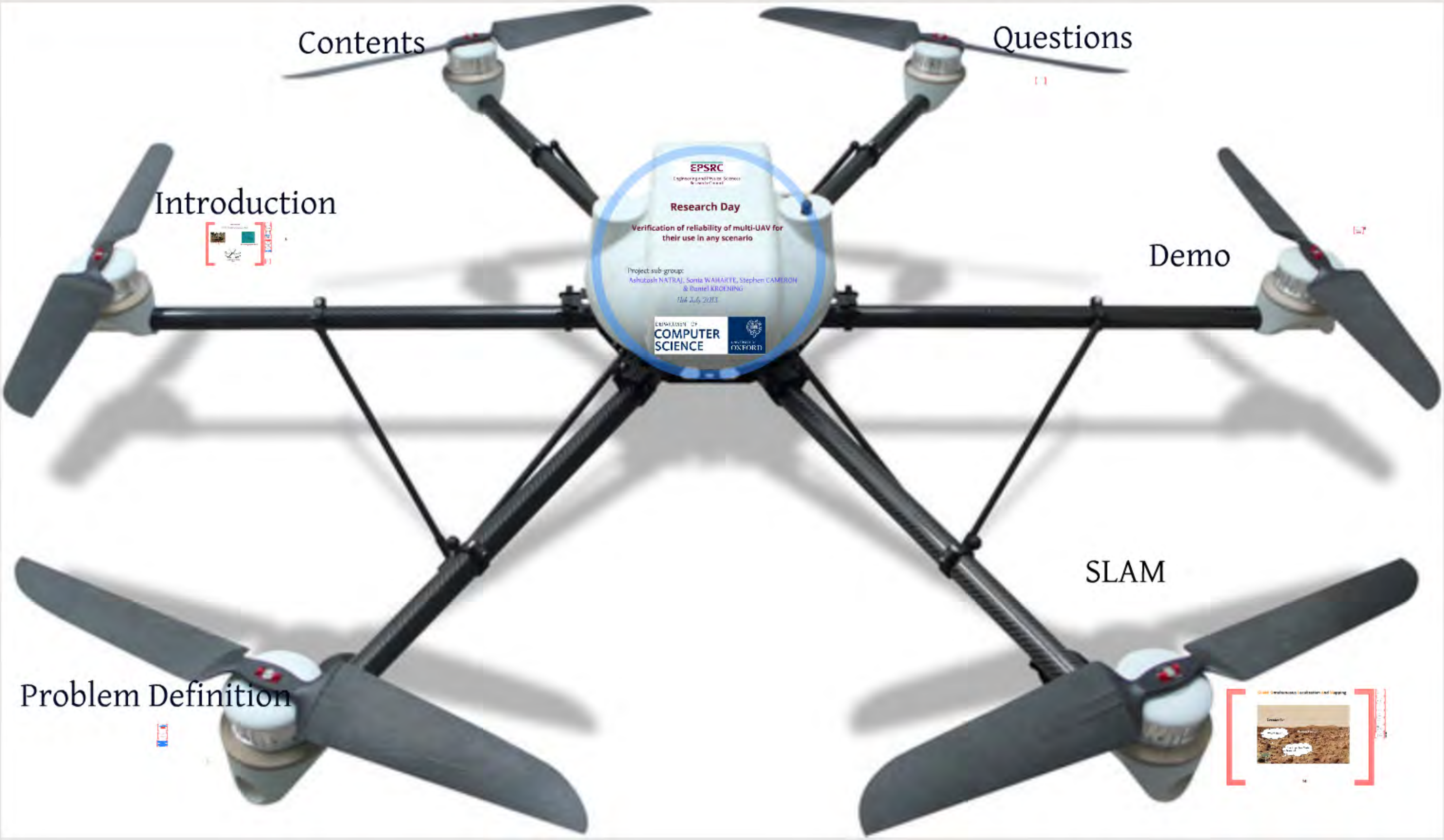
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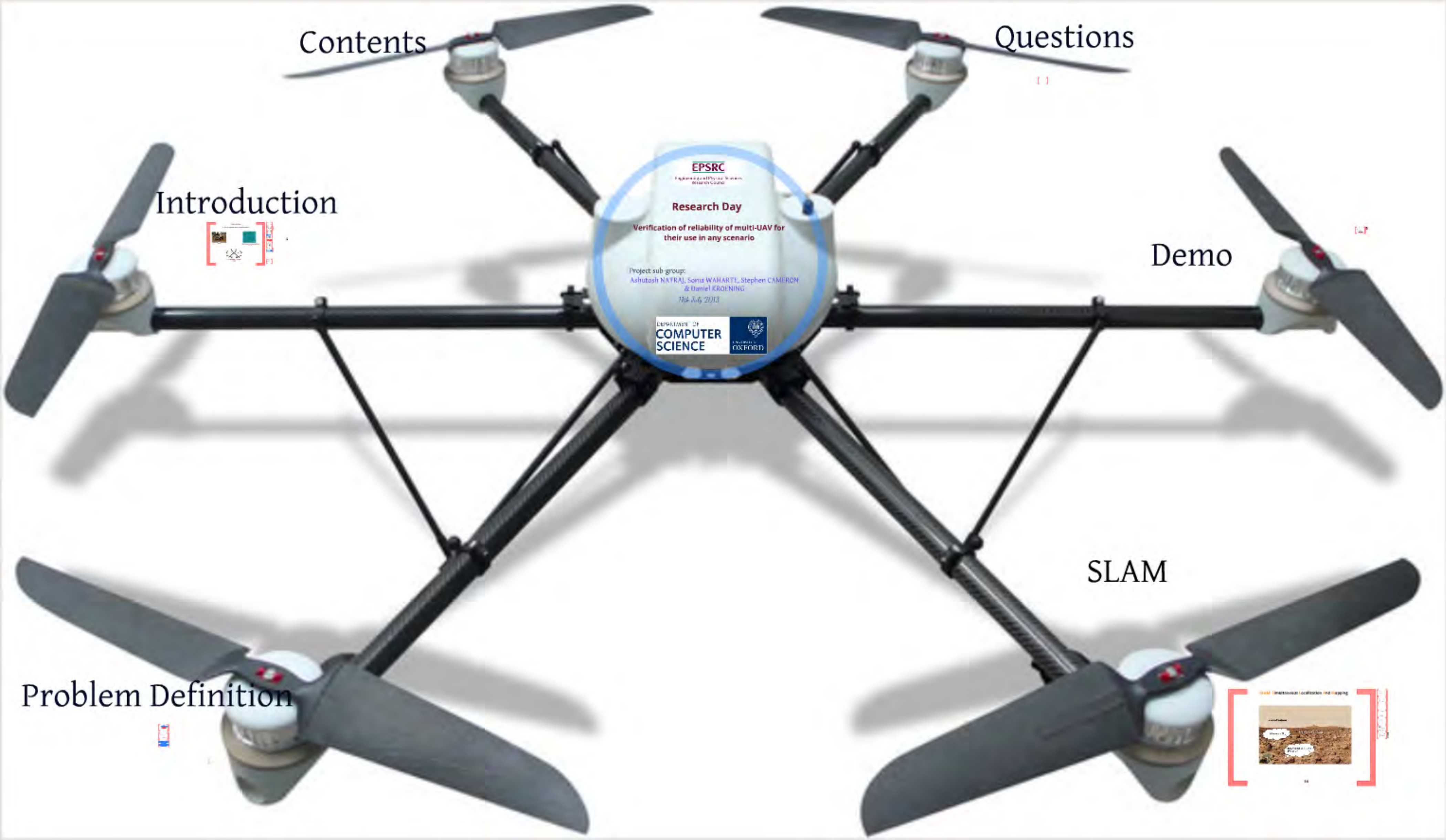

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Engineering and Physical Sciences
Research Council

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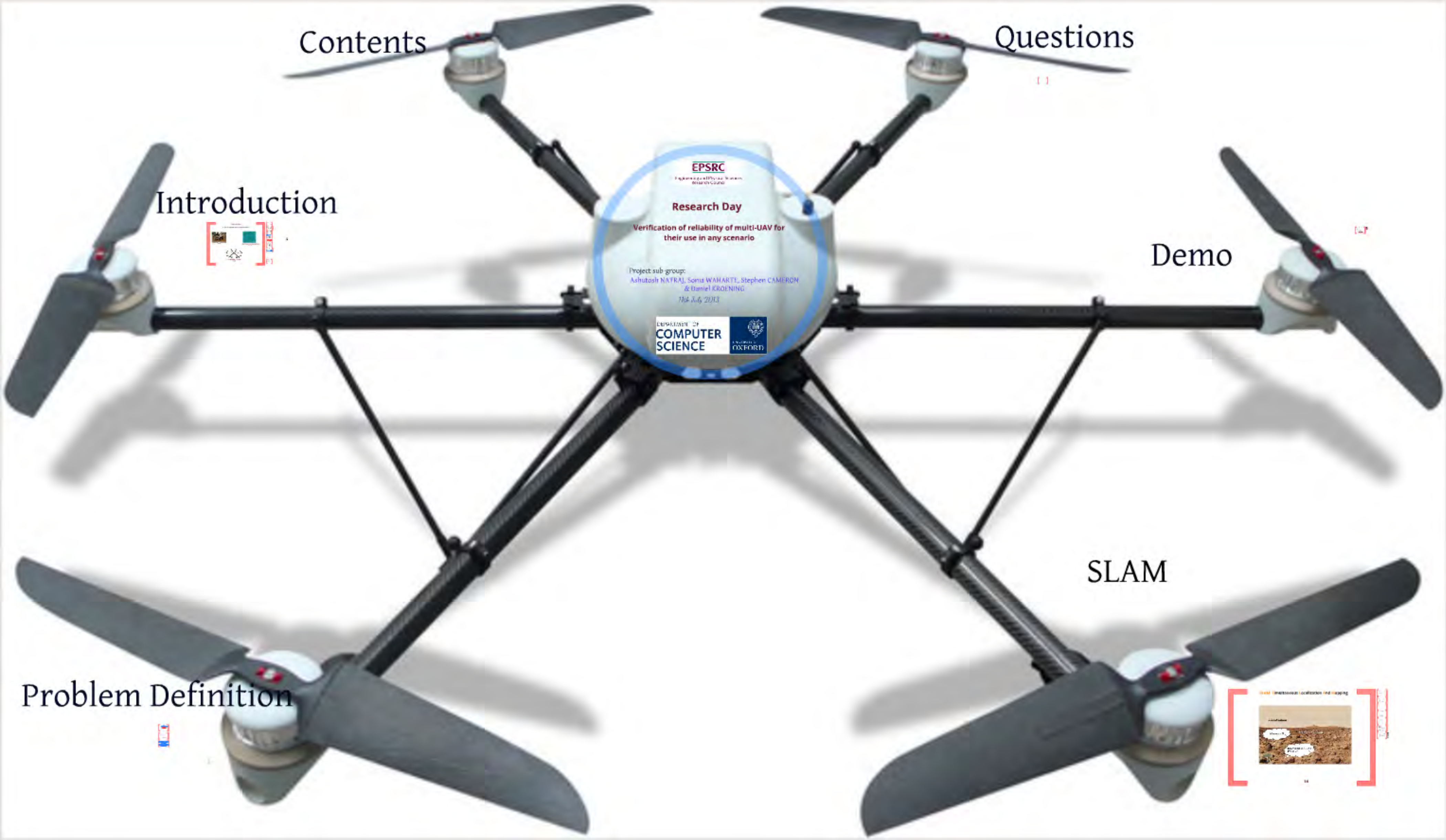

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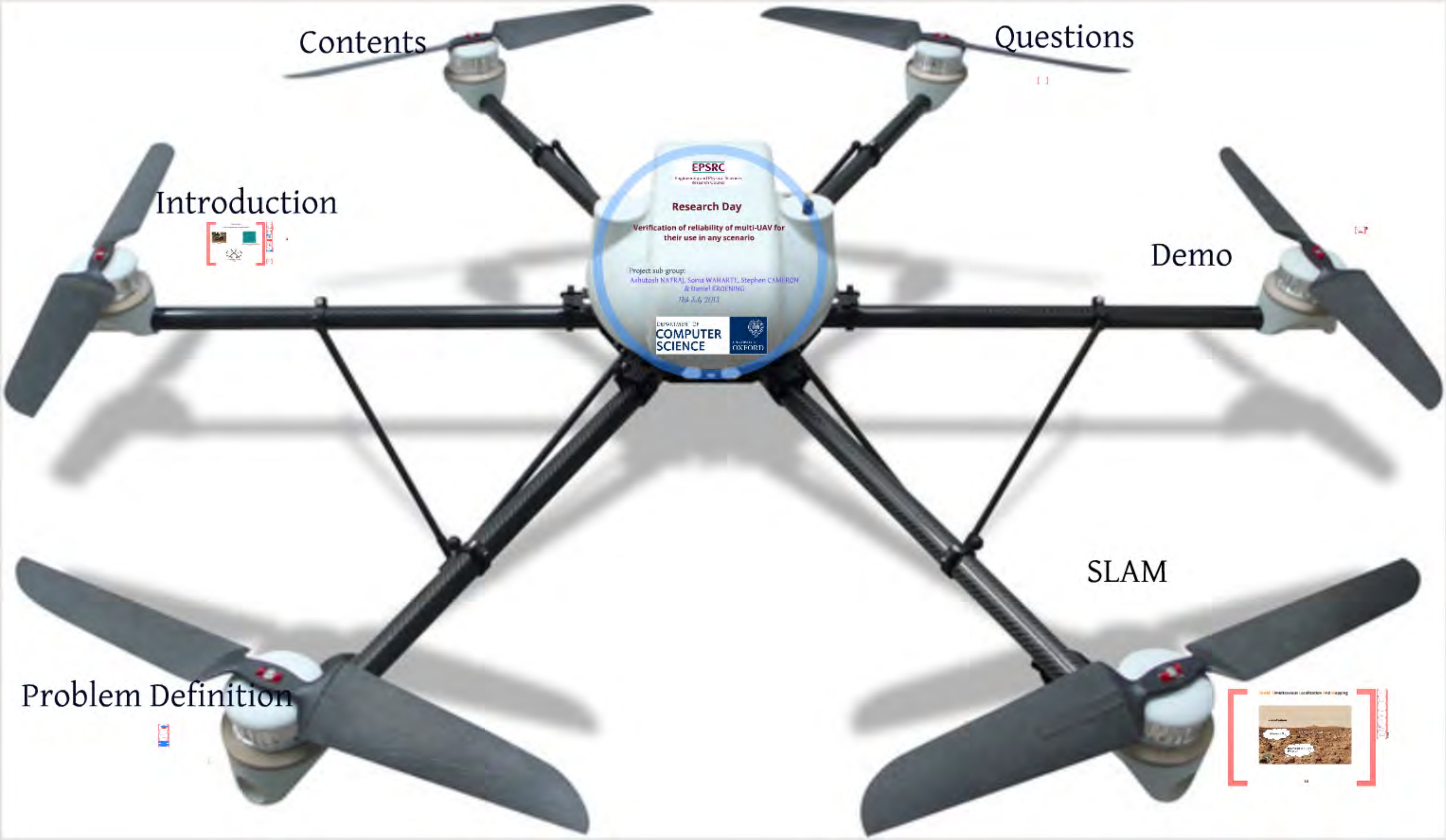
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Introduction

Types of Autonomous Unmanned Vehicles

Unmanned Ground Vehicles (UGVs)

Autonomous Underwater Vehicles (AUVs)

Unmanned Aerial Vehicles (UAVs)

Introduction

Interest : Why UAVs ?

Walk on Ground

3 DoF

Swim in Water

6 DoF

Fly in Air

6 DoF, one of the most complicated but also most versatile

*DoF: Degree of Freedom

Types of UAVs

Types of UAVs

Fixed Wing UAV

Rotor Based UAV

Rotor based UAVs: Can operate in limited space & hover.

Reliability in Robotic Applications is needed

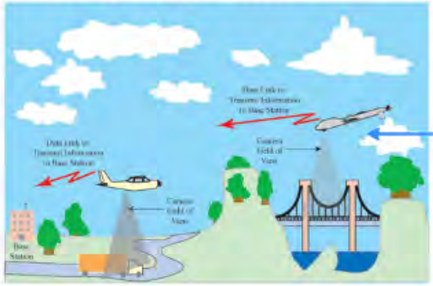
Aerial Photography Cui et.al (2008) low cost, reliable, fast and hassle free.

Fukushima disaster aerial monitoring

UAV for football match/ movie recording

Highway traffic monitoring Ro et.al (2007) help reduce bottle neck traffic congestion.

Monitoring traffic offenders Puri et.al (2008) monitoring traffic offenders & collecting traffic data.



Aerial traffic monitoring & Bridge inspection

Source: The University of Minnesota, Aerospace Engineering, website.

Wild forest fire monitoring.

Coastal & Marine life research Myers et.al (2005)

Wild forest fire Merino et.al (2008)

Planning military coup operations. Used against the militants.

Important Challenges For UAVs

Take Off and Landing of UAVs

Control & Navigation of UAVs

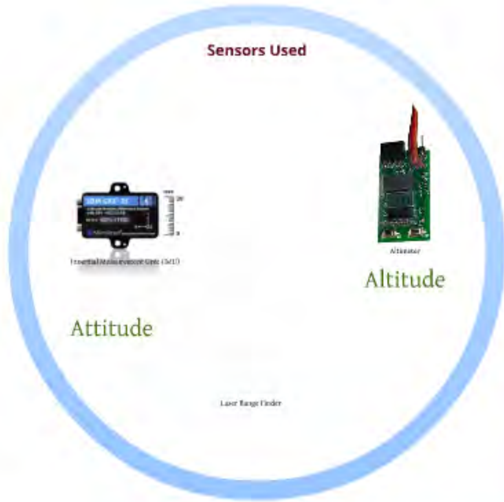
Essentially Require Knowledge About:

Attitude

Altitude

Pitch (rotation along Y axis)

Roll (rotation along X axis)



Sensors Used

Innertial Measurement Unit (IMU)

Attitude

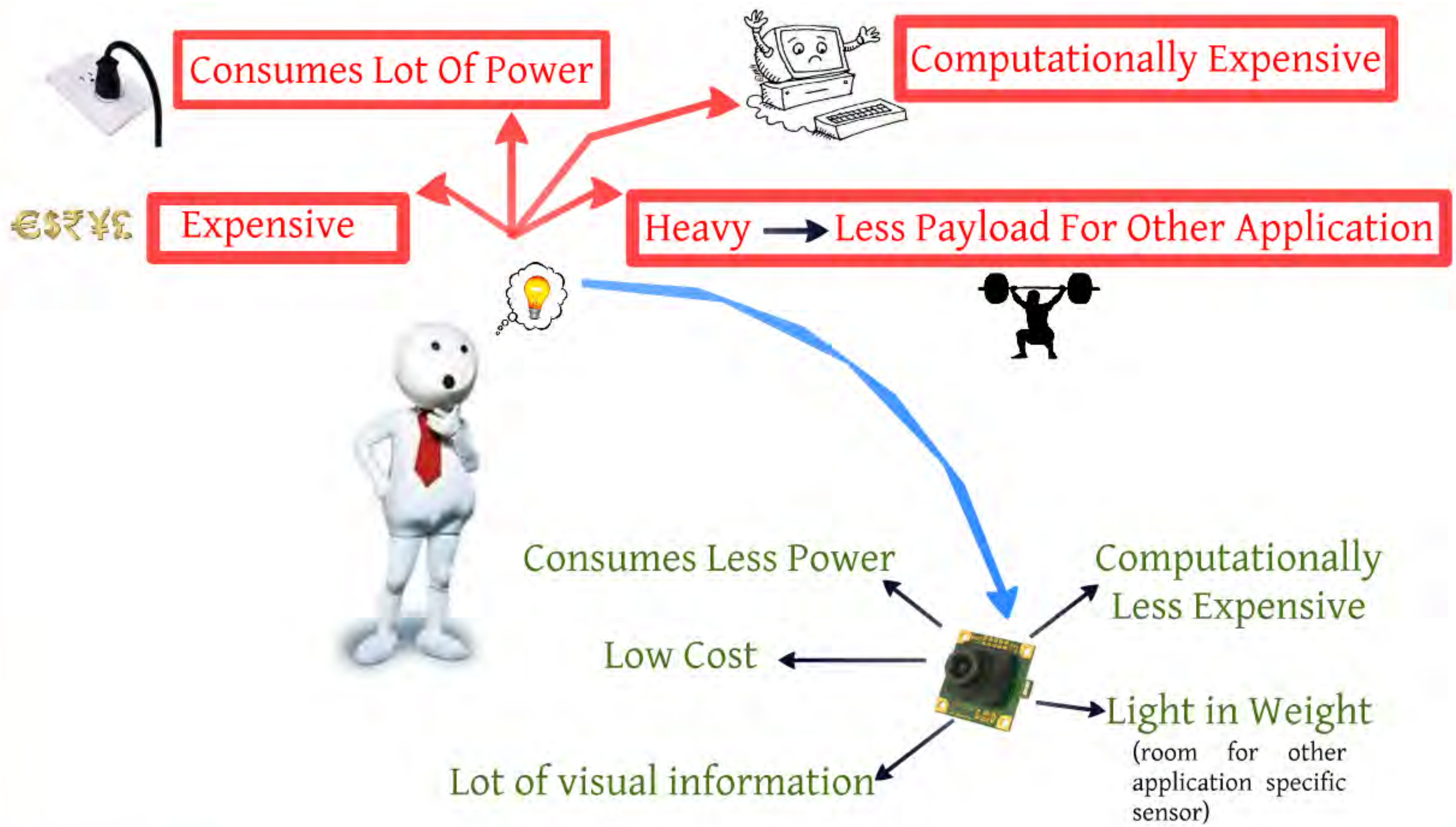
Laser Range Finder

Altimeter

Altitude

Prezi

Drawbacks Of Using Multiple Sensors



Vision Based Tools For Robotic Applications

Tools / Applications

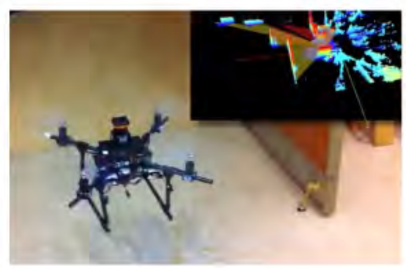
Visual Odometry →

Maimone et.al (2007)

Visual Servoing →

Hutchison et.al (1996)

Visual SLAM →

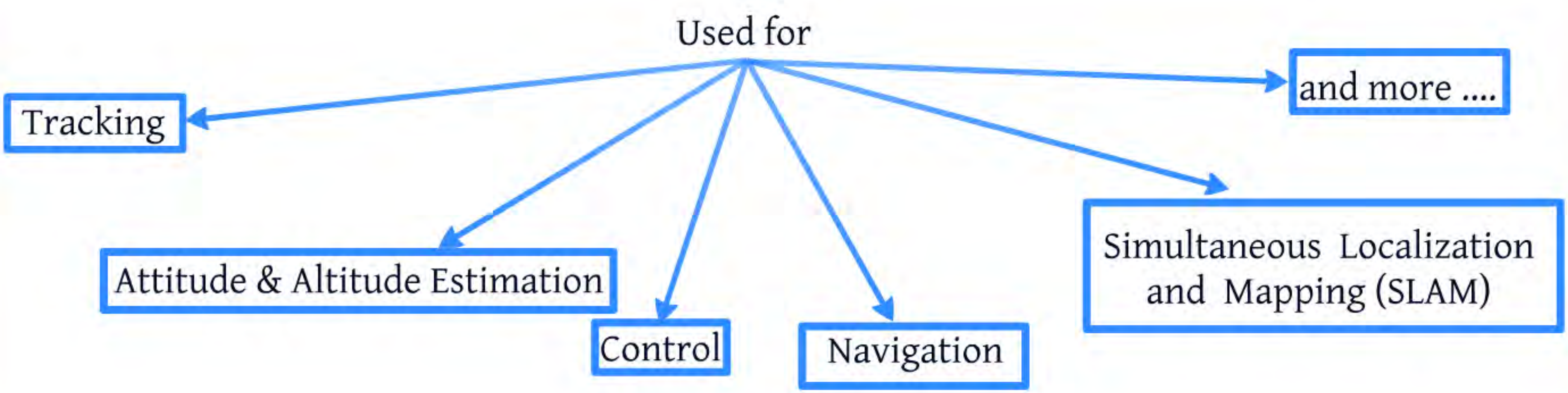


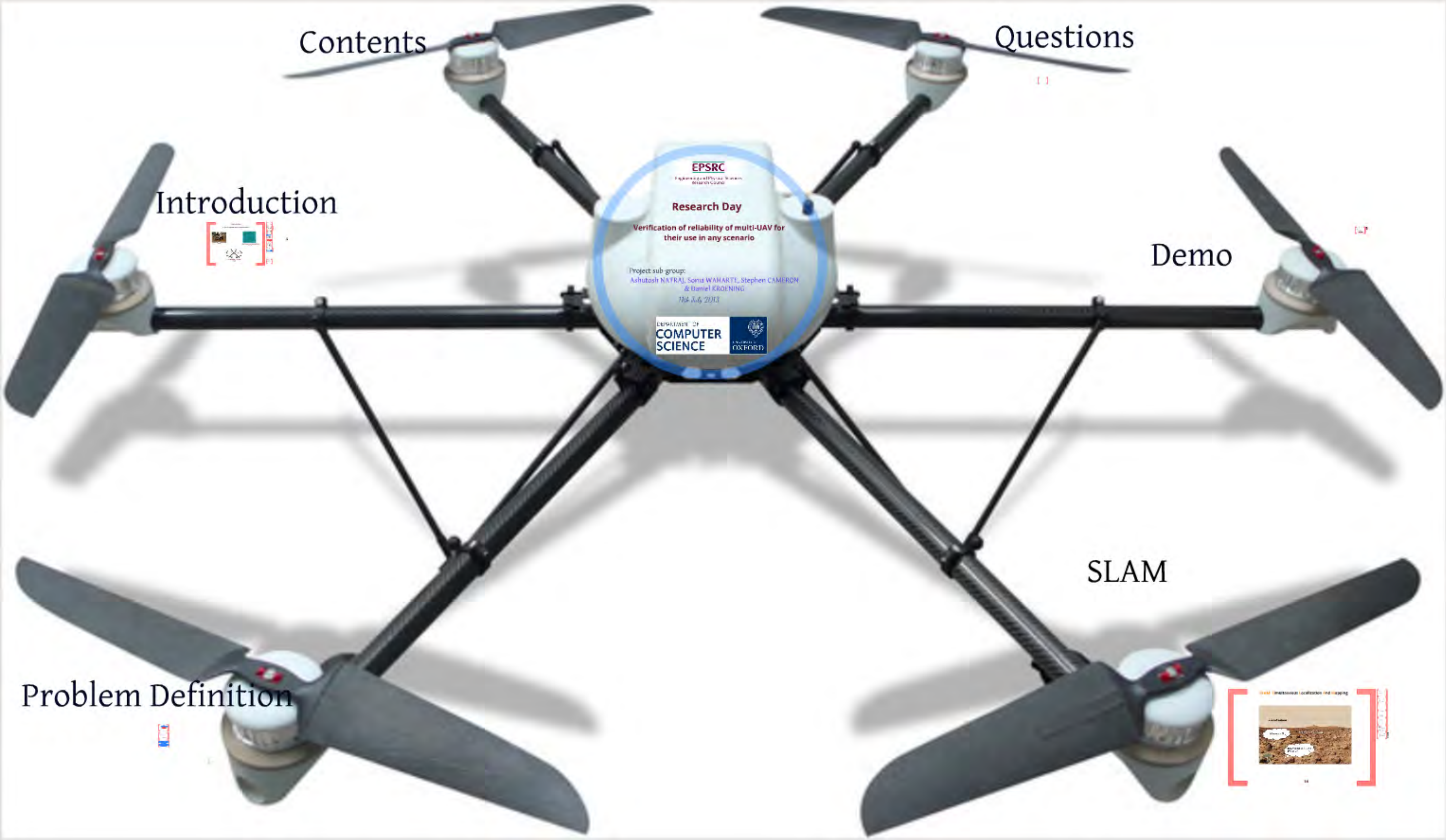
Kushleyev et.al (2011)

Computer Vision For UAVs

Interest : Computer Vision for UAVs, but why ?

What is it ? Visual processing on images captured from camera on board the UAVs.





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Problem Definition

Reliable

Accurate

Repeatable

Robotic Applications

But, what and how do we verify it?

Uncertainty from sensor measurement

Dynamic memory allocation to cause read write conflicts

Errors can occur due to:

Error in positioning due to drift despite the verification of the code implementation and functioning.

Verification -Lends a Helping Hand

Hardware level: Migration conflicts from intel core to ARM core

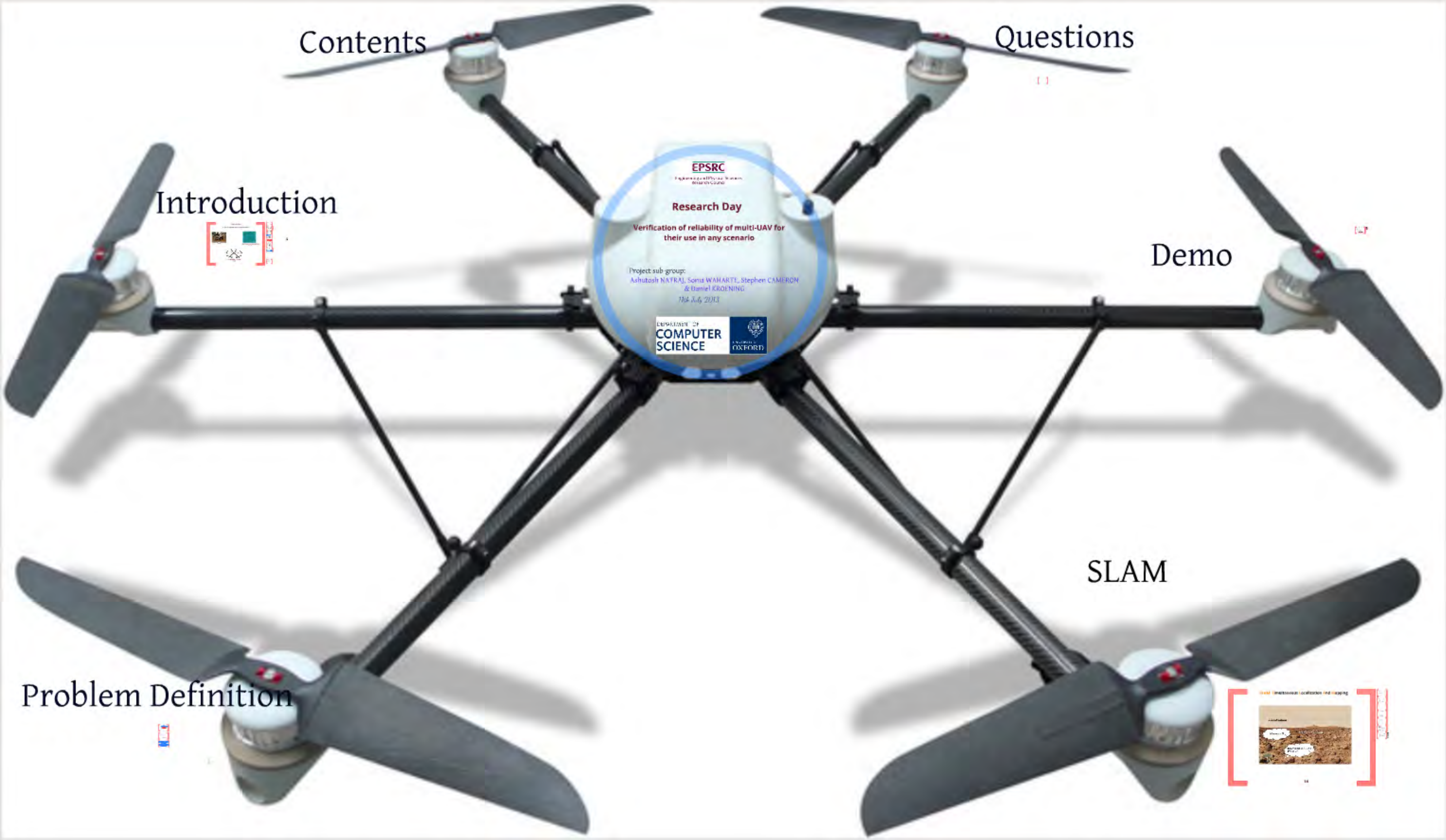
Low level: Memory allocation, read/write conflicts

What needs to be verified:

High Level: Algorithm Implementation

Some more yet to be decided and added in due course of time

Motor malfunction, heating and fire, Loss of sensor physical connection.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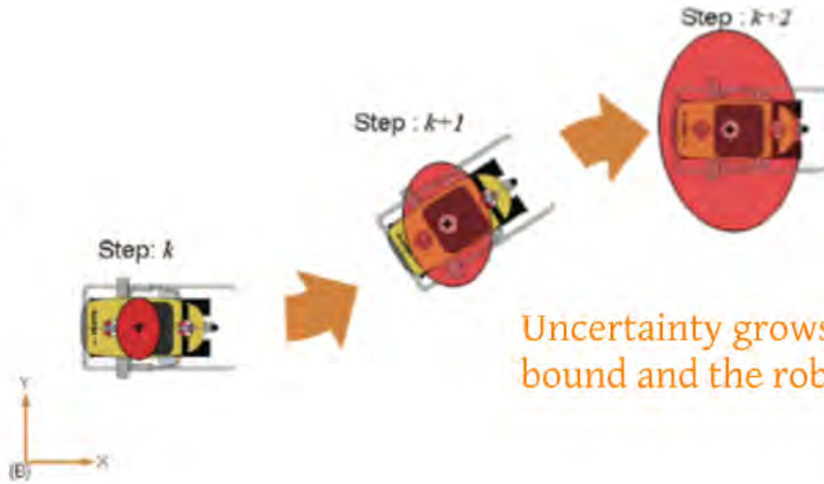
SLAM: Simultaneous Localization And Mapping

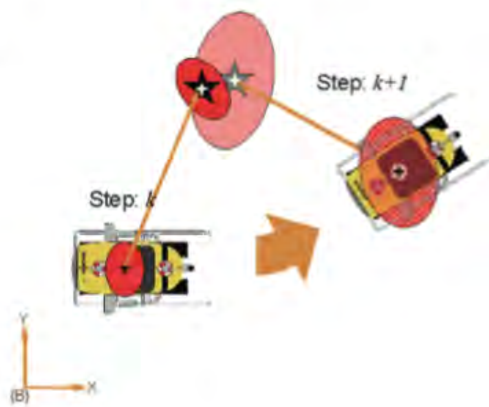
Localization Methods

Dead Reckoning



Uncertainty grows without bound and the robot is lost

Map Based Localization

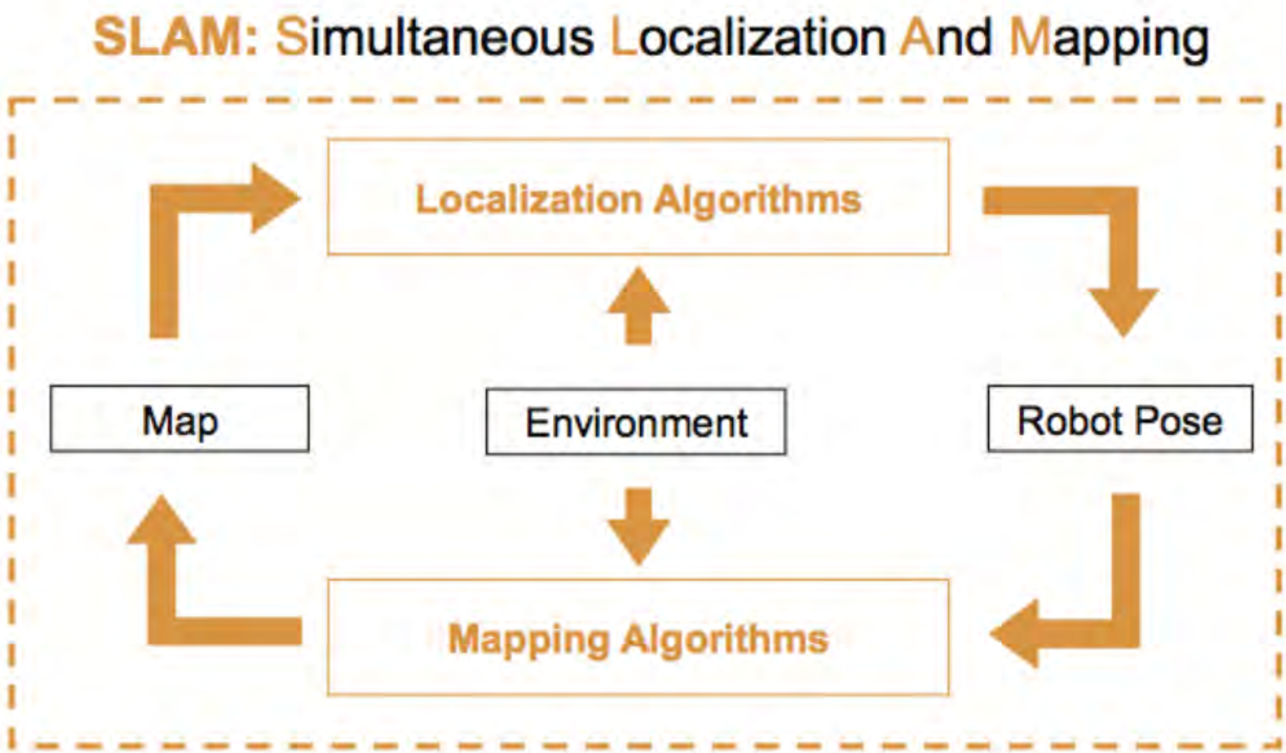


A conventional method for map building is incremental mapping.

Position Reference given by Dead Reckoning

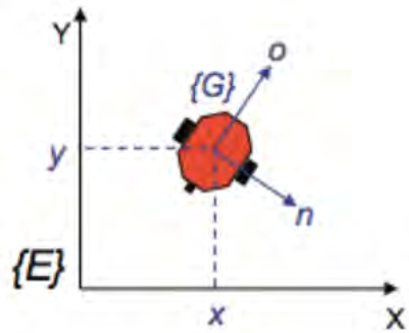
Bad Maps => Poor Localization

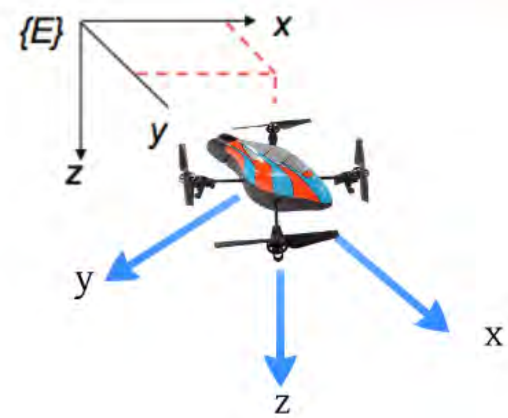
SLAM: Simultaneous Localization And Mapping



SLAM Problem Definition

Pose: 2D: $^{E}(x, y, \theta)^{T}$
3D: $^{E}(x, y, z, \phi, \theta, \psi)^{T}$





Environment:

Static: Only robot pose changes

Dynamic: Robot as well as the pose of other entities change

Localization:

Passive: Localization module only observes

Active: Robot is guided in a way that minimizes the localization error.

Given:

- Map of the environment
- Sequence of sensor measurements

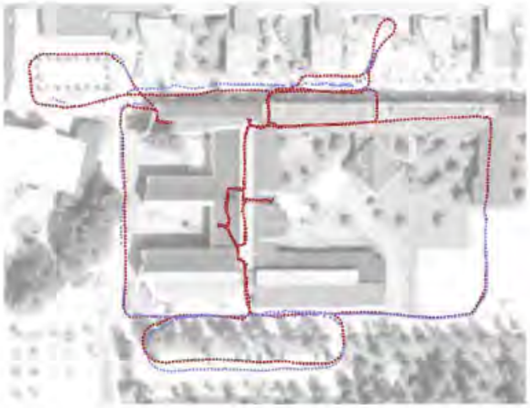
Wanted:

- Estimate of the UAV's position

Problem Classes:

- Position tracking (initial pose known)
- Global localization(Initial pose unknown)
- Kidnapped robot problem (recovery)

Visual SLAM:



Visual SLAM

Source: The University of Minnesota, Aerospace Engineering, website.

Visual SLAM as an important tool for localization as presented by Caballero et.al (2009) low cost, reliable, fast and hassle free.

Visual SLAM from partial structured environment by Artieda et.al (2009) relating features of objects tracked to their distance from UAV.

Visual SLAM from mosaics of images by Bailey et.al (2006)

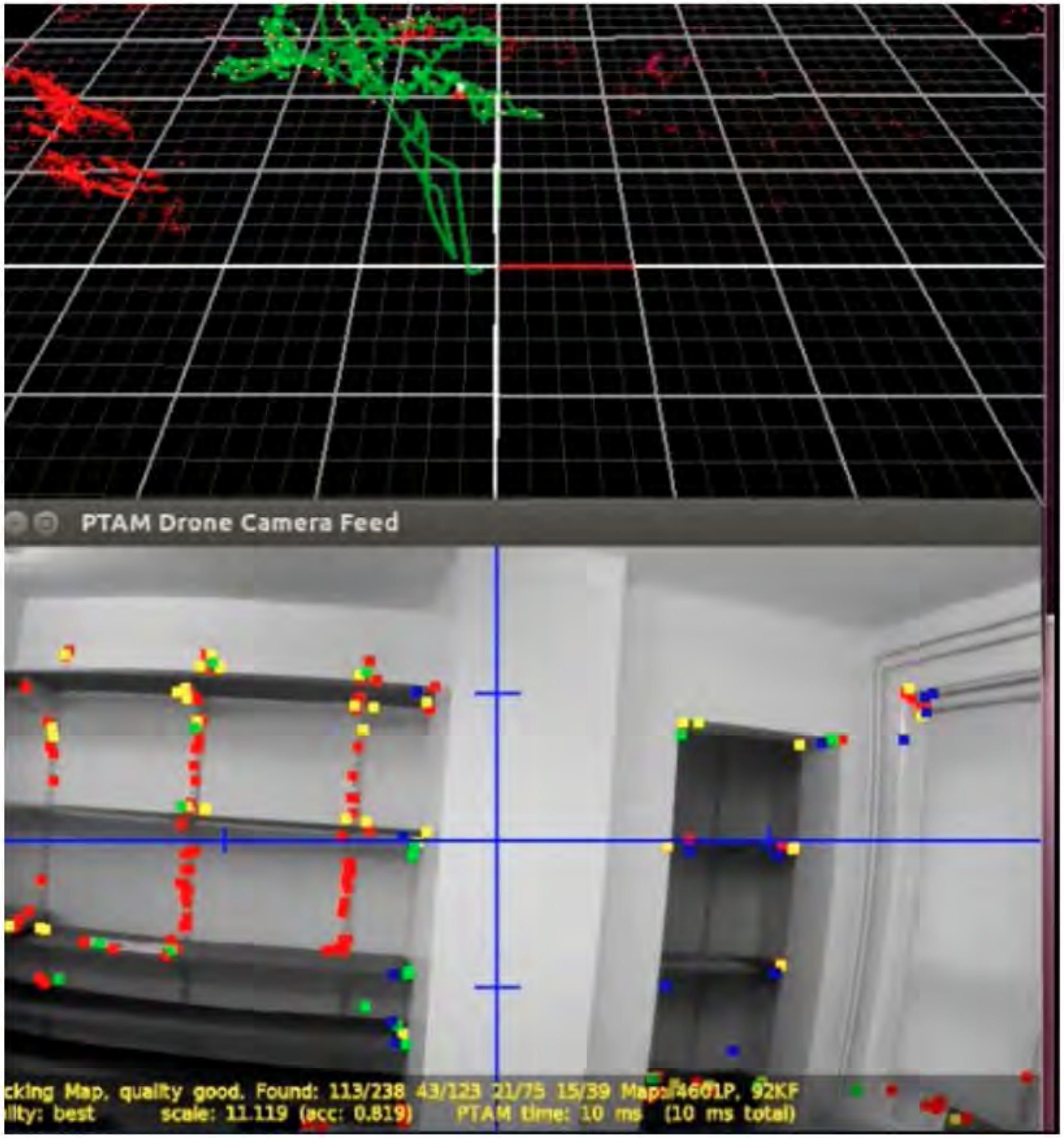
Scenarios

Scenarios :

- **2D Environment:** Hallway with 3 doorways.
- **3D Environment:** The mapping and localization of UAV

Explained with Demo

UAV - Localisation

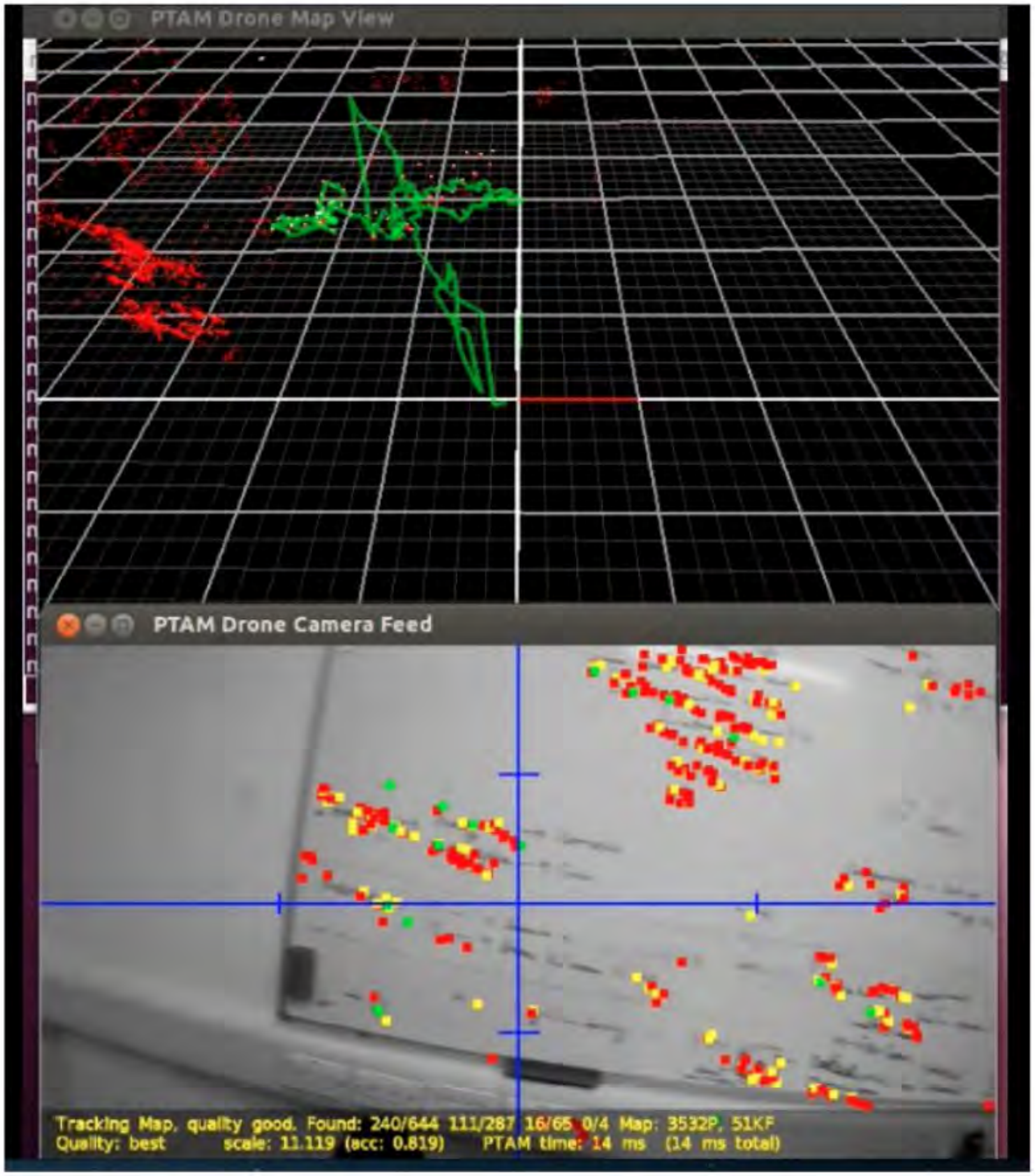


Green trajectory path - Localisation of the UAV

Red feature points – Generation and update of the map

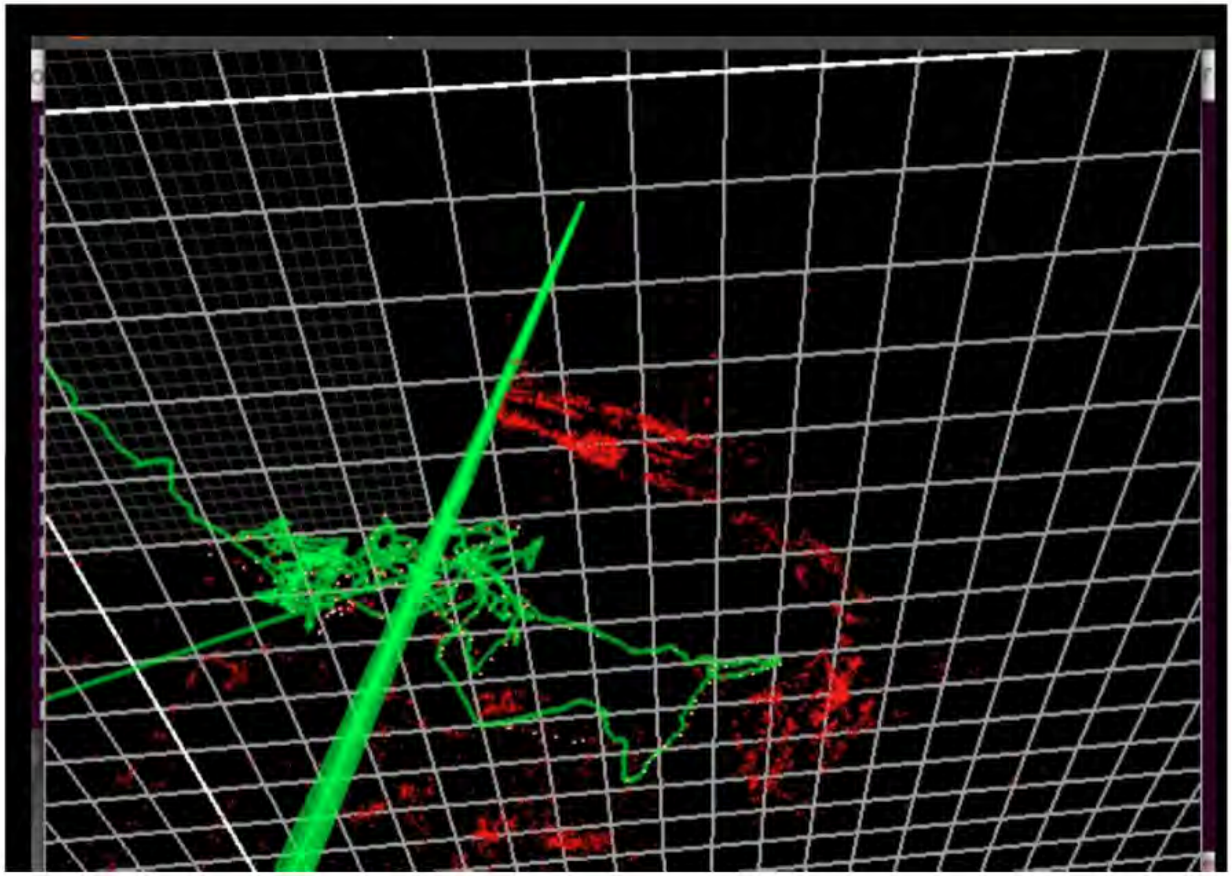
Visual feed from the camera

UAV Localisation



View 2

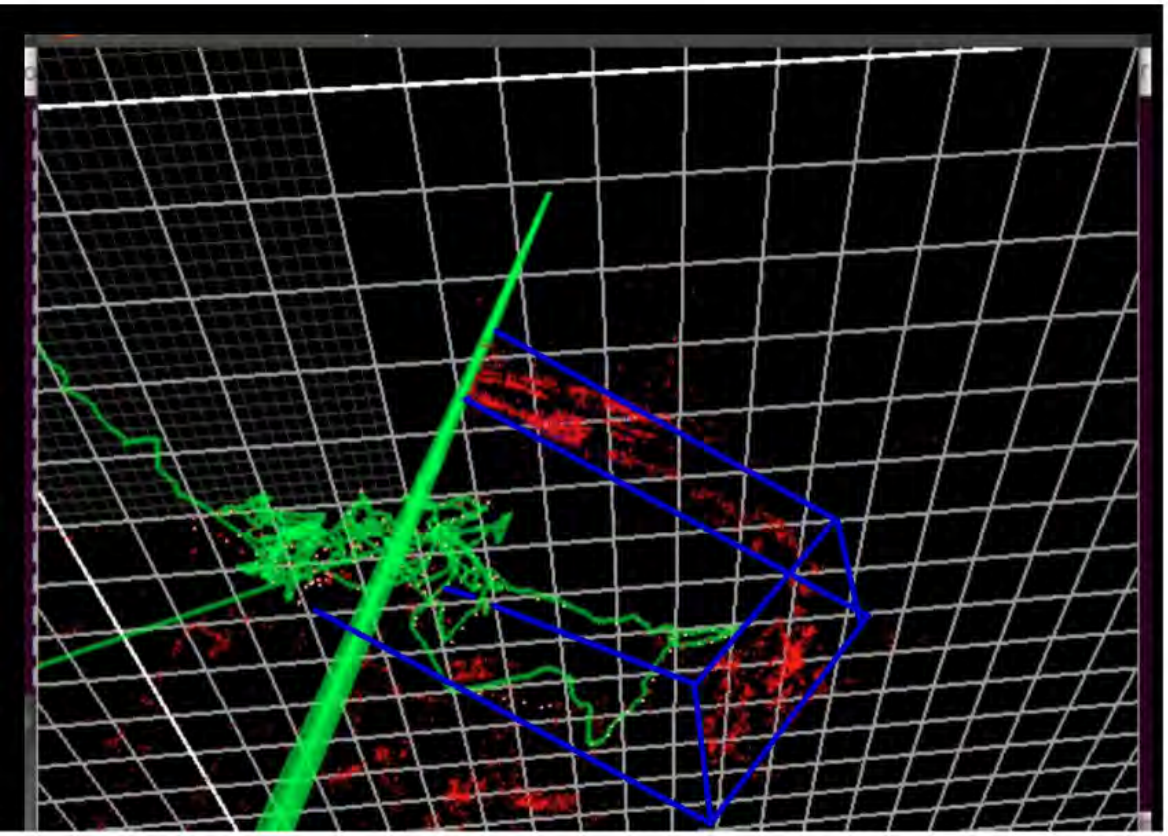
UAV – Map generation



Map generated from
Red feature points.

The map represents the 3 walls of the room .

UAV – Map generation



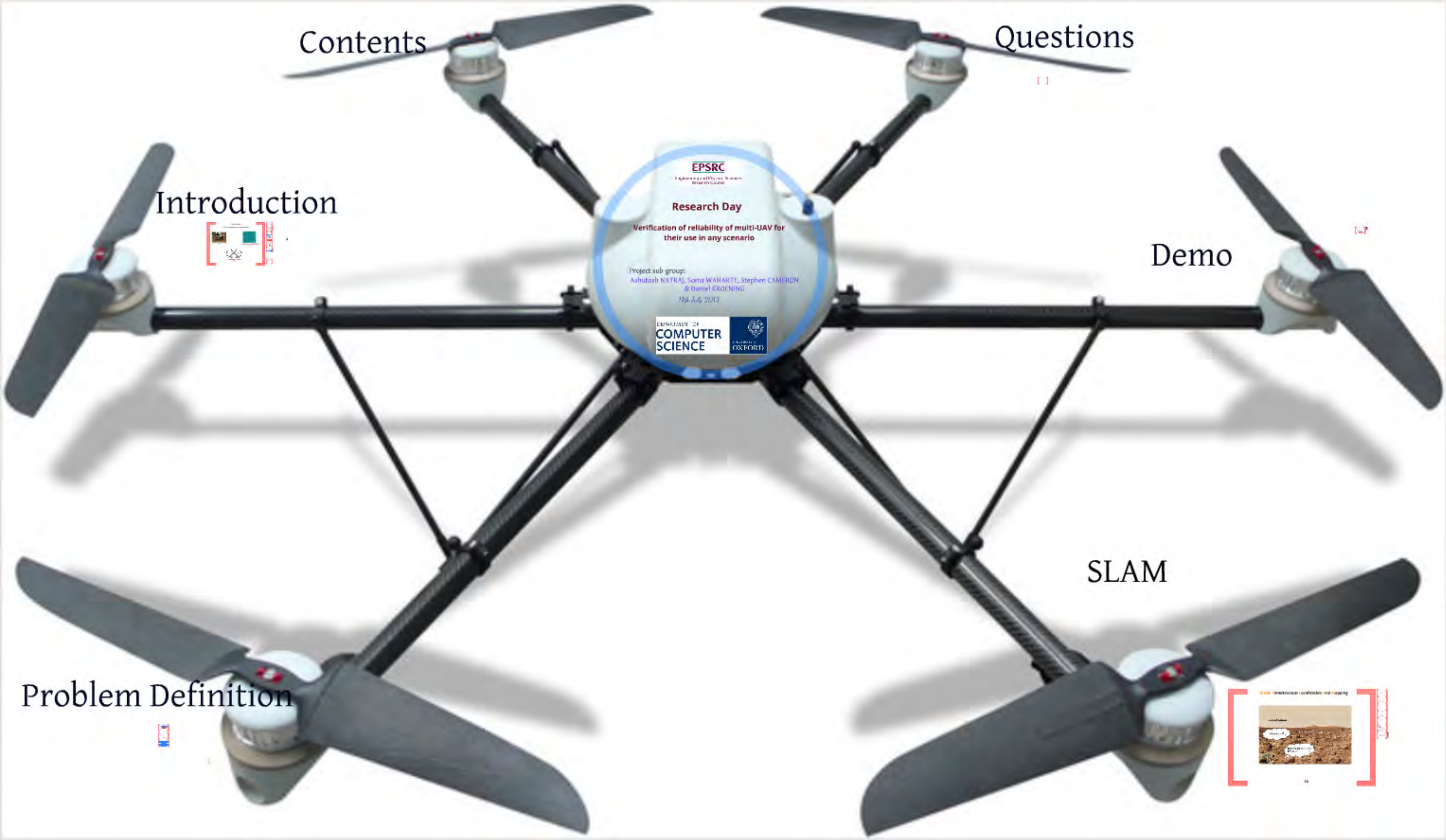
Map generated from
Red feature points.

The map represents the
3 actual walls of the room
In Blue. The 4th is window.

Verification

Identified verification goals from implementation perspective:

1. Fault that arise from the motor malfunction.
2. Fault from drawing excessive current to the motors.
3. Fault that arise from hardware failure – loss of physical connection of the sensor (camera / IMU/ sonar) – loose connection.
4. Fault detection from lack of feature points due to sudden occlusion on the camera or in fairly uniform environment that lack in enough feature points.
5. Fault that arise from losing the wifi established connection.



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Experiment - Demo

Demo

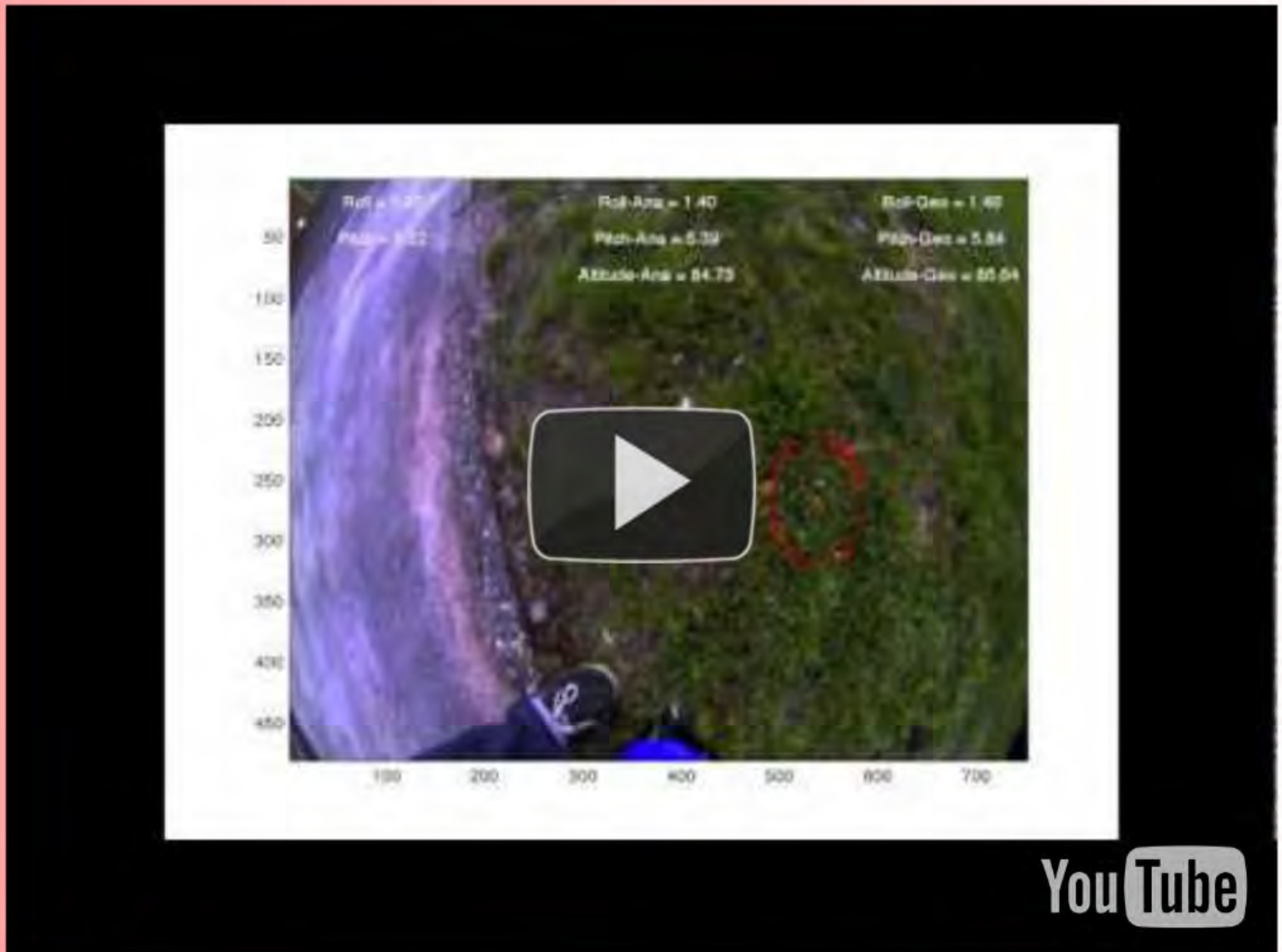
UAV Localization from visual information obtained from the environment.

Verification of identified features


Updates
Visible
YouTube

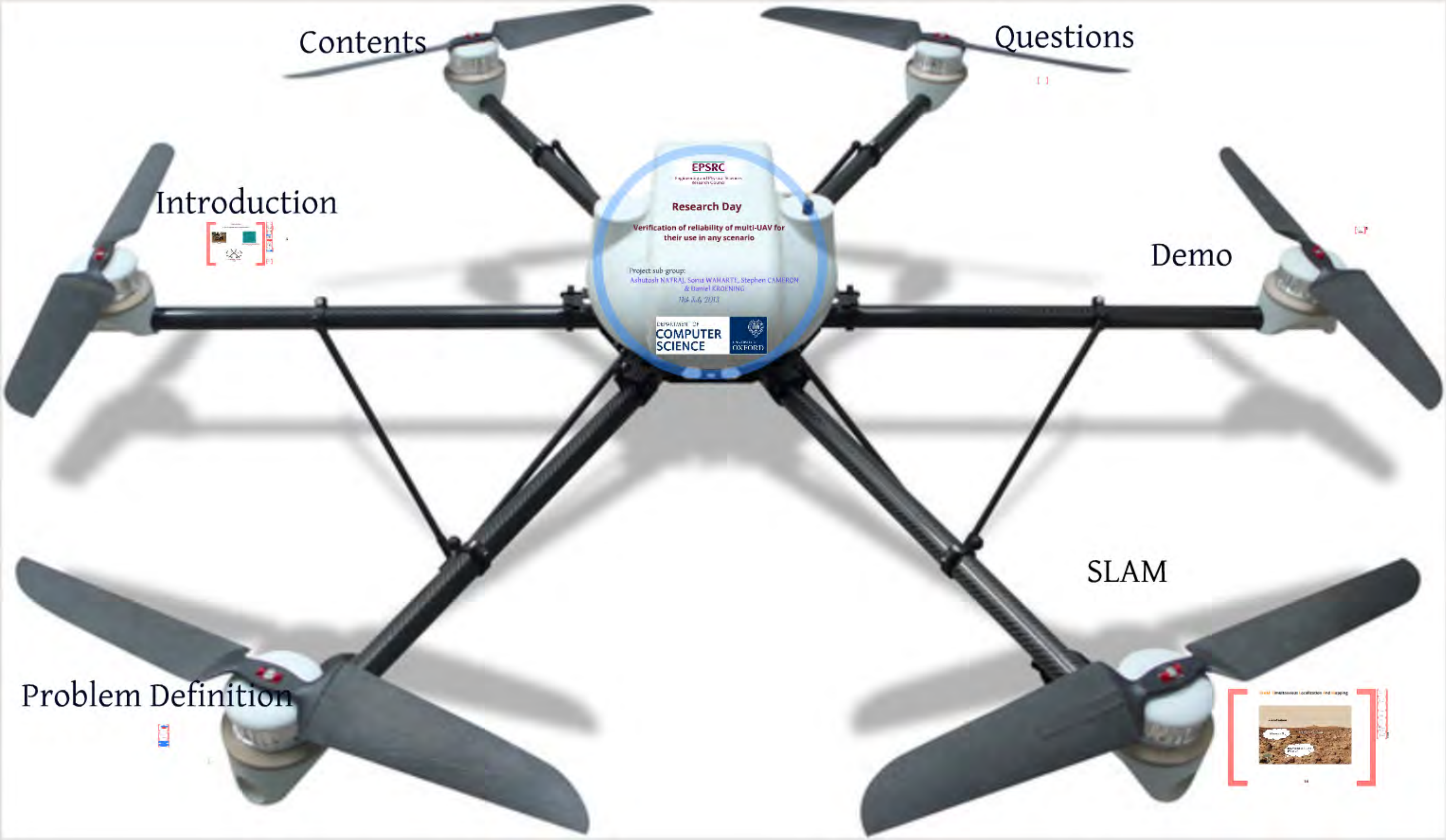

Indoor Navigation & Inspection
YouTube

Previous Works



Roll-Ana = 1.40
Altitude-Ana = 84.73
50
100
150
200
250
300
350
400
450
100
200
300
400
500
600
700

Prezi



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