Part II project - Phase Two Report

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0 Preliminary Information

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Title: A MANET to Facilitate Collision Avoidance in Rowing Boats

1 Introduction

My project will implement routing in a Mobile Ad-Hoc Network (MANET).

Routing protocols find a path from a source to a destination within the network. Different routing protocols optimise different parameters, and are better suited for various networks [1].

A MANET is characterised by wireless nodes, a frequently changing network topology and no reliance on pre-existing infrastructure. They are decentralised and therefore have no single point of failure [3]. MANETs have a large range of uses, from the military [5] to facilitate communication, to autonomous vehicles [6] or disaster relief scenarios [7] to gather and move data across locations where previously existing infrastructure has been destroyed.

My project wishes to use a MANET to share a set of locations throughout a set of rowing boats, in order to facilitate collision avoidance. Collisions in rowing can cause damage to both rowers and their equipment. This project's motivation is to avoid rowing boats colliding with each other and with other obstacles. A radar and AI based obstacle detection system is available [2]. However, to the best of my knowledge, collision avoidance has not been attempted by networking boats together.

In the MANET my project will implement each boat will be a node in the network; storing a set of locations the user should be warned about, and passing these locations throughout the network. The user should be able to add to the list of hazardous locations.

My project will be implemented in hardware, in the real world. In general, networking protocols can be implemented in simulation or in hardware. Depending on the nature of the simulation environment, it might not be possible to use

exactly the same code in the simulator as in the real hardware. Due to the time constraints on a Part II Project, I intend to implement my project only in hardware.

2 Starting Point

I have a little experience with networking, and routing protocols. My experience is limited to the Part IB networking module, although it is being expanded by the Part II Principles of Communications module. I will need to add to my knowledge of networking and routing protocols.

I have previous experience using Raspberry Pi single-board computers with AdaFruit boards. I have no previous experience with microcontrollers. I will need to improve my knowledge of microcontrollers to complete this project.

3 Structure

The first part of the project will be dedicated to research, looking at what routing protocol will be most suited to the network topology rowing boats generate. This phase will also consider whether the whole routing protocol need be implemented for the application. Finally, the research phase will refine the evaluation metrics needed for the project.

After the research phase, I will implement point to point communication between two nodes in hardware.

The next part of the project will implement broadcast and flood routing between at least three nodes.

After a flooding protocol has been implemented, I will use it to implement the secondary routing protocol, decided on in the research stage.

The application layer will then be considered, ensuring that the information passed through the network can be used.

The hardware will then be tested, tweaked and evaluated. Correctness will be evaluated on land, likely in a field, where analysis of the network is easier and larger numbers of metrics can be examined than in the use environment. Performance will be evaluated in the use context - on rowing boats on the water. Evaluation of the network will likely consider the time taken for the network state to be flooded through the nodes, and routing tables then updated, as well as a packet loss ratio [4].

4 Success criteria

There are three success criteria I will hold for my project:

1. Flood routing works across the network

2. A point to point routing protocol works across the network

3. The device warns the user when they are approaching a notable location

5 Extensions

If there is time, I intend to:

1. Review the User Interface (UI) of the device

2. Consider the security of the network

3. If found, consider mitigations for any security flaws in the network

6 Plan of Work

Start of Block	End of Block	Block Length	Notes	Work to be Done	Milestones
14/10/2022	21/10/2022	7	17/10 - Driving test	Research - which protocol, how to implement	Decide which protocol to implement, produce a slightly more refined plan
21/10/2022	28/10/2022	7		Start to work with the hardware - implement point to point communication between two nodes	Two nodes can send point to point messages
28/10/2022	11/11/2022	14	07/11 - Robotics Assignment 1	Implement flood routing	Messages are flooded between at least three nodes
11/11/2022	18/11/2022	7	18/11 - 4s head	Implement routing protocol part A	Routing state information is shared between two nodes
18/11/2022	25/11/2022	7		Implement routing protocol part B	
25/11/2022	02/12/2022	7	28/11 - Robotics Assignment 2	Implement routing protocol part C	Routing protocol can transfer point to point messages across the network
02/12/2022	10/12/2022	8		Implementing application layer - hold a table of locations, and inform the user when approaching these locations	Hardware informs the user when approaching a stored location, written personal notes on work so far
10/12/2022	26/12/2022	16	14/11 - Trial 8s and Christmas	Time off	-
26/12/2022	09/01/2023	14	01/01 -> 11/01 - Camp	Implmenting application layer - allowing the user to add to the table of locations, and propagating that message through the network	A new location is propagated throughout the network
09/01/2023	16/01/2023	7	01/01 -> 11/01 - Camp	Tweaking the hardware, testing point to point links on land	Make hardware work on land, finish proof of concept
16/01/2023				Finish project prototype	
16/01/2023	27/01/2023	11		Water testing and tweaking	The hardware works in the application envronment (water)
27/01/2023	03/02/2023	7	03/02 - Cybercrime 1	Write progress report and presentation	Progress report and presentation
03/02/2023				Progress report and presentation	
03/02/2023	21/02/2023	18	17/02 - Cybercrime 2	Evaluation and tweaking	The hardware is finished and evaluated
21/02/2023	07/03/2023	14	03/03 - Cybercrime 3	Dissertation - plan and bullet point what will be said	Dissertation plan and main parts in bullet point form
07/03/2023	21/03/2023	14	17/03 - Cybercrime 4	Dissertation - Evaluation, introduction and conclusion	Second draft - all written or in bullet point form, sent to supervisor to proofread
21/03/2023	04/04/2023	14	26/03 - Boat Race	Time off	-
04/04/2023	18/04/2023	14		Dissertation - Take on criticism, add references and appendicies	Final draft
18/04/2023	02/05/2023	14		Contingency	-
02/05/2023	12/05/2023	10		Contingency	-
12/05/2023				Final deadline	

7 Resource Declaration

I plan to use my laptop to implement, evaluate and write up the project. It has a comprehensive system of backups through OneDrive and disk images. A backup of the project will exist with Git version control, hosted on GitHub. My own hardware, including Raspberry Pi Picos, breadboards and AdaFruit radio and GPS modules will be used to develop and implement the project.

Libraries to interface with the AdaFruit boards are written by AdaFruit in Circuit Python, and in my experience tend to be robust, although they occasionally contain bugs. If necessary, I can fork the code and implement bug fixes.

My project will partially rely on the mathematical correctness of routing protocols, work that others have already published.

As the project has a real-world implementation, I have permission from Cambridge University Boat Club to test devices on their boats.

References

[1] 2022 Part II Lecture Notes on Principles of Communications. Crowcroft, J. 2022.

[2] DEVICE | rowcus. `https://www.rowcus.com/device`. ROWCUS. Retrieved 07/10/2022.

[3] Mobile Ad Hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations. Corson, S. and Macker, J. Network Working Group. 1999.

[4] SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS Internet protocol aspects – Quality of service and network performance. International Telecommunication Union. 2011.

[5] MILCOM'09: Proceedings of the 28th IEEE conference on Military communications. Richardson, K, Jimenex, C, Stephens D.. 2009.

[6] AD HOC Networks for the Autonomous Car. Davidescu, R, Negrus, E. IOP Conference Series Materials Science and Engineering. 2017.

[7] MANET for Disaster Relief based on NDN. Jin Y., et all. IEEE. 2018.