UNMANNED AERIAL VEHICLE NETWORKS

USING THE NATURAL CONCEPT OF SWARMS, MULTIPLE UAV'S COMMUNICATE AND COORDINATE WITH EACH OTHER TO ACHIEVE A COMMON GOAL, ENABLING THE SUCCESSFUL COMPLETION OF COMPLEX TASKS EFFICIENTLY

INTRODUCTION

Swarm UAVs refers to a group of remotely controlled or autonomous ariel robots, that operate collectively to achieve a specific goal

- Task completion Rate, Survivability and Multitask capability is higher compare to single UAVs
- Use of Ad-hoc network is possible
- Highly capable of introducing quick solutions to emergency situations

CLASSINGS

- Based On The Swarm Architecture

Infrastructure Based	FANET Type (Flying Ad-Hoc Networks)
Common & Loss Complex	Ad-Hoc Network
Each UAV in controlled by the Ground Controlled System (GCS)	Decentralized
Less Demanding & Less Effective	UAV-UAV Communication

- Layer based Classification
  - Single Layer - Every UAV is its Own Leader
  - Multy Layer - Multiple Leaders
- Flexibility Based Classification
  - Static - New UAVs can't be adding during mission
  - Dynamic - New UAVs adding/removing is possible after pre mission state

APPLICATIONS

01. Disaster Response & management
02. Precision Agriculture
03. Military & Defenses
04. Surveillance & Law Enforcement
05. Environmental Monitoring
06. Infrastructure Inspection
07. Logistic & Deliveries
08. Cellular Relaying Networks

FOR MORE INFORMATION PLEASE SCAN THE QR CODE

SCAN ME

CHALLENGERS

Main challengers in implementing such systems lies in the telecommunication aspect

- UAV Networks Remain Fluid
  Network Teopology, Number of Nodes & Links Changes Fast.
- Require Suitable Routing Scheme
  In the case of Ad-hoc type networks, Simple but effective proactive or relative protocols are needed.
- Localization
  Need to determine spatial coordinates of each UVA precisely
- Maintaining Coverage
  Should achieve optimal coverage without losing communication between other nodes or GCS
- Path Planning
- Other Challengers include ensuring data Privacy, Ability to operate in diverse weather conditions and optimizing power consumption

PROTOCOLS

- Proactive
  Destination - Sequences Distance-Vector (DSDV)
  Wireless Routing Protocol (WRP)
  Optimized Link State Routing (OLSR)
- Reactive
  Ad hoc On-Demand Distance Vector (AODV)
  Dynamic Source Routing (DSR)
  Temporally Ordered Routing Algorithm (TORA)
- Hybrid
  Zone Routing Protocol (ZRP)
  Hybrid Wireless Mesh Protocol (HWMP)

CONCLUTION

- Current practically implemented systems employ the infrastructure based swarm architecture
- FANET based systems are emerging and they offer unlimited potential across various disciplines
- Advancements in following technologies cause progress in FANET base UAV networks
  - Machine Learning & SLAM
  - Swarm Intelligence
  - Edge Computing & IOT
  - High Capacity battery and PV cells
  - Miniaturized low cost advaced Sensors

220169V Fernando S.R.N | 220197E Gunathilaka K.L | 220212A Hapuarachchi H.A.D.N.D

UNMANNED AERIAL VEHICLE NETWORKS

SWARM BASED ADVANCED SYSTEM TO ACCOMPLISH COMPLEX TASKS EFFCIENTLY

INTRODUCTION

Swarm UAVs refers to a group of remotely controlled or autonomous ariel robots, that operate collectively to achieve a specific goal.

- Task completion Rate, Survivability and Multitask capability is higher compared to single UAV networks
- Use of Ad-hoc networks (Infrastructureless decentralized network - specifically a FANET)
- Highly capable of introducing quick solutions to emergency situations

CLASSIFICATIONS

- Based On The Swarm Architecture

Infrastructure Based	FANET Type (Flying Ad-Hoc Networks)
Common & Loss Complex	Ad-hoc Network (Special type of MANET / VANET)
Each UAV is controlled by the Ground Controlled System (GCS)	Decentralized control
Less Demanding & Less Effective	UAV to UAV Communication

- Layer based Classification
  - Single Layer - Every UAV is its Own Leader
  - Multi-Layer - Multiple Leaders
- Flexibility Based Classification
  - Static - New UAVs can't be added during mission
  - Dynamic - New UAVs adding/removing is possible after pre-mission state

CHALLENGES

Main challenges in implementing such system lies in the telecommunication aspect

- UAV Networks Remain Fluid
  Network Topology, Number of Nodes & Links Changes Fast.
- Require Suitable Routing Scheme
  In the case of Ad-hoc type networks, Simple but effective proactive or relative protocols are needed.
- Localization
  Need to determine spatial coordinates of each UAV precisely
- Maintaining Coverage
  Should achieve optimal coverage without losing communication between other nodes or GCS
- Path Planning

Other Challenges
- Ensuring security
- Ability to operate in diverse weather conditions
- Optimizing power consumption

APPLICATIONS

- Disaster Response & management
- Precision Agriculture
- Military & Defenses
- Surveillance & Law Enforcement
- Environmental Monitoring
- Infrastructure Inspection
- Logistic & Deliveries
- Cellular Relaying Networks (5G communication)

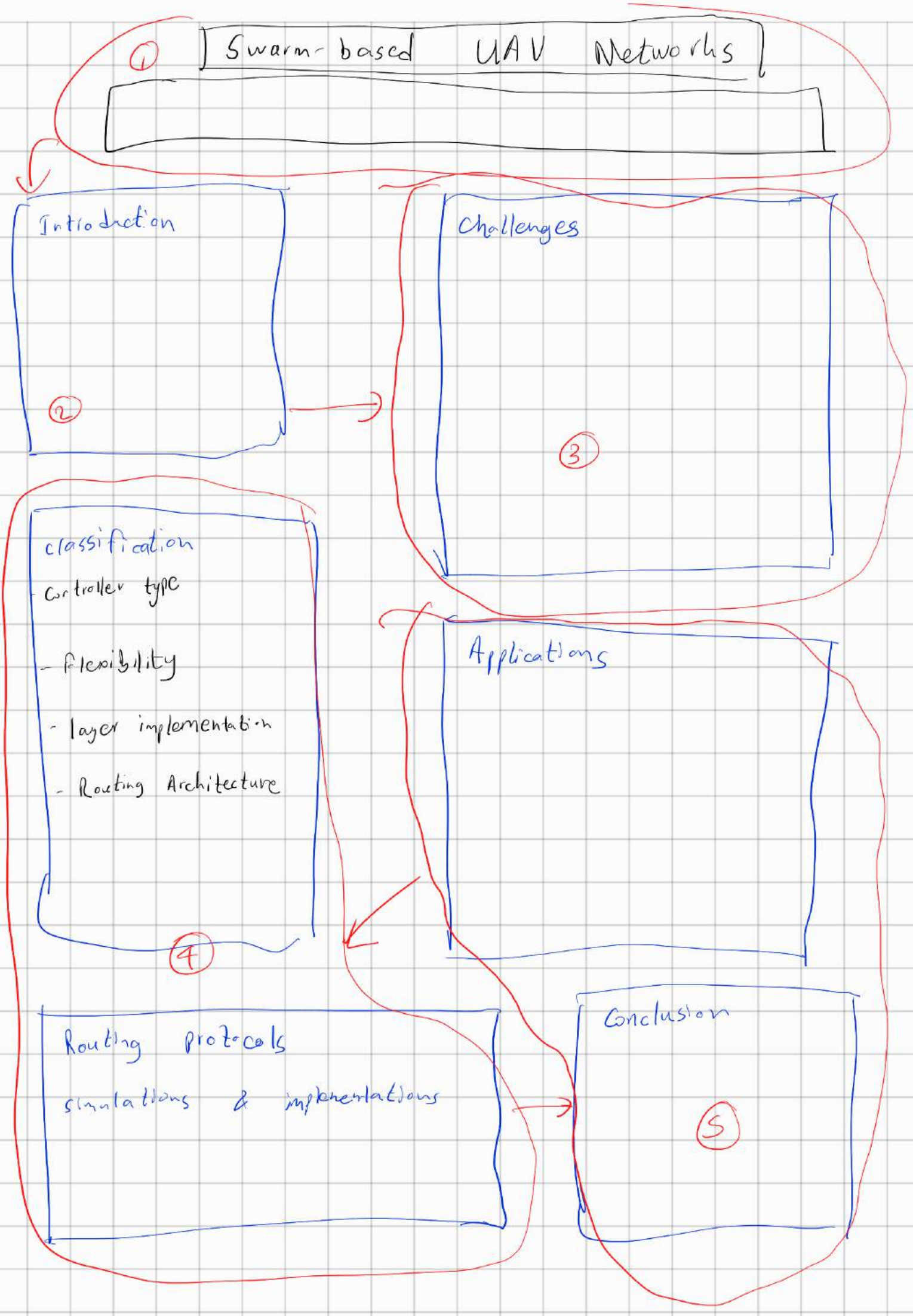
ROUTING PROTOCOLS

- Proactive (Every node in the network keep a routing table)
  Destination - Sequences Distance-Vector (DSDV)
  Wireless Routing Protocol (WRP)
  Optimized Link State Routing (OLSR)
- Reactive (Routes are created upon request)
  Ad hoc On-Demand Distance Vector (AODV)
  Dynamic Source Routing (DSR)
  Temporally Ordered Routing Algorithm (TORA)
- Hybrid
  Zone Routing Protocol (ZRP)
  Hybrid Wireless Mesh Protocol (HWMP)

CONCLUSION

- Current practically implemented systems employ the infrastructure based swarm architecture
- FANET based systems are emerging and they offer unlimited potential across various disciplines
- Advancements in following technologies cause progress in FANET base UAV networks
  - Machine Learning & SLAM
  - Swarm Intelligence
  - Edge Computing & IOT
  - High Capacity battery and PV cells
  - Miniaturized low cost advaced Sensors

220169V Fernando S.R.N | 220197E Gunathilaka K.L | 220212A Hapuarachchi H.A.D.N.D


1
Swarm-based UAV Networks
Introduction
2
Challenges
3
classification
- Controller type
- Flexibility
- layer implementation
- Routing Architecture
Applications
4
Routing protocols
simulations & implementations
Conclusion
5

①

Swarm-based UAV Networks

advanced system to accomplish complex tasks efficiently.

Our Names

② Introduction

Swarm UAVs refers to a group of remotely controlled or autonomous aerial robots, that operate collectively to achieve a specific goal, ~~while interacting with each other~~ and the enviroment.

- Task completion Rate, Survivability, Multitask capability is higher compared to single UAVs.
- use of Ad-hoc networks possible.
- highly capable of introducing quick solutions to emergency situations

③ Challenges

Main challenges in implementing such system lies in the telecommunication aspect

- UAV networks remain fluid - network topology, number of nodes, links chages fast
- require suitable routing scheme - in the case of Ad-hoc type networks, simple but effective proactive or reactive protocols are needed.
- Localization - need to determine spatial coordinates of each UAV precisely

* Maintaining Coverage - should achieve optimal coverage without losing communication between other nodes or GCS.

* Path planing.

Other challenges Include,

* Energy / battery constraints.
* navigate through environmental disturbances,

④ UAV Network classification

- common classification is based on the Swarm architecture.

1) infrastructure based
   * common & less complex
   * each UAV is controlled by the Ground Control system (GCS)
   * less demanding & less effective

2) FANET type (Flying Ad-hoc Network)
   * Ad-hoc network (Minimized infrastructure needed)
   * decentralized
   * UAV - UAV communication
   * specific type of MANET / VANET
   * can implement relay network

- layer base classification
  1) single layer - every UAV is it's own leader
  2) multi layer - multiple leaders

- Flexibility
  1) static - no new UAVs can be added during mission
  2) dynamic - new UAV adding / removing possible after pre mission stage,

Routing Protocols Used.

Proactive (each node contains a Routing table)
OLSR, DSDV, BATMAN, FSR

Reactive (Route are created upon on-request)
AODV, DSR, TORA, ZRP

need to find example implementations and link them

5 Applications

1) Disaster response & Management
2) Precision Agriculture
3) Military and Defence
4) Surveillence & law enforcement
5) Entertainment industries
6) Infrastructure inspection (powerline, bridges, pipelines)
7) logistic & Deliveries.
8) Environental monitoring
9) Cellular relaying network (for remote areas & energencies)

Conclusion

Practically implemented systems
Current mostly employ the infrastructure based swarm architecture.

FANET based systems are emerging and they offer unlimited potential accross various desciplines.

Advancements in following technologies cause progress in FANET based UAV networks.

- Machine Learning & SLAM
- Swarm Intelligence
- Edge computing & IOT
- High capacity battery and PV cells
- Miniaturised low cost advance sensors.

We choose to create our poster about Unmanned Aerial Vehicle Networks. From them, we specifically focused on Swarm based multiple UAV networks rather than single UAV network as they have much potetial and applications compared to single UAV networks.

After the introduction we presented the ways we can classify them. Main method of classification is based on their Architecture. So if every UAV in the network is controlled by a ground controlled system, then it is a infrastructure based network. If the network is autonomous and the UAVs can communicate with each other then it's classified as a FANET based network

We also included two other classification methods that were presented in the papers.

Then we introduced the wireless routing protocols used to communicate between UAV's, specially in the case of FANET type networks.

After that we mentioned the challenges we have to face when implementing such system. We gave priority to the challenges that arise in the telecommunication aspect while just listing out the challenges encountered in other domains.

Then we list out the possible use cases of such networks and mentioned our final conclusion. We also mentioned development in what technologies can make significant progress in these swarm UAV networks.

The QR code here will redirect to a web page for further information. At the moment we have only included the links to the papers and articles, but if it is necessary we will update this page to look like an article with more clarifications regarding the poster.

So that's it about our poster.

Presentation Script

In the context of modern technological innovation, Unmanned Aerial Vehicle Networks are an emerging technology with unlimited potential. From them, swarm based UAV networks offer much more efficient solutions accross many domains compared to single UAV networks as it can complete a given task faster, has higher survivability, capable of handling multiple tasks, and coble of introducing quick solutions to lot of emergency situations. So basically Swarm UAV network refer to group of autonomous or semi-autonomous aerial vehicles that can operate collaboratively to achive a specific goal.

Mainly Swarm UAV Networks are classified into two categories considering their infrastructure. Besides the traditional networks with centralized control, typically with a ground control system, there is another type of network that present the afformentioned unlimited potential. And those are called Flying Ad-hoc Networks or in short, FANETS. In an ad-hoc Network, communication is decentralized and nodes communicate with each other without relying on pre-existing infrastructure. These FANETS are special type of ad-hoc network from the already existing mobile ad-hoc networks, MANETs, Vehicular Ad-hoc Networks or

VANETS. These FANET based systems are relatively complex but introduce higher flexibility, higher range and multitask capabilities compared to the centralized, infrastructure based UAV networks.

Apart from considering that, these UAV networks are classified ^ whether they have multiple layers with a leader assigned to each layer Or it is layerless and each drone is considered as it's own leader. Also there's another classification considering it's flexibility of adding or removing new nodes after the pre mission state.