Final Year project Term 1: Quadcopter Swarm

HUANG ZILONG Edward
YI WEIYING
Supervised by:
Professor MAK Sui Tung Terrence
Professor LEUNG Ho Fung

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING,
THE CHINESE UNIVERSITY OF HONG KONG

Outline

Introduction

- Why Quadcopter ?
- Why Quadcopter Swarm ?

Communication

- Objective
- Current situation and problems
- Our approach
- Video Demo
- Further objective

Outline

Coordination

- Current situation and problems
- Our approach
- MATLAB Simulation
- Further objective

Simple GPS Tracking prototype

- Mechanism
- Video Demo

Introduction

- Why Quadcopter ?
- Why Quadcopter Swarm?

Figure 1. Quadcopter swarm from GRASP Lab, University of Pennsylvania

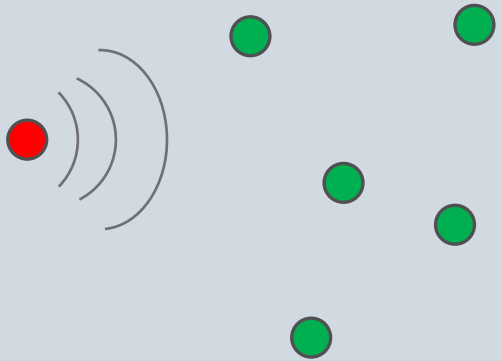
Communication

Communication
– objective

- Reliable
  - A corrupted message may cause disaster
- Fast
  - Large delay means no swarm
- Security
  - Important but not our major concern

Communication
– current situation

- One-to-one
  - easy but not useful for quadcopter swarm
- Broadcast
  - easy to use
  - fast

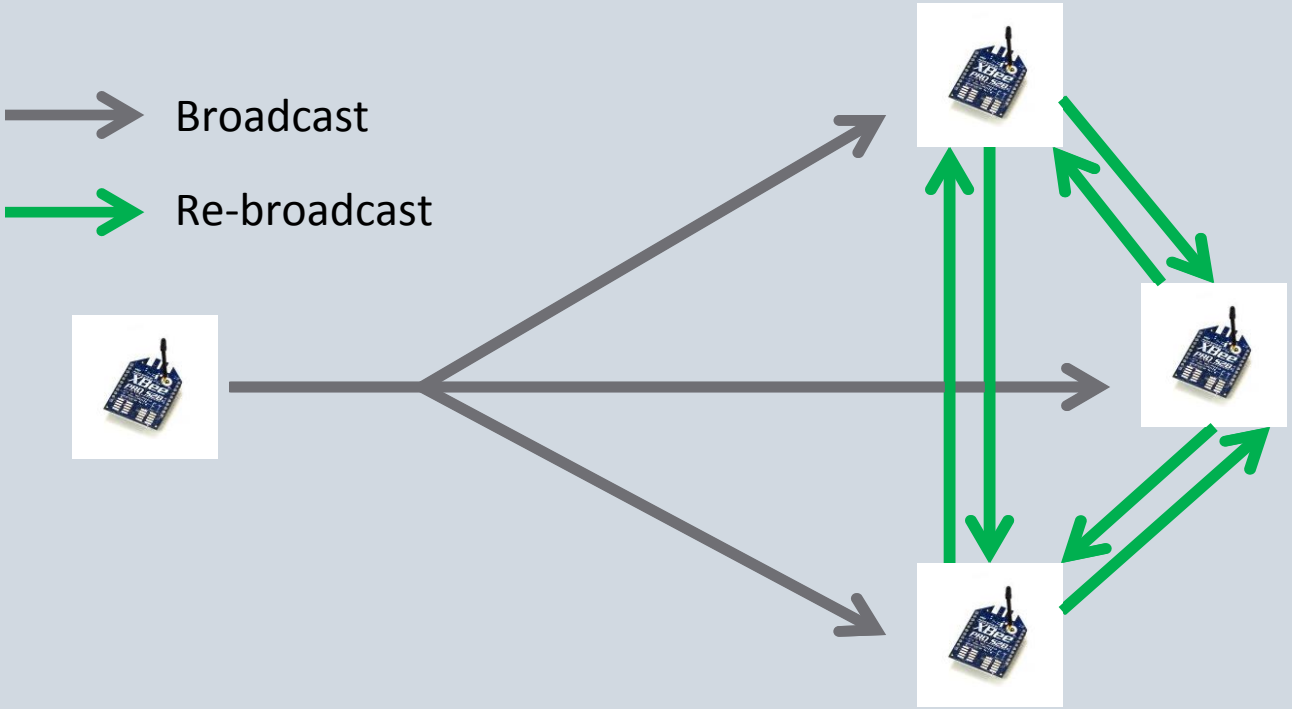


Communication
– problem of Broadcast

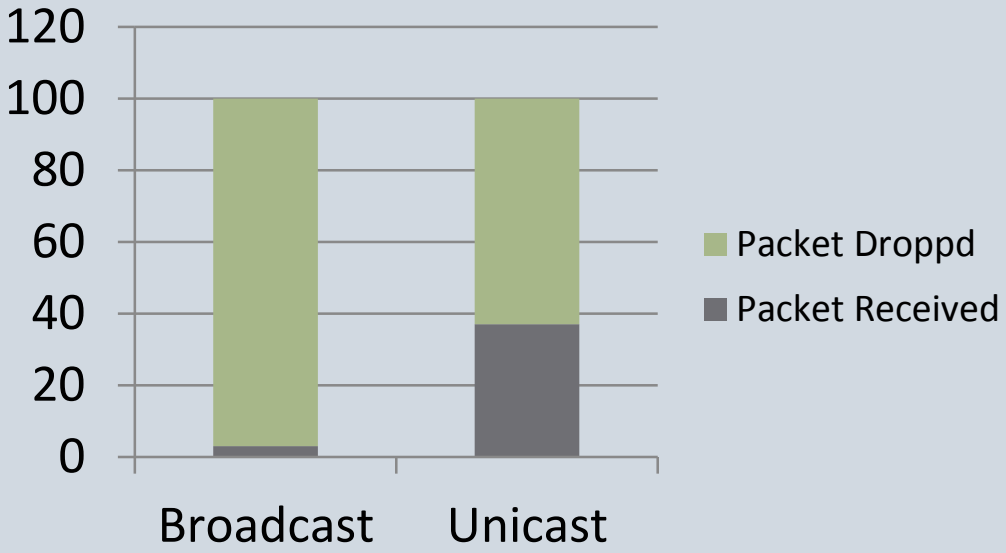
- Large payload
  - lower the broadcast frequency
  - put several messages into one packet

- Channel jamming
  - re-broadcast

Communication
– problem of Broadcast

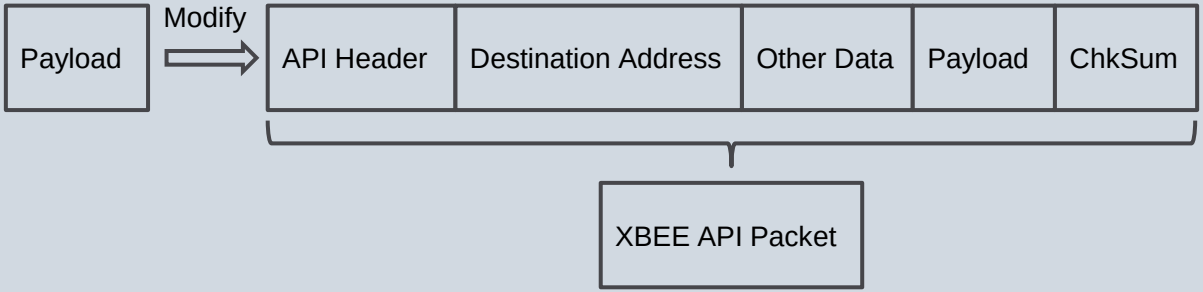


Communication
– problem of Broadcast

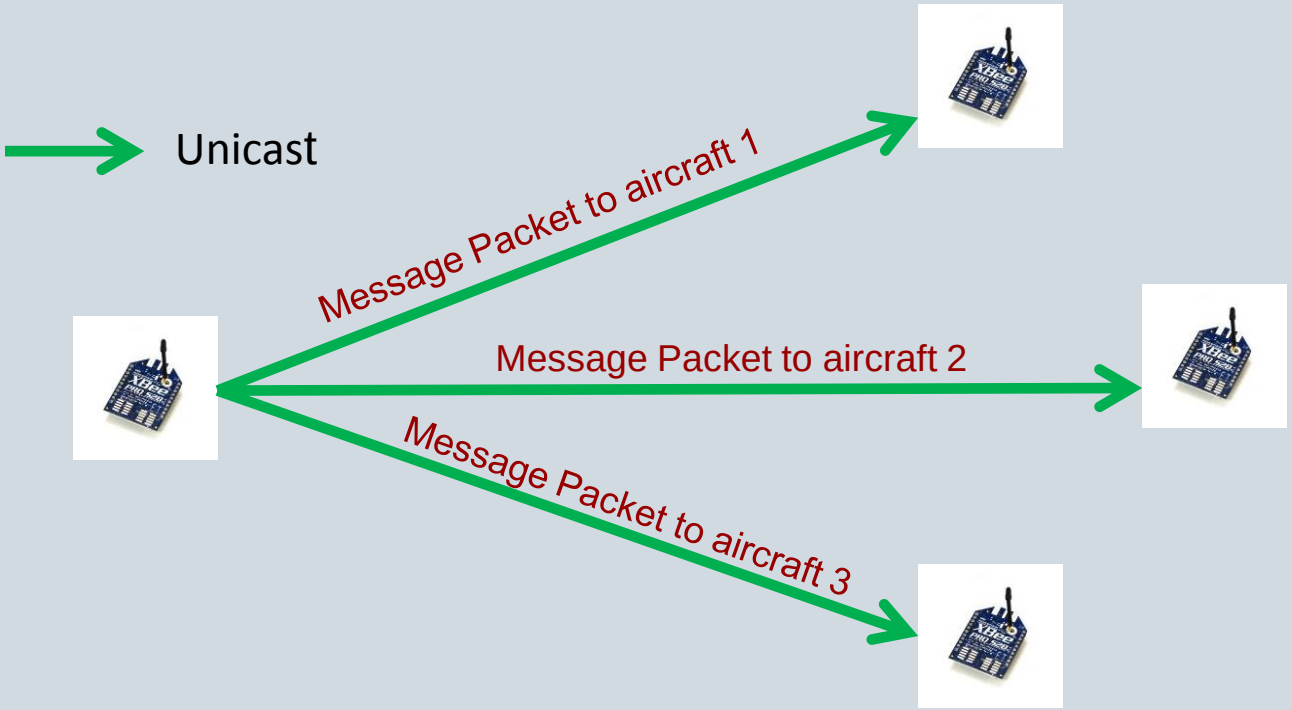


Communication
– approach

- Unicast
  - Sending message packets one-by-one
  - No re-broadcasting problem
  - No channel jamming



Communication
– approach



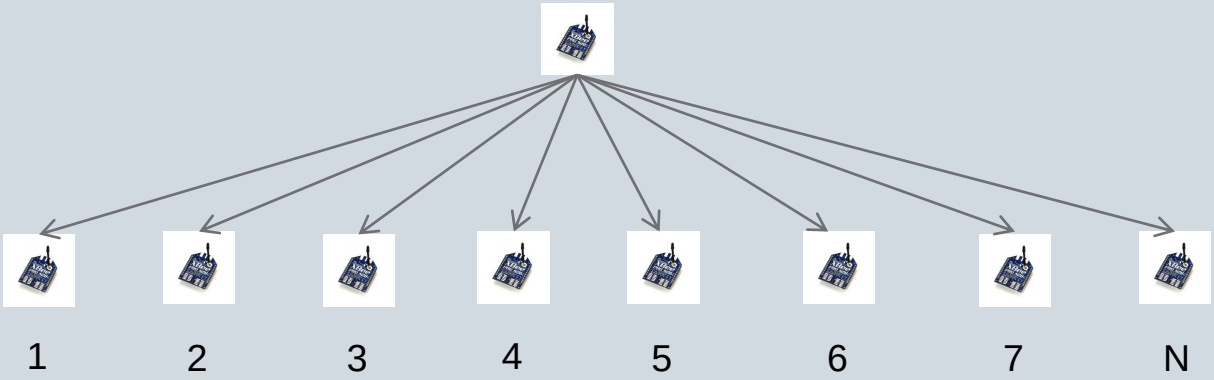
Communication

- video demo
  - Comparison between broadcast mode and unicast mode

Further Objective for communication

- Potential problem of Unicast

  - large delay between first receiver and last receiver



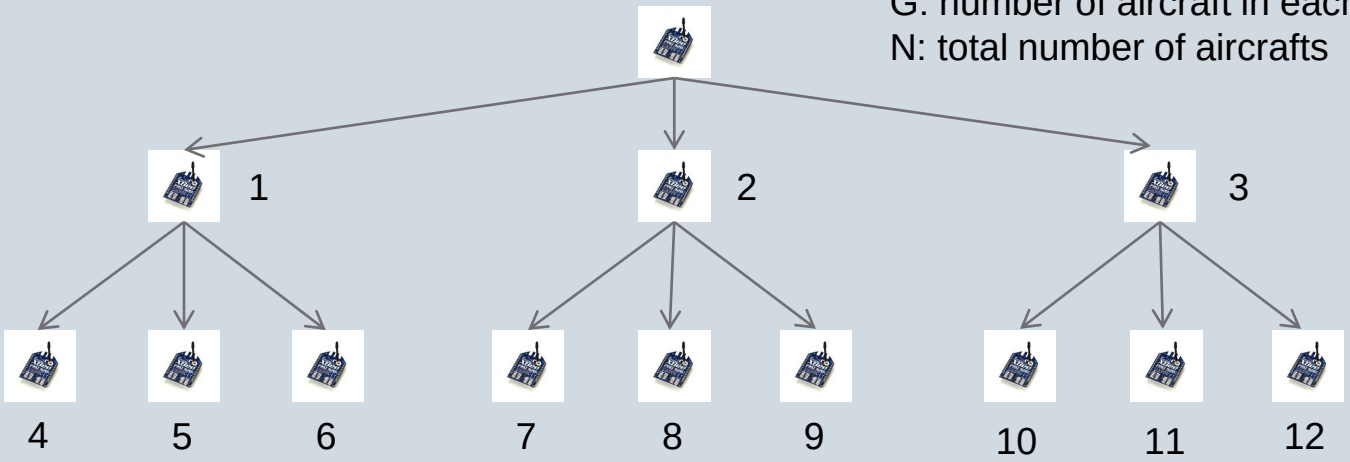
- maximum delay is proportional to N

Further Objective for communication

- Dynamic hierarchy communication model

  - cut down the maximum delay

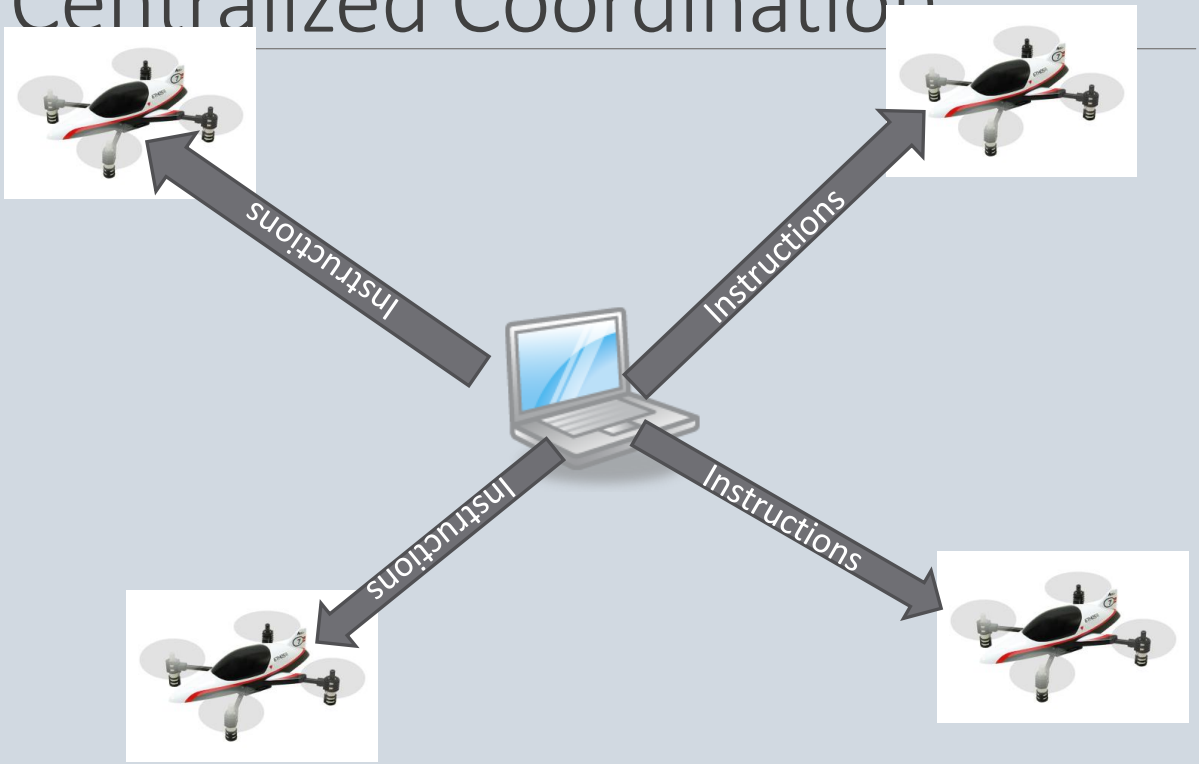
H: height of the tree
G: number of aircraft in each g
N: total number of aircrafts



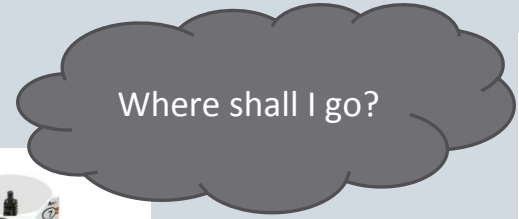
  - maximum delay is proportional to $G*\log_G N$

Coordination

Centralized Coordination



Decentralized Coordination



Coordination
- current situation

Centralized Coordination	• Model other quadcopters as moving obstacles with known trajectory
Decentralized Coordination	• Each quadcopter acts based on its own obstacle detection functionality

Coordination
- problem

Centralized Coordination

(based on modeling other quadcopters as moving obstacles with known trajectory)

- Requires high positioning precision
- Requires fast positioning update rate

Decentralized Coordination

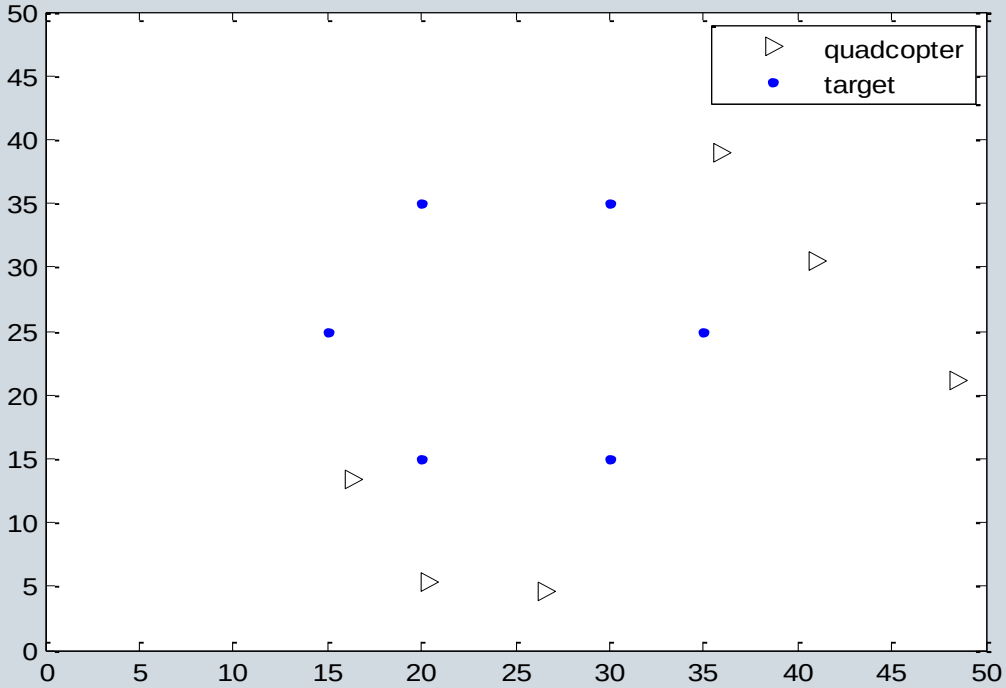
(based on individual obstacle detection functionality)

- Requires well functional Obstacle Detection module mounted on every quadcopter

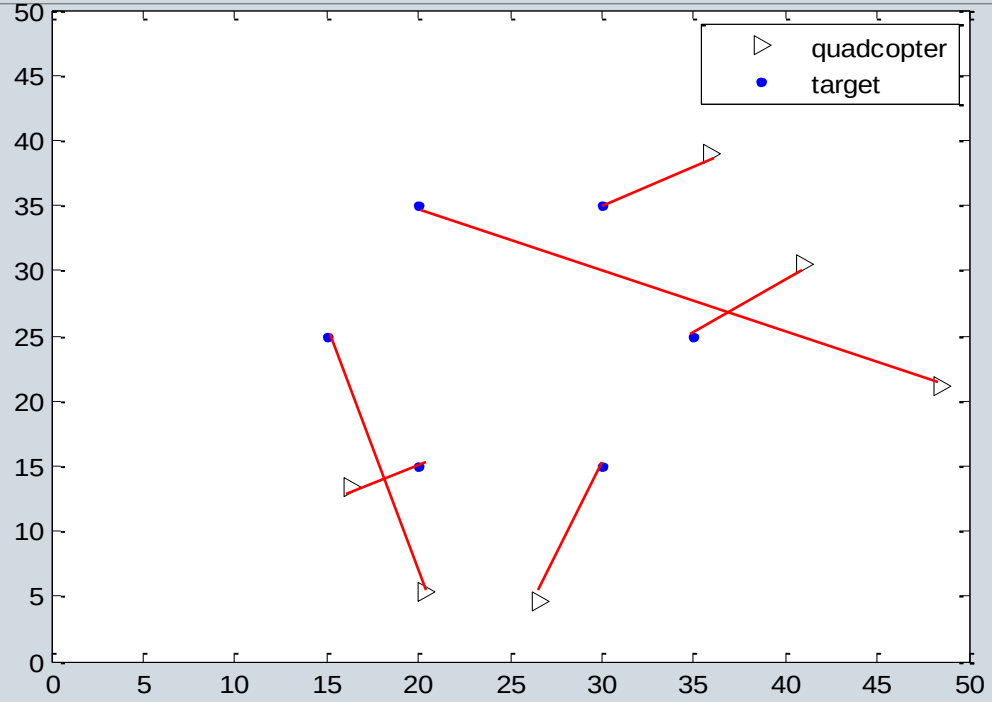
Direct-Path Intersection Avoiding Coordination

- Draws direct paths
- Detects possible intersections
- Sends adjusted-path

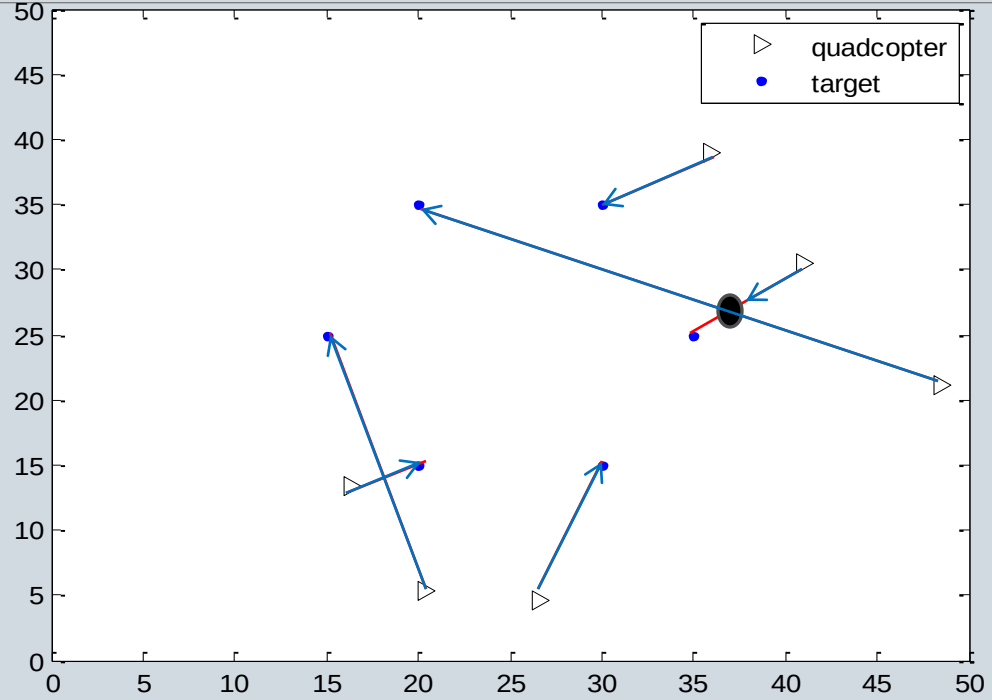
Coordination
- approach



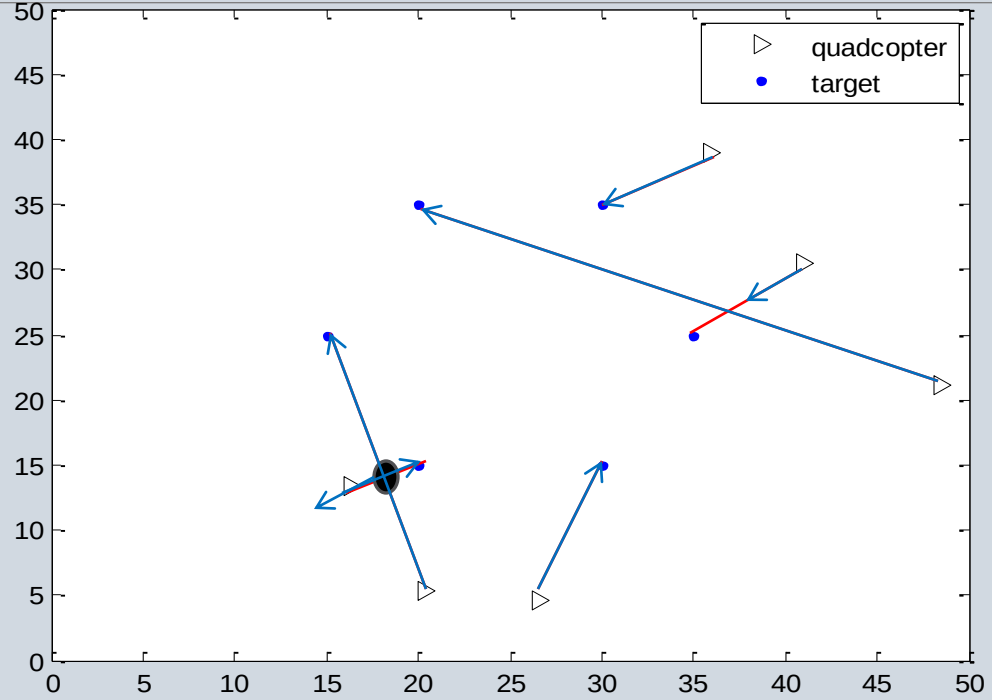
Approach
- assign targets



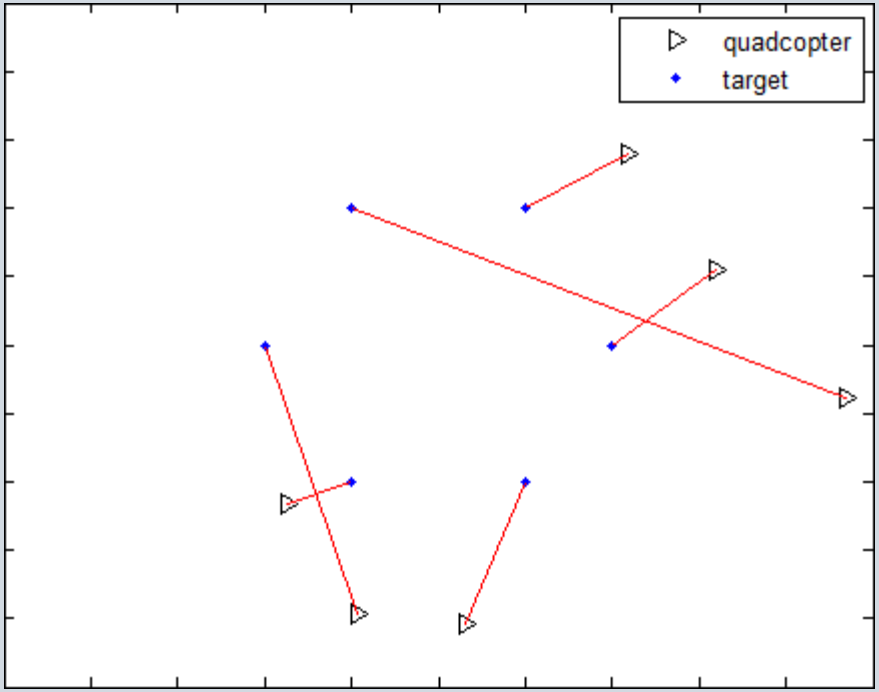
Approach
- Find intersections and assign temporary waypoints



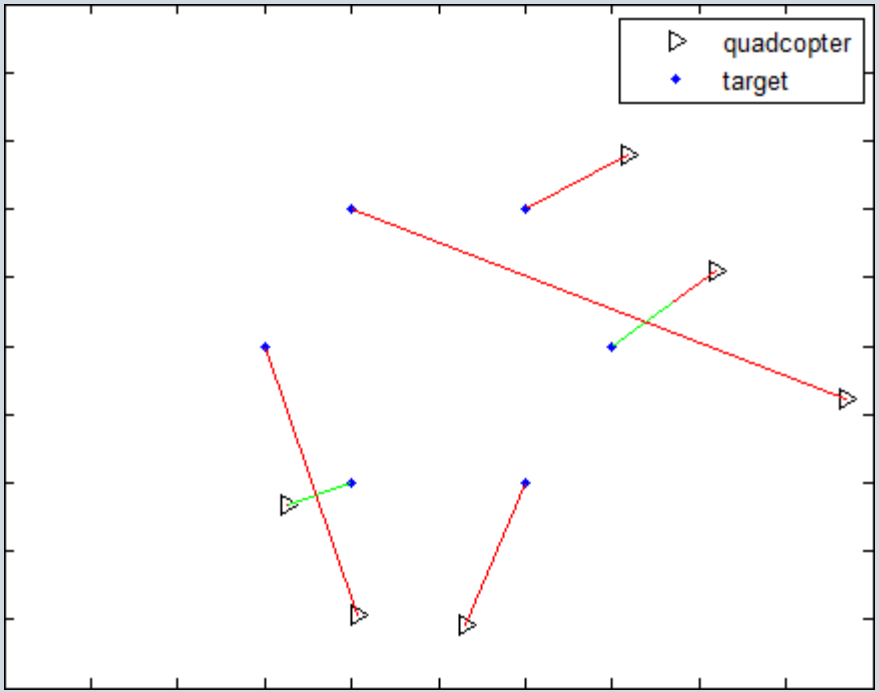
Approach
- Find intersections and assign temporary waypoints (Recursive)



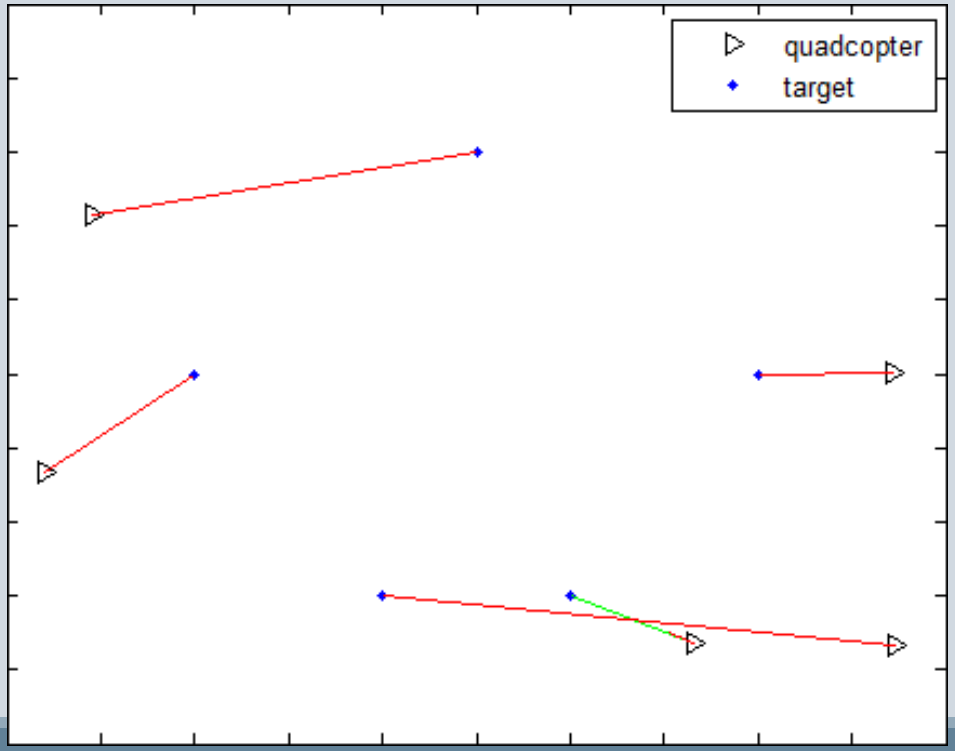
Coordination
- MATLAB Simulation (without using our approach)



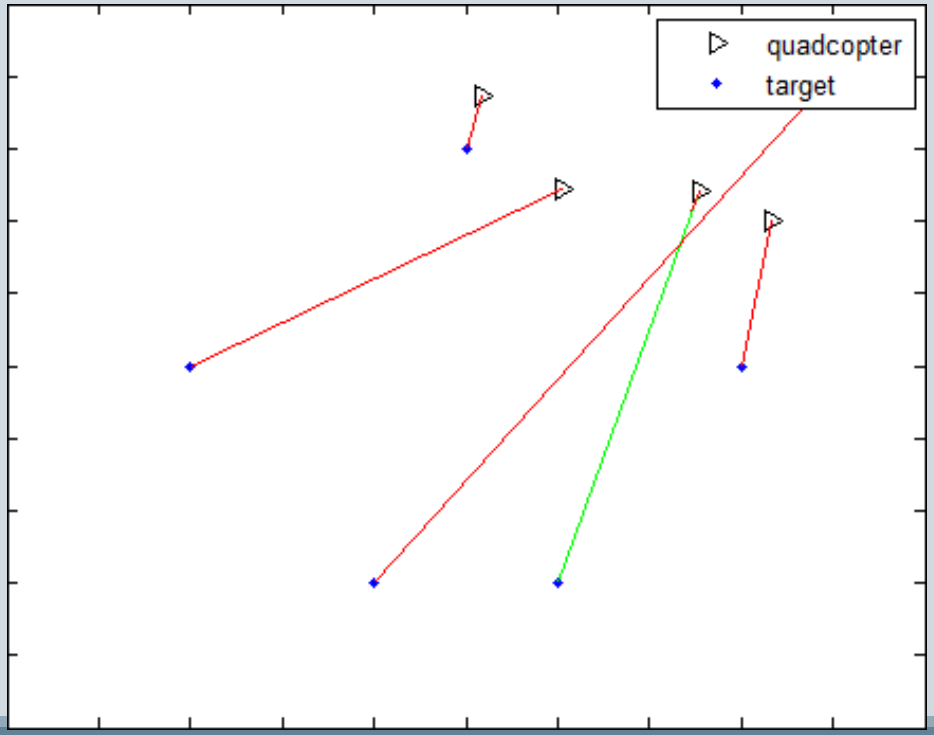
Coordination
- MATLAB Simulation



Coordination
- MATLAB Simulation



Coordination
- MATLAB Simulation

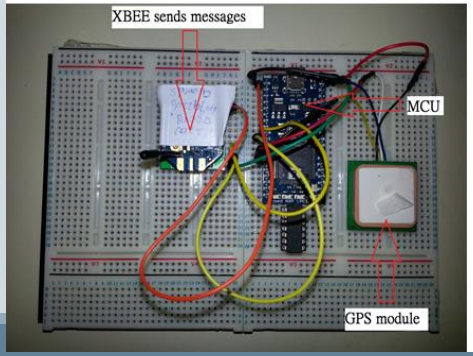


Further Objective for coordination

- Adopt a better target assignment strategy for the overall optimization
- Implement the coordination procedure on real quadcopters

A Simple GPS Tracking Prototype

GPS Data



A Simple GPS Tracking Prototype

Video demo

Q&A Thank you

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