Drone Mounted Sensor Networks

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Introduction

A great amount of work has gone into research surrounding sensor networks in recent years, and the explosion in popularity of the internet of things (IoT) means there is a great deal of support from both academia and industry for development in the field.
The use of quadcopters (and drones in general) has also increased in both the civilian and military sectors. By combining the power of distributed sensor networks with the manoeuvrability of unmanned drones it is possible to quickly survey and map properties over a large area.

Simulation Tools

The following materials were required to complete the research:

- Curabitur pellentesque dignissim
- Eu facilisis est tempus quis
- Duis porta consequat lorem
- Eu facilisis est tempus quis

The following equations were used for statistical analysis:

$$\cos^3\theta = \frac{1}{4}\cos\theta + \frac{3}{4}\cos 3\theta \tag{3}$$

$$E = mc^2 \tag{4}$$

Phasellus imperdiet, tortor vitae congue bibendum, felis enim sagittis lorem, et volutpat ante orci sagittis mi. Morbi rutrum laoreet semper. Morbi accumsan enim nec tortor consectetur non commodo nisi sollicitudin. Proin sollicitudin. Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh.

Project Management

Integer sed lectus vel mauris euismod suscipit. Praesent a est a est ultricies pellentesque. Donec tincidunt, nunc in feugiat varius, lectus lectus auctor lorem, egestas molestie risus erat ut nibh.

Objectives

This project focuses on methods by which such networks can be controlled and tasked. We are working to create a framework by which autonomous flying vehicles can be tasked remotely to map sensor properties over predefined areas. This encompasses:

1. Routing of drones through shared airspace
2. Routing of communications
3. Specification of tasking language
4. Fault tolerance of the network
5. Division and dissemination of instructions

Physical Routing

Donec faucibus purus at tortor egestas eu fermentum dolor facilisis. Maecenas tempor dui eu neque fringilla rutrum. Mauris *lobortis* nisl accumsan.

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 1: Table caption

Nulla ut porttitor enim. Suspendisse venenatis dui eget eros gravida tempor. Mauris feugiat elit et augue placerat ultrices. Morbi accumsan enim nec tortor consectetur non commodo.

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 2: Table caption

Communications Routing

Mobile Ad-hoc Networks (MANETs) have several distinguishing characteristics which must be accounted for when designing and evaluating routing algorithms[1]:

1. Dynamic topologies
2. Bandwidth-constrained, variable capacity links
3. Energy-constrained operation
4. Limited physical security

All electromagnetic signals dissipate as they propagate through space, limiting the range at which communications can be received. Under ideal conditions this can be modelled using the Friis free space equation:

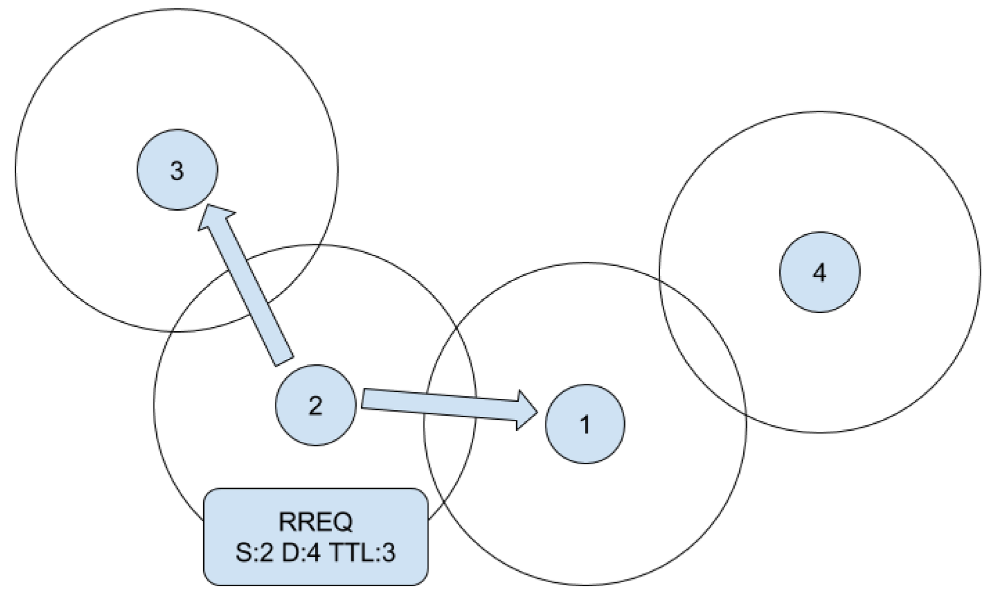
$$P_{rx} = P_{tx}G_{tx}G_{rx}\frac{\lambda^2}{4\pi D} \tag{1}$$

Where P is the power of the radio signal, G the gain (or efficiency) of the antenna and D the distance between them. Under real world conditions additional path loss can be modelled using the log distance path loss model:

$$L = 10n\log_{10}d + C \tag{2}$$

Multiple algorithms exist to route packets within a network, which are usually classified into topological and positional. For mobile networks, topological models are ineffective due to the aforementioned dynamic topologies employed.

Ad hoc On-Demand Distance Vector (AODV) routing is one of the most popular reactive protocols used in MANETS[2]. When a node wishes to send a message but does not have a route to the destination, it broadcasts a route request (RREQ) packet to it's neighbours. Each neighbour either returns a route if it has one (RREP) or rebroadcasts the RREQ to it's own neighbours. Sequence numbers are used to eliminate suboptimal routes and by extension to prevent cyclical routes.



If the network topology has changed and a route is invalid, a node returns a route error (RERR) message. This causes other nodes to flush the parts of their routing tables which have become invalid. AODV does not have a security component, but this can be added separately. As all nodes in the network are known beforehand, keys can be distributed prior to deployment.

For MANETS, reactive protocols like AODV are preferred to proactive protocols (such as OLSR) due to low power and processing requirements.

Planned Work

- Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh. Phasellus fermentum rutrum elementum. Nam quis justo lectus.
- Vestibulum sem ante, hendrerit a gravida ac, blandit quis magna.
- Donec sem metus, facilisis at condimentum eget, vehicula ut massa. Morbi consequat, diam sed convallis tincidunt, arcu nunc.
- Nunc at convallis urna. isus ante. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing.

References

[1] J. Macker. Mobile ad hoc networking (manet): Routing protocol performance issues and evaluation considerations. 1999.

[2] Charles Perkins, Elizabeth Belding-Royer, and Samir Das. Ad hoc on-demand distance vector (aodv) routing. Technical report, 2003.

[3] A.E Abdallah, T. Fevens, and J. Opatrny. Hybrid position-based 3d routing algorithms with partial flooding. In *Electrical and Computer Engineering, 2006. CCECE'06. Canadian Conference on*, pages 227–230. IEEE, 2006.