**Navigating a robot using Computer Vision**

# Problem Statement

Researching and implementing a navigating robot which relies primarily on a camera feed as the primary input for perception, elements such as object avoidance and goal recognition.

Many robots use cameras for aspects of their perception but underutilise them, making further use of cameras and utilising them more efficiently can free up resources for further analysis of the environment.

The project aims to utilise the camera more efficiently as a sensor module, inferring a greater amount of information from the feed than is standard for a robot of this complexity. Algorithms such as SIFT may prove beneficial for allowing odometric based object localisation as the robot moves around, ideally this will alow for a relatively accurate SLAM (Simultaneous Localisation And Mapping) which allows for reasonable navigation through a maze environment or similar.

This work is applicable for a variety of purposes due to the commonality of cameras being used on robots, thus allowing for cheaper robots in the future whilst more expensive and technically intricate sensors continue to fall in price as technology advances.

# Objectives

* 1. Calibration/Familiarity goals:

Move the robot in a square.

Move the robot in a predefined fashion in response to a visual stimulus

Move back and forth when a Red object is visible

Move towards a Red Object

Recognise small Brightly coloured obstacles

Differentiate an obstacle from a goal

* 1. Progress Goals:

Move the object in a way that follows a goal and avoids obstacles

Recognise larger flat obstacles

Attempt to avoid flat obstacles whilst moving

Make predictions on the location of the goal object in relation to the position

Manoeuvre around a more complex set of obstacles given knowledge of the goal

Search for the goal object in an unknown environment avoiding obstacles.

* 1. Stretch goals:

Use background distinguishing features to aid dead-reckoning of location

Avoid varied obstacles e.g.

Posts

Cylinders

Arbitrary non-goal objects

Identify multiple goal objects and their separate locations, mapping between them

# Methods

Acquire a small collection of documentation and resources for reference

Using Git version control, develop each goal iteratively

If the objectives have been made well, then the goals should build up onto each other

Test computer vision using a static raspberry Pi where appropriate

Test robot focused implementations in locations that have minimal foot traffic.

# Timetable

Term 1:

Research and reference acquisition until roughly week 4 when Turtlebot3 is expected to be delivered

From Week 4 to Week 7:

Calibration/Familiarity goals to be completed

Aim to have spotted any major pitfalls with the project

Week 8: Coursework deadlines make meaningful progress unlikely

Ideally get some work done on Progress Report

Week 9: Write then submit Progress report

Term 2:

Weeks 0 (Holiday) – 5:

Focus on Progress goals

5 Progress goals exist, ideally complete one per week

Weeks 6 – 10:

Fine tune project

Focus on Project report

Weeks 9/10

Give Project presentation

Term 3:

Weeks 0 (Holiday) – 2

Prepare and submit Project Report

# Resources

* 1. Turtlebot3 Burger
     1. <http://emanual.robotis.com/docs/en/platform/turtlebot3/specifications/>
  2. Raspberry Pi 3 Model B+
     1. <https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/>
     2. Part of Turtlebot3 Burger and a separate one for testing
  3. Raspberry Pi Camera Module V2
     1. <https://www.raspberrypi.org/products/camera-module-v2/>
     2. <https://www.raspberrypi.org/documentation/hardware/camera/>
     3. Makes up the primary vision source for the robot
     4. May potentially be worth using two for Stereo vision if time/budget allows
  4. Sams Teach Yourself C++ in One Hour a Day (7th Edition)
     1. **ISBN-13: 978-0672335679**
     2. **Author:** Siddhartha Rao
     3. **Already competent and familiar with C++, but it makes good reference material for STL use and some sensible design patterns**

# Risk Assessment

Due to module split this year of 4:2 (4 in first term, 2 in second) time to meaningfully work on the project is leant heavily towards the second term, this reduced time period may be a problem if issues are encountered.

Attempt to get familiar with the robot in the first term, expect issues to happen and plan accordingly

# Ethical Considerations

Footage taken whilst testing or running the robot will not be published

No meaningful ethical considerations