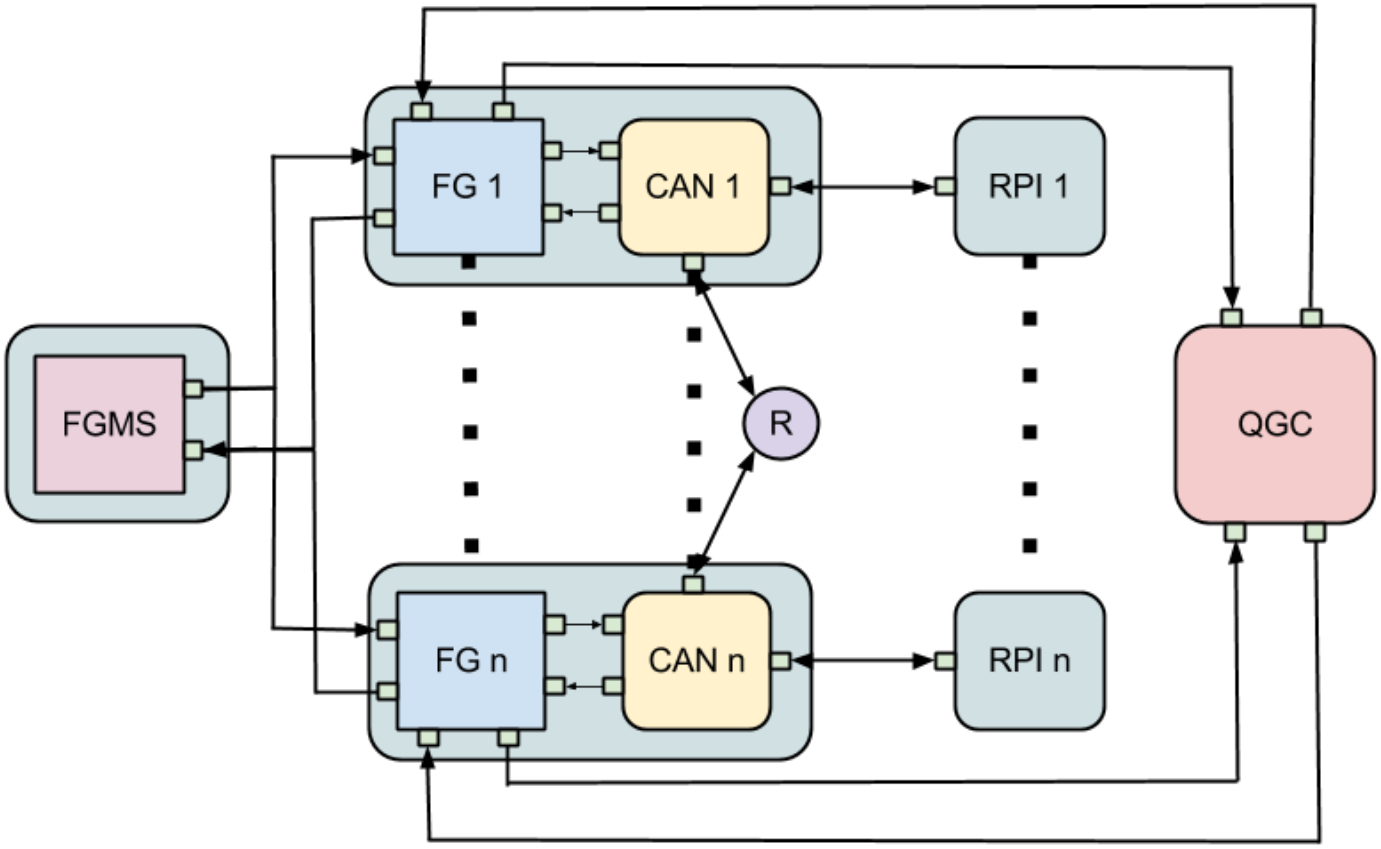
Figure: http://aft.ro/bro.pdf

Destination	law enforcement, reconnaissance, search and rescue, cartography
Dimensions	Wingspan 2.35 m / Length 1.1 m / Weight 7 kg
Speed	Max 130 km/h, Cruise 90 km/h
Payload	0.7 kg
Propulsion	Electric
Endurance	180 m
Range	15 km

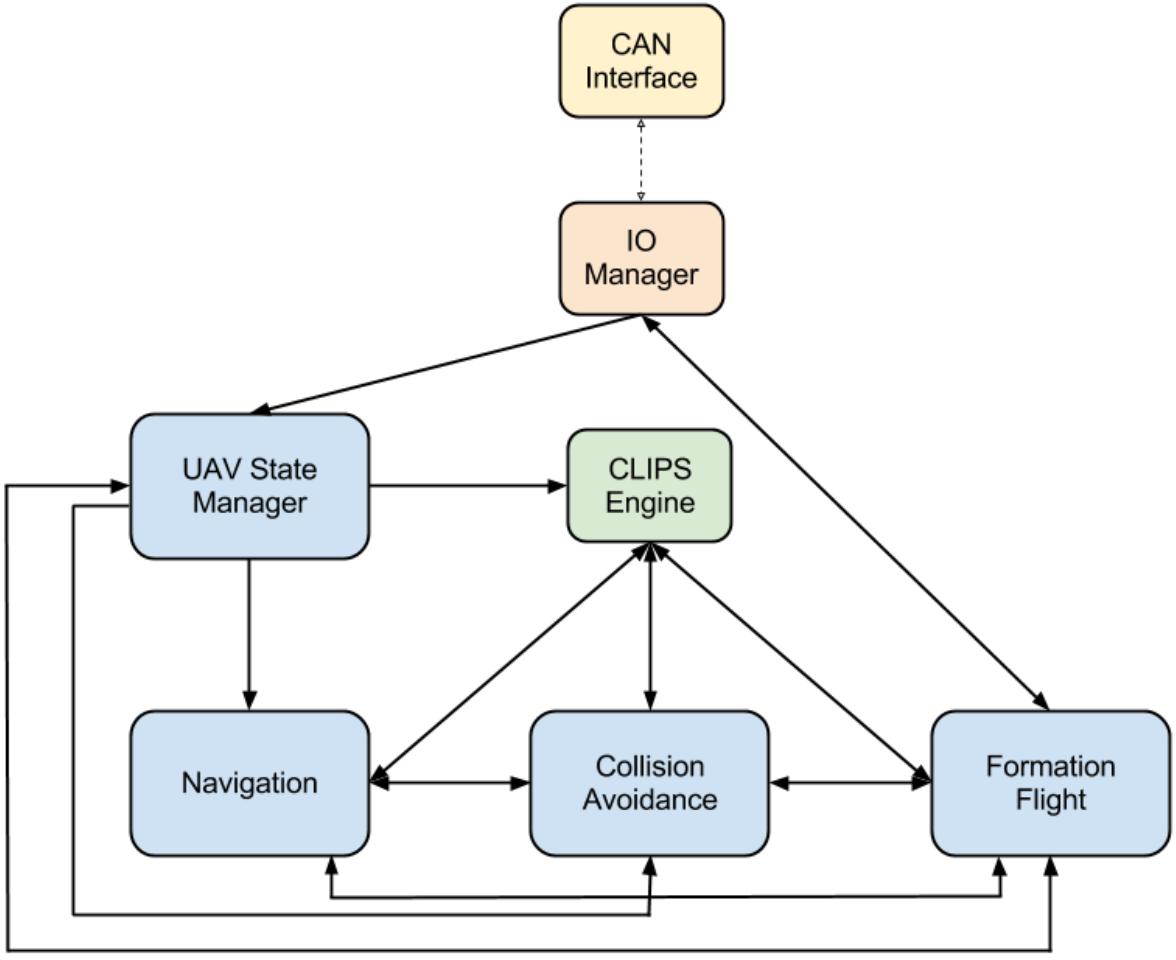
Platform Objectives

- Ground Control System based on QGroundControl
- Mission Monitor System
- Remote Control Module for mission override and manual control
- Autopilot for Hirrus with *Collision Avoidance* and *Formation Flight* modules
- Artificial Intelligence Module for mission execution.

Platform Simulation Architecture



Autopilot Architecture



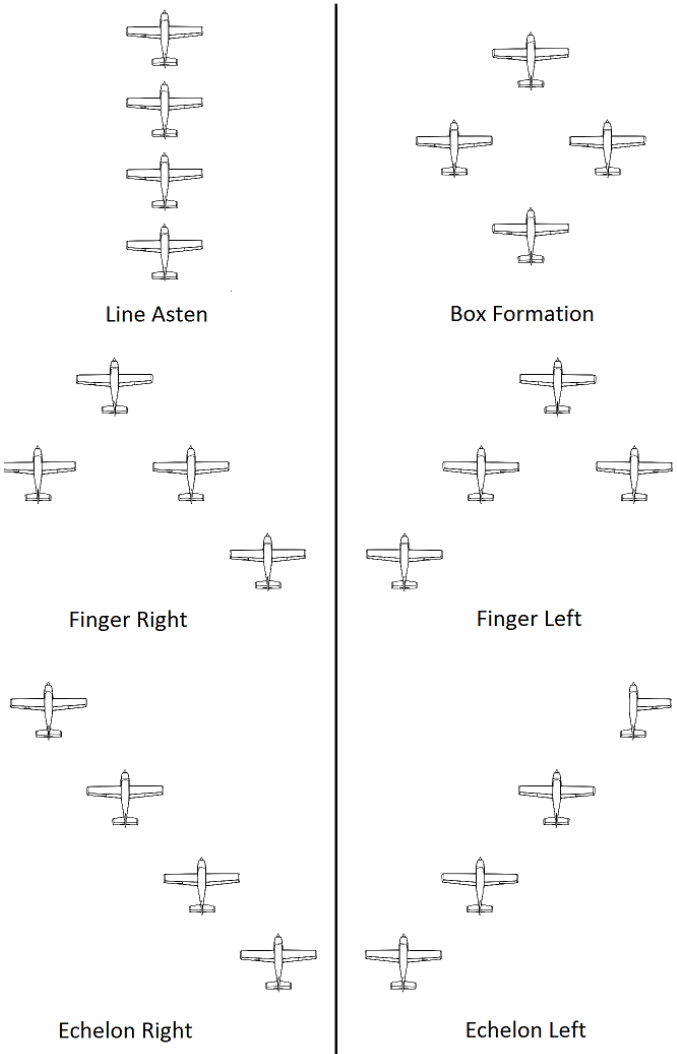
Thesis Objectives

- close range formation flight module
- decentralized communication
- reactive agents
- inspired by real life animal swarms

Formation Flight

- 3 or more UAVs flying in formation
- simulated using Flight Gear Flight Server
- close range
- follow the leader algorithm
- GPS and ECEF coordinates based on WSG84 ellipsoid

Types of Formation



Tested Formations

3 UAVs Formations

- Line Astern
- V Formation

Evaluation and Results

- tested with dedicated leader
- leader with it's own mission
- other UAVs have a *follow the leader*
- 9% to 25% of time spend for maintaining the formation
- 60% to 70% of time spend for entering the formation
- 15% to 20% of time relieving control for collision avoidance

- communication delay can decrease the time spent in formation maintaining
- communication delay can induce formation detachment
- 300 feet ($>$ 100 m) distance between UAVs
- for tighter result another coordinate system is needed
- computational errors are induced by the ellipsoid model while converting coordinates

Future Work

- formations based on a virtual leader (geometrical center of formation)
- simulating with Flight Gear instances running on dedicated machines
- communication between AI modules and Hirrus via CAN bus
- PID controllers for speed and steering

Questions

Keywords:

- UAV
- Decentralized
- Reactive
- Flight Gear
- Hirrus
- QGroundControl
- Formations
- Communication
- Swarm
- Close Range Formation