Software Design Study
Final Report

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Chapter 1

Introduction

1.1 Problem Definition

We began this project by exploring the 'Safety in Cycling' problem space. Our motivation for this was that we felt cyclists were involved in too many avoidable accidents. A key part of exploring this space was speaking to different stakeholders to get their opinions on the main causes of accidents. We also looked a lot of statistics from various sources in an attempt to try and spot some interesting trends.

Initially we looked into all different formats of cycling; mountain biking, BMXing, road cycling, etc. however the data showed quite clearly that the majority of serious accidents were happening on the road. Moreover they were happening on fast moving roads during commuting hours.

This information allowed us to narrow the problem definition down to the following:

- Reducing number involving cyclists on UK roads
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1.2 Purpose

This report is written for the benefit of any software or hardware engineers who are tasked with implementing this product. For this reason, in parts, the report may assume some basic technical knowledge of these fields.

The report should describe, in detail, our solution to the problem above. The detail should be enough so as that a small team of people would be able to implement the solution in its entirety with relative ease. The report should address all of they key areas of the solution and be void of any ambiguities so that it alone can clarify any queries about the product.

1.3 Scope

1.4 Overview

Firstly we will give an overview of the system as a whole before further explaining the key design decisions that were made.

1.5 Definitions, Acronyms and Abbreviations

RTA Road Traffic Accident

1.6 References

The design decisions that we made are based on our earlier research and we will continually refer to this research throughout the report, all of which is documented in the Research Report found in the appendix.

All other papers, articles, etc. that were used to formulate our ideas are referenced in the Bibliography.

Chapter 2

System Overview

2.1 Rejected features

During our research we considered a multitude of different approaches to improving safety in cycling and as with any project we had to reject some of these features when we came up with a plan for our system. because they were either unnecessary,

Chapter 3

Design Considerations

3.1 Assumptions

When designing this system we have had to make a few assumptions about certain characteristics of the end users, this is because it would be almost impossible to design a system of this nature that is both effective and easy for everybody to use.

Firstly we have assumed that the end user will be fully able-bodied. We feel that this is a necessary assumption despite the fact that one in twenty cycling commuters are disabled [1]. Cycling is a very physical activity and generally those with severe physical disabilities are better off with a bike that is specifically designed to cater for their particular disability. It is very much possible that the final product will be usable for the less severely disabled, however we will not be creating our design with any of these disabilities in mind.

Secondly we will be assuming that end users some familiarity of bikes and particularly road bikes. We will not be designing an educational tool that teaches how to ride a bike nor we will it be an assistance

3.2 Constraints

3.2.1 Cost

We are attempting to create a solution for the average cyclist to use on the road. This means it is important for us to be able to obtain all of the components and produce the bike within a reasonable cost. To decide what constitutes 'reasonable' we analysed how much cyclists currently spend on their bikes and asked cyclists how much they would be willing to spend on a bike of this style/quality.

Current spending The number of bikes sold each year in the UK has remained fairly constant since 2003 (slightly over 3,500) but the total amount spent on bikes has increased steadily. This indicates that people are willing to spend a considerable amount on a good quality bike.

In spite of this, however, the average amount a person spends on buying a bike in the UK is only 233. This is most likely due to a large amount of cheap bikes sold to casual cyclists; however these are not the people we are aiming this product towards. [1] The Cycle to Work scheme - which allows people to buy commuting bikes and equipment tax free - saw commuters spending an average of over 1,100. This is more in line with the price our bike would retail for and the cyclists we are aiming at. As well as this, our earlier research found that commuters spend a further 195 on accessories alone, many of which would be redundant with our bike.

3.3 Design Goals and Guidelines

During the design process our overriding guideline

Chapter 4

Data Design

4.1 Data Description

4.2 Data Dictionary

Chapter 5

System Architecture

5.1 Architectural Design

Chapter 6

Component Design

6.1 Collision Avoidance System

Why we need this? What is the system responsible for?

6.1.1 Component Requirements

- Function during times of the day when there are levels of light.
- Detect vehicles (differentiating them from other objects) and then apply a unique identifier to that vehicle.
- Track vehicles and acknowledging them with their unique identifier over time.
- Notify the user when there is a possible collision.
- The future trajectory of the vehicle should be predicted and, in addition to, the bicycles speed, direction, GPS route) used to to calculate the probability of a collision.
- Apply an evasive action when the algorithm predicts that a collision, involving the user, is of a high enough probability.

6.1.2 Interface Description

What does the components interact with (other software, hardware) diagram?

6.1.3 Possible Solutions

Collision has to be broken down into 4 different steps (detection, tracking ...)

Forward Trajectory Solutions

Solution 1

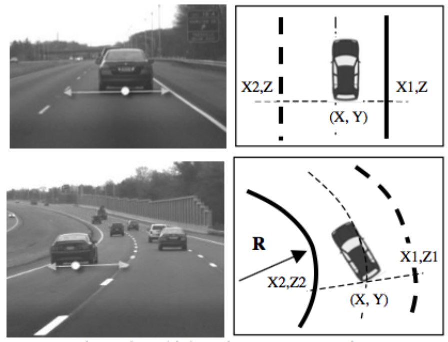

Figure 6.1: Vehicle trajectory computation at straight and curved lanes [2]

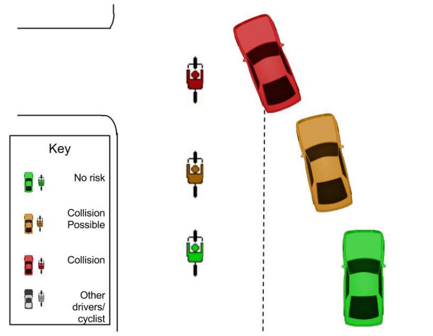

Figure 6.2: Cyclist and vehicle lane changing collision

One paper [2] detect and tracks preceding vehicles using a monochrome camera to predict whether the vehicle is going to change lane (in a left or right direction) or stay in its current lane. This involves the detection and tracking of both vehicles and the road lines they reside in. It uses Support Vector Machine (SVM) with a motion and appearance cue to recognise driver pattens, that are trained for a two class feature set. The two class features are used to predict lane-changing recognition, via the input of timestamped 3D positioning.

A kalman filter is used to track the motion of the lane boundary and predict from frame-frame its new location. There is an intersection between two lane boundaries, which is known as the vanishing, and is used to detect the pitch angle change of the camera. Line features are used to establish vehicle hypotheses, which are verified by an SVM (with HOG) trained for vehicle recognition via a pre-learned vehicle model database. Post verification, a Kanade-Lucas-Tomasi feature tracker is used and the bottom of the tracked vehicle in each frame to calculate its 3D position.

Most papers based on predicting a vehicle future prediction require, not just the detection and tracking of vehicles, but the detection and tracking of road lines, too.

One paper [2] needs to to detect road lines and vehicles to function correctly.

Adj Dis

Solution 2

Adj Dis

Conclusion - decision complying with criteria at the start

Vehicle Trajectory Prediction

Bicycle Evasive Action

Chapter 7

User Interface Design

7.1 Overview of User Interface

7.2 Screen Images

7.3 Screen Objects and Actions

Chapter 8

Detailed Design

Chapter 9

Libraries and Tools

Chapter 10

Time Planning

Chapter 11

Conclusion

Bibliography

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[2] Feng Han, Yi Tan, and Jayan Eledath. Preceding vehicle trajectory prediction by multi-cue integration. In *Machine Vision Applications*, 2007.