TEAM10

[P16] INTELLIGENT TRAFFIC MONITORING SYSTEM

Introduction

Brief introduction of the knowledge and skills we have.

Project Analysis and Management

Our vision of this project and how we will manage this project.

Project Estimation

Our detailed estimation of the process.

[P16] Intelligent traffic monitoring system

Project Title	Intelligent traffic monitoring system
Team Members (TEAM 10)	
Name	**Email Address**
Ruizi Han	biyrh2@nottingham.edu.cn
Shiliang Chen	scysc1@nottingham.edu.cn
Yani Huang	scyyh7@nottingham.edu.cn
Yijie Lu	scyyl9@nottingham.edu.cn
Yiming Tang	scyyt1@nottingham.edu.cn
Yuting Jiang	scyyj2@nottingham.edu.cn

Contents

Part 1: Introduction

The main reason why our team members are interested in this project is that we believe the project outcome can be very useful in real life and help improve the traffic situation. Also, our team is equipped with many desirable skills.

1. Project understanding

Background

According to our background research, traffic congestion is a serious problem nowadays. The economic losses and environmental pollution it caused can be enormous. Take Beijing as an example, public transportation system is sometimes almost paralyzed because of the rush hours traffic congestion, and the time loss of passengers is equivalent to 79.2 billion RMB's economic loss. (Gao, 2016)

With the rapid development of electronic technology, communication technology and computer technology, some traffic monitoring systems are developed in order to manage this problem.

Limitations of other systems

Limitation of traditional traffic monitoring system
Though widely applied, some technologies used in traditional traffic monitoring system such as radar speed measurement and magnetic detectors have many shortcomings, such as limited range of application, high cost and high damage rate.

Limitation of existing intelligent traffic monitoring system
After studying some existing similar projects, we found that some systems are already capable to accomplish many basic tasks as traditional system do with more advanced technology, but there are still lots of limitations.

Firstly, the precision of their detection is not that satisfying. The output is subjected to the whole system's hardware and software and could be easily influenced by small changes of environment, weather, illumination and disturbances, such as water reflection and day-night shift. Besides, the calculation of image processing is huge, so the real-time performance is poor.

What the project can bring
This project's outcome can partly solve these problems and improve current transportation system's performance, and we are really excited and interested to produce such a useful software. This system will be a good complement to traditional ones and is able to replace some outdated technologies.

With the intelligent multifunctional traffic monitoring system, many detections can be done by only using cameras which are already installed

with every traffic light. Then the traditional traffic monitoring system's high cost problem will be solved since this system can be widely used and deployed with very low cost and fewer detectors are needed.

Compared to traditional methods, intelligent traffic monitoring system has more noted advantages. Its installation does not need to damage the road and the maintenance is relatively easy and convenient. It can also detect some abnormal traffic events and get image evidence which could be helpful for accident management. Moreover, a single camera and processor are able to detect many lanes, in that case, the system does not need many cameras and detectors, the cost will become much lower.

After analyzing those implements, the team considers the project as an executable software, rather than a simple tool. The team chooses to extract the essence and discard the dross of them, and develop a modern, learning friendly and simple-to-use software.

Innovation

Our goals

What we plan to do can significantly improve the existing system. Firstly, we decide to record those overspeed cars, which helps the traffic management. Then, we hope we can improve the calculation process by using some advanced algorithms, once we successfully reducing the calculation time, it is possible to tag each car with their real time speed. Estimating traffic volume and speed using machine learning techniques is also what we want to achieve, those statistics can help a lot in future traffic management.

Our assumptions

For other problems in those similar projects, we will try to solve them. The detection accuracy will become low when day shifts to night since there is not enough light to "see" the vehicle clearly, maybe we can solve this problem by detecting car lights. Another problem is that, when serious traffic congestion takes place, all cars stay still, it will be difficult for the system to detect out cars as foreground from background. Our idea is to use machine learning techniques and recognize those vehicles. But those are only our initial thoughts, hope we can go that far.

2. About Team

Team experience

For team 10, we all have a wide range of experience working in organizations, teams and real companies.

Most of our members engaged in the summer research program last summer vacation, so we are quite familiar with the whole process of research. We know how to do background research and reproduce other's work, which will help us begin our project smoothly.

Other members of the group also have noted experience. Shiliang Chen and Ruizi Han used to be in the same team working on machine learning topic, which will be undoubtedly useful to this project.

Team management

Though we have not got a team leader yet because we thought it would be wiser if we decide it after the project awarding, we have many excellent candidates. Shiliang Chen used to be the team leader of his FSE group and he gained a high score in this course. Besides, Yiming Tang and Yani Huang are two big organizations' department leaders. Team management will not be a problem for our group.

Yijie Lu is a real team worker who has rich experience in every phase of software engineering. She is skilled in many aspects, such as producing UML and plan writing, and she achieved a high score in FSE. With her ability, the whole software engineering process will go well.

Technical skills

Besides, Yuting Jiang has the experience in data visualization and Yiming Tang used to design and develop full UI of a program, those abilities perfectly fits the needs of this project. Also, many of team members have design experience, so the UI will be both good-looking and user-friendly.

Video clip might be a desirable skill for this project because the input is video. Luckily, most of group members have experience of dealing with videos and we even have an expert, Yiming Tang, who produced many videos for our school. We believe our promotional digital artefact will be excellent and attractive, too.

The team has carefully examined and researched the project and holds a part of knowledge towards the project up to now. After two weeks of running-in with team members and frank talks, the team is working gradually as an efficient team. With many discussions towards what the project is and how to design the software, although there is still lots of knowledge to learn and tons of difficulties to conquer, the team is firmly ready to take over this project.

Part 2: Project Analysis and Management

Key words: **VISION, SKILLS, TECHNICAL PLAN, TOOLS, PROJECT MANAGEMENT**

We have already done a lot of background research, get a general idea of how we can achieve our goal. Following part is the plan of how we work.

1. Our vision to the features it needs

This project aims to develop an intelligent transportation system which is capable of taking video clips as input and output traffic data in a user-friendly visual format. Specifically, the software can do:

- **detect** and **track** vehicles
- **detect** lanes
- **display** average number of vehicles in each lane
- **display** average traffic speed in each time slot
- **estimate** and display traffic volume and speed using historical data

We also come up with two more features that could be helpful

- **display** real-time speed of each vehicle
- **warn** if an accident happens by calculating relative speed of two cars

2. Our skills to accomplish these features

- **Computer vision** skills to detect and track
  Ruizi Han has researched on video colorization, Shiliang Chen has worked on image colorization and many members have experience of handling videos (Yani Huang, Yiming Tang, Yuting Jiang). Besides, Yani Huang has experience on facial recognition.
- **Machine learning** techniques to estimate and warn
  We have learnt machine learning skills last semester and gained above average grades in this course.
- **Statistics methods** to estimate and warn
  Our mathematical knowledge is abundant, and we will refer to and work hard on some example formulas.
- **GUI design** skills to display
  Yiming Tang has rich experience of UI design, he used to design and develop full UI of a program. Many of our members have experience in design, such as posters, video clips and photoshop, so we know how to make the interface look good. Moreover, Yuting Jiang has experience in data visualization.
- Knowledge of **versioning**; Experience with **Git**
  Some of our members (Yiming Tang, Shiliang Chen) have experience of working in a real company, and they used git a lot during their intern, so we also have git experts in our team.
- **Programming** skills
  All of us have basic programming skills on C, Java, MATLAB, etc. and

we are willing to learn any new stuff.

- Ability to **obtain traffic clips**
  We have access to surveillance video from all over the world. Also, many of us are equipped with video clip ability.

3. Our technical plan to implement the software

- **Pre-process of images**
  As images are taken by digital devices, random noise can be mixed into the sequence of images which may cause some difficulty to the detection of objects. Recording devices can also be shaky, which will lead to blurred images. It is concluded from experiments that *median filtering (MF)* could be helpful to the detection of vehicles.

- **Background modelling and foreground segmentation**
  In case that video clips of traffic are always recorded in a stable perspective, background is likely to be considered stable while vehicles are foreground that moves. An easy way to detect and track moving objects is background modelling. The specific modelling method which is suitable for this project could be *Gaussian Mixture-based Background*.

- **Multiple-object tracking**
  It is required to display average number of vehicles in each lane and calculate the traffic volume and speed, therefore, multiple vehicles shall be tracked simultaneously. *CamShift, Lucas-Kanade*, etc. could be used to track multiple objects.

- **Statistics estimation**
  Machine learning method such as *CNN* will be a good choice to handle the statistics obtained from previous steps.

- **GUI design**
  To offer user useful data in a user-friendly visual format, *JavaFX, QT, etc.* can be used as powerful tools to create a graphical interface. This will contain ways for input, real-time output clips, settings of algorithms and arguments and estimations.

4. Tools

OpenCV, JavaFX, QT, Java, C++, Python, MATLAB, Git

5. Project management

The whole project will be carried out by the six of us. Since it is a small development team and we hope to have great customer involvement, **Agile** project management approach will be used to embrace changes to requirements, delivers and frequent releases.

Specifically, we will use **Scrum** method utilising **backlogs** as a formal "to do list" which contains a set of tasks, worked out with supervisor at meetings to trace our work. MSFT Planner may help us maintain backlogs.

During our development process, **Sprints** will be planned based on the backlogs which are made during the meeting. They are two-week development iterations, and it will help us complete subtasks weekly. Other than formal meetings with supervisor, informal meetings **stand-ups** will be held weekly to make sure the efficiency of our team.

As for code quality, we have systematic ways to guarantee it during the whole process. The thing would be confirmed at the very beginning is a **coding convention** including comment, naming, indentation, and change log. **Git** will be used as version control tool. What is more, software will be developed using a **test-driven** development approach where appropriate and **pair programming** is deployed to mostly avoid mistakes. Deep into the process, team is managed by several useful **GitHub features**. We will use issues with labels to raise questions, distribute tasks, alert bugs, show what is *to-do*, *Doing* and *Done*. *Boards* is a clear and visible feature for managing tasks showing the whole process at the same time. *Milestones* will also be used for making stage-based objectives with due time, to control the productivity.

A brief early-stage management plan is as follows,

Stage one

- Analyse requirements and do background research
- Write user stories and personas according to the requirements
- Design prototypes with collaboration to customer
- Outline planning and architectural design

Stage two

- Divide members in pairs and distribute works to pairs.
- In each sprint, develop with testing and customer
    a. Access
    b. Select
    c. Develop
    d. Review
- Daily informal meeting and weekly formal meeting with supervisor

Stage three

- Project closure and evolution

Part 3: Project estimate

1. Estimated phases

1. Research
   1.1 Background research (exiting system analysis, paper review, reproduce other's project)
   1.2 User research (discussion, research, survey, market research)
   1.3 Relevant knowledge acquirement (learning necessary skills)
2. Design
   2.0 Group page
   2.1 Write user stories and personas
   2.2 Design prototypes
   2.3 Architectural design
   2.4 Outline planning
   2.5 GUI design
3. Implementation
   3.1 Create testing structure
   3.2 Detect vehicles
   3.3 Detect lanes
   3.4 Number of vehicles
   3.5 Track vehicles
   3.6 Speed of traffic
   3.7 Estimate traffic volume
   3.8 Estimate traffic speed
   3.9 Visualise data
   3.10 GUI
4. Reports
   4.1 Interim Report
   4.2 Final Report
   4.3 Individual Report
5. Testing
   5.1 Release testing
   5.2 Acceptance testing
6. Evaluation
   6.1 Software demonstration
   6.2 Team presentation
   6.3 Promotional digital artefact
   6.4 End of project

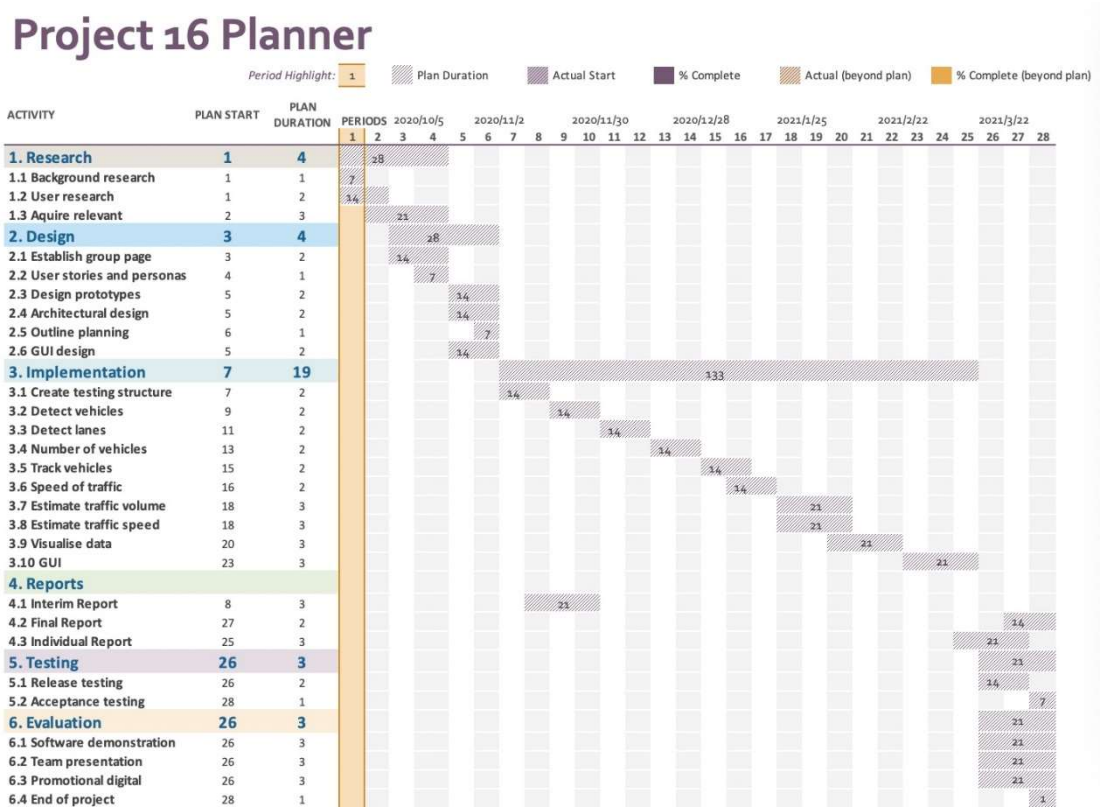

Fig.1 GANTT Chart of project plan

2. Simple prototypes

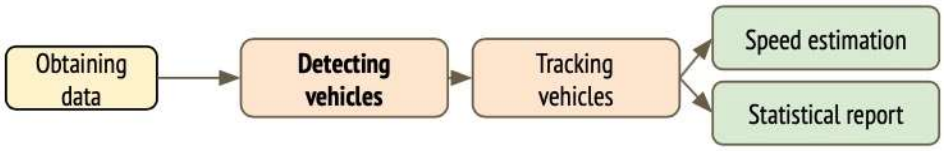

Fig.2 How to obtain statistics from video clips

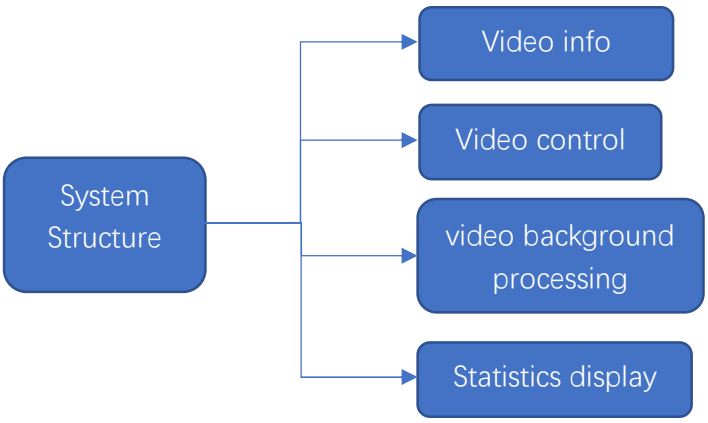

Fig.3 Early-stage System Structure

After studying some existing similar projects, we have already come up with a simple model (Fig.3) about the system we are going to build and what stages we will go through (Fig.2).

In our initial idea, the system will be composed of 4 modules, video information module, video control module, video background processing module and statistics display module.

The first and second modules are designed to control inputs, which also help users get to know this system better.

Video background processing module is the core of this system, all statistics are produced in this part. Basically, it will first detect vehicles, then tracking them and gain some useful statistics for later calculation and estimation.

Statistics display module is a visual-related part, we want to achieve the effect that real-time speed of each vehicle is tagged above it.

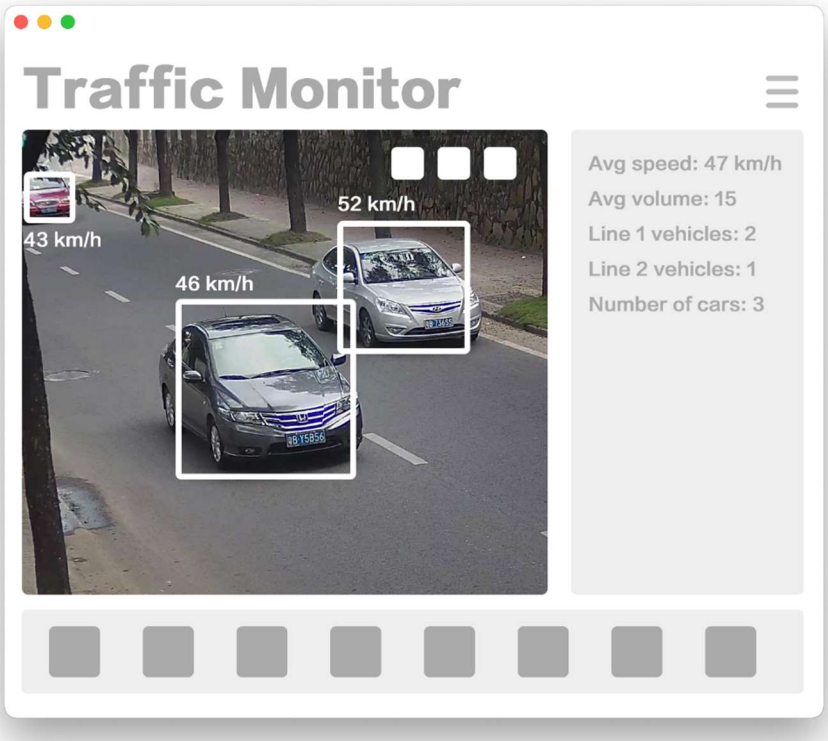

Fig.4 Demo GUI

This is a very early-stage demo GUI (Fig.4) in order to show how our software will basically display and perform. In the menu bar, there will be three options, *Video*, *Edit* and *Help*. Import videos or save videos are under *Video* option, Edit arguments is in *Edit* and get help or change language are placed under *Help* option. Under the menu bar is a *Info Box* which contains statistics analysed from the video in real-time. The left side displays the video clip. On the top-right corner, three buttons are set for controlling the video. The function bar at the bottom aims to provide extra features such as Night Mode, etc.

Reference List

[1] Gao, X.D., (2016). Research on Traffic Flow Surveillance Technology Based on Computer Vision, Lanzhou University, China

[2] Taha, M., Zayed, H., Nazmy, T., Khalifa, M., (2016). Day/Night Detector for Vehicle Tracking in Traffic Monitoring Systems. *World Academy of Science, Engineering and Technology International Journal of Computer and Information Engineering*, Vol: 10, No: 1

[3] Gansbeke, W.V., Brabandere, B.D., Neven, D., Proesmans, M., Gool, L.V., (2019). End-to-end Lane Detection through Differentiable Least-Squares Fitting, Dept. ESAT, Center for Processing Speech and Images, KU Leuven, Belgium

[4] Fernández-Sanjurjo, M., Bosquet, B., Mucientes, B., Brea, V.M., (2019). Real-time visual detection and tracking system for traffic monitoring. *Engineering Applications of Artificial Intelligence*, Vol: 85 (pp. 410–420)

[5] Arruda, V.F., Paixa, T.M., Berriel, R.F., Souza, A.F.D., Badue, C., Sebe, N., Oliveira-Santos, T., (2019). Cross-Domain Car Detection Using Unsupervised Image-to-Image Translation: From Day to Night, Universidade Federal do Esp´ırito Santo, Brazil