Specification report for project

“Vehicle tracking in large area video”

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Project Supervisor: Ralph, Jason

Declaration of academic integrity

I confirm that I have read and understood the University’s Academic Integrity Policy.

I confirm that I have acted honestly, ethically and professionally in conduct leading to assessment for the programme of study.

I confirm that I have not copied material from another source nor committed plagiarism nor fabricated, falsified or embellished data when completing the attached piece of work. I confirm that I have not copied material from another source, nor colluded with any other student in the preparation and production of this work.

SIGNATURE : Ye, Zehao DATE : 2022/10/13 .

Abstract

This report is proposed as a preliminary report to introduce the global planning about the final year project. Consist of three main sections, which are the introduction of the project content, the allocation of tasks on the time scale, and the criteria to measure the completion of the project, the specification report provides clear instructions on project intent, performance and construction for the project of vehicle tracking in large area. The clarification of the specifications would also help the supervisor and assessor to guide and evaluate the project more efficient to assist student have a clearer understanding about the entire procedure of developing a project.

1. Introduction

As the population of the city proliferates, the challenge about urban managements is coming to the fore. Despite the wide distribution of ground surveillance systems, such as CCTV, the integrated urban managements are not satisfactory. In face of the challenge, the Wide Area Aerial Surveillance (WAAS) system [1] has great promise as the simplest way to provide continuous coverage [2] by replacing ground-based monitoring systems. Therefore, tracking vehicles through aerial photography can be an efficient solution to accomplish urban management. In this context, this project is proposed to accomplish an algorithm to vehicle tracking in large area. The researcher expects to realise the tracking of multiple targets in the city-sized area at the same time ultimately.

This report consists of nine sections, which would describe the introduction, project description, project specification, methodology, project plan, project rationale and industrial relevance, literature review, conclusion, and related appendices in order.

2. Project Description

In this project, the algorithm that tracking vehicles in large areas would be designed. The aim of the project is to achieve tracking of multiple vehicles within the range of the Field of Regard (FOR). The accomplishment of the aim is the ultimate expectation of the project. To realise the aim of multiple-tracking, series of objectives need to be taken. Firstly, develop the image reading programme to extracting the corresponding frames in the files. Secondly, get the trajectory of all the vehicles in certain area by image processing. Thirdly, utilize template matching method to classify vehicles. Fourthly, realise large area tracking of a single vehicle. Fifthly, revise the feature of target vehicle to change tracking targets. Ultimately, track multiple vehicles at the same time. The specifications and requirements would be discussed in the section of Project Specification/objectives.

3. Project Specifications/objectives

To design and develop an algorithm to accomplish multiple vehicle (more than 5 objects) tracking in Field of Regard, in 5 minutes duration from aerial photography videos, calibrated and tested to within a tolerance of 25% error rate compared to manual tracking, providing an aerial surveillance system to assist the agendas of policy makers in Smart City to implement urban management, by April 2023.

In this specification, the ultimate success criterion is to track five vehicles simultaneously and create their routes accordingly. The accuracy of these routes should overlap with the actual routes (In this project, the human analysts routes are thought to be correct answer.) by at least 75% to ensure the reliability of the program.

4. Methodology

From the perspective of programming language, MATLAB would be used for research in order to avoid spending time on constructing environment, because the functionality of MATLAB would be adequate to accomplish the project. Based on MATLAB, the Kalman Filter and Particle Filter are expected to utilized to realise vehicle tracking in large area from the perspective of algorithm theory.

5. Project Plan

As shown in the Gantt chart in the appendix 2, the project planning is as follow. The entire plan should be arranged based on a series of deadlines accordingly. There are four deadlines in this project, which are specification report, presentation about project, bench inspection report and final report. Despite the urgency of certain deadline, a structured

project plan, with the procedure of designing, development, and testing, should be devised to achieve the ultimate success criterion.

After elaborating on the significance of planning and the Gantt chart, another element of the project that cannot be ignored is the preliminary preparation of the project. In hence, literature review of the project is scheduled from 26th September to 28th October. Meanwhile, the completion of preliminary report and forms is arranged from 3rd October to 14th October.

Afterwards, the design and development of the project should be started. The design of the project is scheduled form week 4 to week 8 on semester 1, accompanied with development of the project from week 7 semester 1 to week 2 semester 2. The long period of time, which from week 4 semester 1 to week 2 semester 2 would be spent on developing algorithms to accomplish milestones gradually. At the same time, during week 9 to week 11 on semester 1, the presentation about temporary results is required.

The following procedure of the project would be the testing form week 2 semester 2 to week 6 semester 2. This procedure would provide the opportunity to continue optimizing the algorithm.

Ultimately, the duration from week 5 to week 10 on semester 2 is scheduled to finish the final report and bench inspection, which can analyse and summarize the results of the entire project.

6. Project Rationale and Industrial Relevance

This project is intended to provide an efficient aerial surveillance system to complement and improve the urban monitoring network. Compared with the ground-based monitoring system, the cost of aerial surveillance system is higher. Meanwhile, the obtained data are time-sensitive and research-oriented. According to these premises, the possibility of industrialization and marketization about this project is relatively low.

7. Literature Review

This section is proposed to review the development and significance of technology about vehicle tracking in large area.

From the perspective of the project proposal, this project is mainly utilized to assist the agendas of policy makers in Smart City (SC) [3] as a means to enhance the life quality of citizen. However, the acquire data from sensor, which would be applied in Big Data analysts, far exceed the processing limits of the communication network [4]. The transferred data still complex at the scale of ability and availability of human analysts [2]. In this context, agendas of policy makers desire to develop an simpler way to access data for urban management.

From the perspective of the theory of project, the Kalman filter and Particle filter are used to develop the algorithm of vehicle tracking. Kalman filter is solving linear Gaussian problems in the Bayesian filtering framework. The single target tracking tend to use nearest neighbour association techniques. However, it would be complex while multi-target tracking [5]. To solve this problem, the Multiple hypothesis trackers [5] are expected to be utilized in this algorithm.

8. Conclusion

This report provides the clear instructions on project intent, performance and construction. Firstly, this project is proposed to design and develop an algorithm to accomplish multiple vehicle tracking, whose specifications are simultaneously tracking multiple vehicles in large area with the 75% overlap of manual routes. After the success of the project, it may be added to the aerial surveillance system to help managers make progress in urban management.

Despite of the specification, this report also schedules the tasks on the time scale and creates Gantt chart. Meanwhile, corresponding milestones of the project are set for better completion.

Ultimately, the literature review about the project is discussed for this section is significant for further literature writing and project development. The background of this project is also mentioned in this part. However, there are still some imperfections that need to be further improved in the future.

9. Appendices

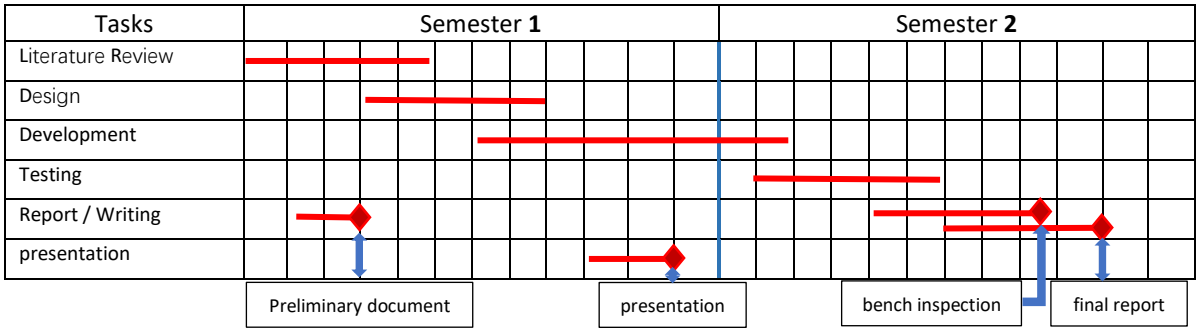
Appendix 1. Key Specification.

An overview of your key specification/objectives including how you can verify that you achieved them.

Parameter	Verification
Frame handling	Switch files when vehicle approach boundary
Track duration from 0 to 5 minutes	Test by aerial photography video
Track 5 vehicles simultaneously	Test by aerial photography video
Tracking and manual route overlap of 75%	Compared the route with manual tracking route

Appendix 2. The Gantt Chart.

Table 1: The Gantt Chart of Final Year Project



Appendix 3. List of work packages, milestones and deliverables.

Work Packages:

To design and develop an algorithm to accomplish multiple vehicle (more than 5 objects) tracking in Field of Regard, in 5 minutes duration from aerial photography videos, calibrated and tested to within a tolerance of 25% error rate compared to manual tracking,

providing an aerial surveillance system to assist the agendas of policy makers in Smart City to implement urban management, by April 2023.

Milestones:

1. develop the image reading programme to extracting corresponding frames in the files.
2. get the trajectory of all the vehicles in certain area by image processing.
3. utilize template matching method to classify vehicles.
4. realise large area tracking of a single vehicle.
5. revise the feature of target vehicle to change tracking targets.
6. track multiple vehicles at the same time. The specifications and requirements would be discussed in the section of Project Specification/objectives.

Deliverables：

1. Track duration from 0 to 5 minutes
2. Track 5 vehicles simultaneously
3. Tracking and manual route overlap of 75%

Appendix 4. The risk assessment form.

SINLGE USER BEng, MEng, MSc GROUP PROJECT RISK ASSESSMENT FORM - REPORT ONLY SIGNIFICANT HAZARDS

Unsafe working methods will lead to a reduction in your final project mark! ALL hardware work must be completed within the laboratory

Students are encouraged to come on site to perform their lab work but are advised that in some circumstances (Adriano, raspberry Pi and micro-controller boards which operate at <20V) equipment is allowed to be brought home. Students removing any other equipment from the lab needs to be authorised in writing by your supervisor - supervisors please confirm with HOD/safety team to confirm.

NAME- Zehao Ye **Student ID Number- 201601167**	**LOCATION-** **Final year Laboratory**
SCHOOL/DEPARTMENT: Electrical Engineering & Electronics Undergraduate year of study : 3	**BUILDING: Electrical Engineering and Electronics, A-Block**
TITLE OF PROJECT: Vehicle tracking in large area video	
Description of Work: This project will be concerned with developing tracking algorithms for detecting and creating a track for specific vehicles through a complex urban environment. This project will use existing video simulations (eg. https://stream.liv.ac.uk/zbj9sswg) showing complex environments where vehicles are occluded as an air vehicle moves through a city.	
Select a category for this project: **Category**	**Category 1 – Projects based on specialist equipment:** Projects requiring equipment available in the electronics laboratories (such as power supplies, multimeters, oscilloscopes, etc.) or any other specialist equipment that requires specific health and safety considerations (such as drones, etc.) that students would not normally be allowed to take home.

1 / 2 / 3	**<u>Category 2 – Projects based on "home-friendly" equipment:</u>** Projects requiring small pieces of equipment that do not require specific health and safety considerations and students can safely use at home (Raspberry Pi's, Arduinos and other similar low-voltage boards with double insulated power supplies).
	<u>Category 3 – Projects based on software only:</u> Projects fully based on software that can be completed using only a computer, without requiring any other equipment.

If students are in an observation capacity only when experiment is being performed

- please state this on form as well as risk in being observers - i.e. possible distracting experimentalist,
- State risk if they could be injured in this respect and how. Significant risks only should be stated.
- Class of any laser is required

State voltage & current values of all power sources being used. Any power supplies that have the ability to generate current and voltages > 10mA AND >20V respectively can be regarded as potentially extremely hazardous:

Voltage 0V Current **0mA**

HAZARDS (Location, equipment and substances, activities)	**WHO CAN BE HARMED?**	**CURRENT CONTROLS**	**Likelihood (L) × Consequence (C) = RISK SCORE (R)**		
			L	**C**	**R**
DSE (Design work, programming, producing documentation). RSI, poor posture leading to muscular discomfort etc	Person operating DSE.	DSE assessment, provision of adjustable height monitors, chairs. Updating of DSE assessments, provision of footrests and other adaptations for use of DSE at workbenches where required.	1	1	1
Food and drink spillage and contamination	Any persons in the vicinity	No food or drink allowed In the laboratory at any time. Take refreshment breaks outside the laboratory. Confiscate and dispose of food and drink found around the workbenches	1	1	1

- **For work using only Raspberry Pi and/or Arduino boards or other hardware connected via USB cable the main hazards are Display Screen Equipment (DSE) related, e.g. Repetitive Strain Injury, Carpal Tunnel Syndrome. L=1, C=1, R=1**

Training table - All boxes must be ticked in the following section to indicate either YES or NO.			
	N0	**YES**	**If you have ticked YES please follow the hyperlinks in the attached document, complete and return supplementary paperwork and/or implement and adhere to the guidance given.**
Use of tenon saw/hacksaw	✔		**Read Safe Operating** Procedure and other documentation on hand tools
Will work require the lifting of weights (>15kg)	✔		Manual Handling
Laser – If yes please input class of laser. Laser documents and hazard should be described on page 2 if laser is **NOT** class 1	✔		Please read all documents in the following link README : Laser: information and registration Guidance on the Safe Use of Lasers in Education & Research
Use gas cylinders or compressed gas?	✔		Gas Cylinder safety : Email local safety team to verify if training is required
Use hazardous Chemicals only? If stated on the form, description of hazard is required.	✔		COSHH - Use on-line EEE COSHH system to create COSHH risk assessment. Email local safety team to verify if training is required
Use voltages over 30V DC/AC If hazard has been previously described this	✔		Electrical Safety/Electricity – Includes reading the Sch. of EEE & CS dangers of electricity document
Use Power tools or rotating motors and machines	✔		SCR15-4 PUWER
Use Cryogenic Liquids/gases	✔		Cryogenic liquids and solids – Email local safety team to verify if training is required
Use Vacuum Systems and pressurised vessels	✔		Pressure systems : Email local safety team to verify if training is required
Use Radiation (UV, x-rays, microwaves)	✔		UV radiation (including links to local rules & safety advisor website)

LEVEL of Supervision?	**A** = Work May not be started without direct supervision
	B = Work may not start without Supervisor advice or approval
	C = No specific extra supervision requirements

Other relevant specific assessments (Local rules, Ethic approval forms)-

Disclaimer

- *The University of Liverpool ensures as far as is reasonably practical the health and safety of its staff and students.*
- *All equipment used by the students for their project must be safety tested and approved by the laboratory technicians before use. This includes but is not limited to, soldering irons, oscilloscopes, power supplies, probes and multimeters.*
- *Students **MUST NOT** undertake hazardous experimental/development work associated with their project outside of their designated laboratory space.*
- *ALL equipment that is used in the laboratory space & project MUST be purchased through the departments purchasing procedures.*
- *No equipment to be plugged into the mains supply unless circuit has been approved by technician or supervisor.*
- *Failure to abide by these conditions can result in the project receiving 0%.*
- ***Submission of this form implies acknowledgement by all the students named below.***

I can confirm that Hazards identified and precautions specified are appropriate for the task :-

Acknowledgement by Student 1 Name: Zehao Ye , Signature: Zehao Ye , Date: 2022.10.7 .

Academic supervisor Name: Jason Ralph , Signature: JFR , Date: 14/10/2022 .

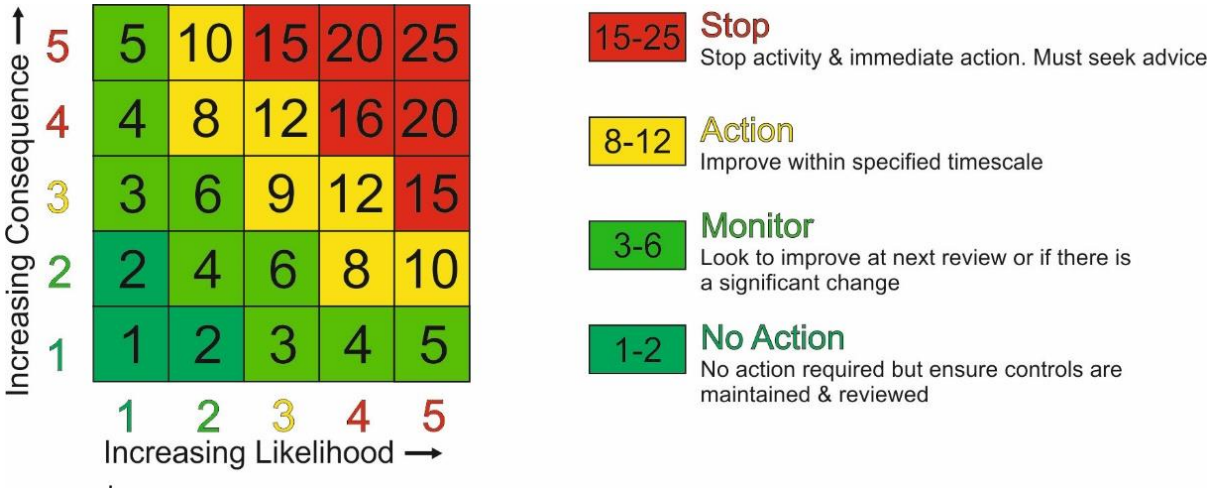
Common reasons for previously rejection of the form

- Project category was not stated on the assessment.
- Contradiction of hazards listed on page 2 compared those identified in training table. Users inserted description of hazards such as chemicals & live working but failed to insert yes in hazard table. Only hazardous chemicals should be described. Only significant hazards observed in experimental process should be described.
- Missing supervisor signature – risk assessment is invalid & students cannot enter the laboratory area
- Additional hazards noted in training table that are not described in hazard section. Lasers were described in training table required but hazard was not described in main assessment. Laser users should refer to risk assessment template document to identify how these should be described.

GUIDANCE TO COMPLETE THIS RISK ASSESSMENT FORM (LIKELIHOOD / CONSEQUENCE / RISK SCORE)

Likelihood		Consequence		Risk score	ACTION TO BE TAKEN
1	Very unlikely	1	Insignificant – no injury	1-2 NO ACTION	No action required but ensure controls are maintained and reviewed.
2	Unlikely	2	Minor – minor injuries needing first aid	3-9 MONITOR	Look to improve at next review of if there is a significant change
3	Fairly likely	3	Moderate – up to seven days absence	8-12 ACTION	Reduce risk if possible, within specified timescale
4	Likely	4	Major – more than seven days absence; major injury	15-25 STOP	Stop activity and immediate action
5	Very likely	5	Catastrophic – death; multiple serious injury		

- For work using only Raspberry Pi and/or Arduino boards (i.e. no other hardware connected using additional power supplies) the only hazards are Display Screen Equipment (DSE) related, e.g. Repetitive Strain Injury, Carpal Tunnel Syndrome. L=1, C=1, R=1



Appendix 5. Ethical approval questionnaire.

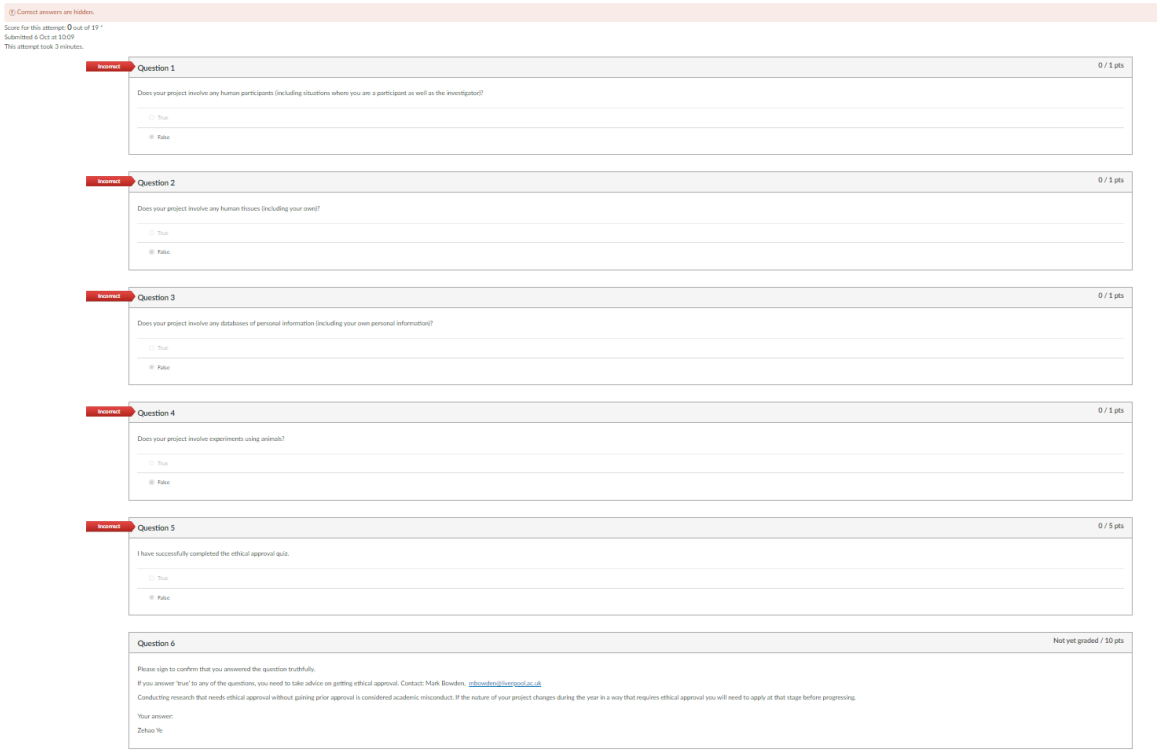


Figure 1: Screenshot of Ethical approval questionnaire

Appendix 6. References.

[1] L. Menthe, A. Cordova, C. Rhodes, R. Costello, J. Sullivan, The Future of Air Force Motion Imagery Exploitation: Lessons from the Commercial World, Technical Report, DTIC Document, 2012.

[2] E. J. Griffith, C. Mishra, J. F. Ralph, and S. Maskell, “A system for the generation of synthetic Wide Area Aerial surveillance imagery,” Simulation Modelling Practice and Theory, vol. 84, pp. 286–308, May 2018, doi: 10.1016/j.simpat.2018.03.003.

[3] P. Neirotti, A. De Marco, A. C. Cagliano, G. Mangano, and F. Scorrano, “Current trends in Smart City initiatives: Some stylised facts,” Cities, vol. 38, pp. 25–36, Jun. 2014, doi: 10.1016/j.cities.2013.12.010.

[4] R. G. Baraniuk, “More Is Less: Signal Processing and the Data Deluge,” Science, vol. 331, no. 6018, pp. 717–719, Feb. 2011, doi: 10.1126/science.1197448.

[5] J. F. Ralph, “Target Tracking,” Department of Electrical Engineering and Electronics, The University of Liverpool, Liverpool, UK