

CHAPTER 1 – INTRODUCTION

1.1 Background

In the 21st century, the development of autonomous vehicles, such as autonomous cars are growing rapidly because of its potential benefits such as reduced mobility and infrastructure costs, increased safety, increased mobility, increased customer satisfaction and reduced crime. An autonomous car is a self-driving vehicle that has the capability to perceive the surrounding environment and navigate itself without human intervention [1]. For the autonomous car to navigate, it must be able to detect its surrounding. Some popular techniques are by using radar, laser light, satellite navigation, odometry and computer vision. This project focuses on the satellite navigation technique for autonomous cars navigation using Real Time Kinematic Global Navigation Satellite System that is combined with electric power steering.

Real Time Kinematic Global Navigation Satellite System (RTK GNSS) is a correction method to pinpoint a geographic location from data derived from satellite-based positioning systems (global navigation satellite systems, GNSS) such as GPS, GLONASS, Galileo, QZSS, BeiDou, and IRNSS [2]. There are various user applications of RTK GNSS such as vehicle tracking, aviation navigation, animal behavior studies, route navigation and many more as RTK GNSS can provide up to centimeter-level accuracy. However, when RTK GNSS is used in an urban environment, usually a noise called multipath signal occurs. Multipath results in an error in pseudo-range measurements and thus affects the positioning accuracy since the multipath signal takes a longer path than the direct signal [3]. Numerous researchers have been trying to eliminate multipath signal by using various methods, such as a fisheye view image-based mask, precise 3D-map based mask, and SNR observation quality check-based mask.

In this thesis, a completely different approach is used, which uses the satellite filtering technique by eliminating satellites that have the tendency to cause multipath signal

accordingly with the environment. The current existing electric power steering in the market needs an improvement as well. Right now, it does not have the ability to sense its position, implying that if a vehicle utilizes electric power steering, it does not know whether it is turned left or right or in the middle position at a certain time. Consequently, this project likewise covers adding an extra sensor to the electric power steering so it can distinguish its present state for the ease of navigation.

1.2 Thesis Purpose

The purpose of this thesis is to improve the existing RTK GNSS technology and electric power steering. Multipath signal is filtered accordingly to the environment in order to have a better the positioning accuracy. Rotary incremental encoder will be installed in the electric power steering as well so that the electric power steering can detect its current position. When these improvements are implemented in an autonomous car, a self-driving car which has great precision in any environment is possible to build.

1.3 Thesis Problem

In this thesis, there are several issues that will be addressed:

1. The code modification in RTKLIB must be designed so that it will not adversely affect the function of existing programs.
2. The difference between single, fixed, and float solutions must be observed in order to determine which solution gives the best accuracy.
3. The effect of elevation mask angle to RTK solutions must be observed in order to obtain the desired solution as much as possible.
4. The relation between elevation angle and SNR must be researched in order to achieve as low noise as possible.
5. The suitable satellite constellations to be chosen in testing area must be determined in order to achieve better RTK solutions.
6. The limitation in the rotary incremental encoder should be observed to determine the suitable electrical components and algorithm.
7. The TCP communication function must be implemented in RTKLIB for receiving heading data.

8. A stable internet connection must be maintained when using NTRIP as communication basis between base and rover station receiver.
9. Algorithm for high-speed rotary incremental encoder reading with safety validation and energy saving mode must be constructed.
10. Back-up power supply mechanism must be designed and then implemented in the electronic power steering so that it will not lose its position data when the main power supply is off.

1.4 Thesis Scope

In this thesis, the scopes are:

1. Multipath detection and optimization method is done by modifying the satellite selection algorithm in RTKLIB.
2. The ideal place to put base station receiver is in an open space without trees or buildings in the surrounding, therefore it will be put in Imam Bonjol street.
3. The maximum suggested distance between base and rover station receiver is 10km to maintain the accuracy, therefore the modified RTKLIB program testing area is limited to the placement of base station receiver.

1.5 Thesis Limitation

The limitations of this thesis are:

1. The mechanical design for autonomous car is not discussed.
2. The mechanical design for mounting the rotary incremental encoder with power steering is not discussed.
3. The feedback loop mechanism between rotary incremental encoder and the electric power steering is not discussed.

1.6 Significance of Thesis

This thesis is significance for three reasons:

1. Since the multipath signal could affect the positioning accuracy of RTK GNSS, a reliable technique to filter those unwanted signals is crucial.
2. The implementation of NTRIP as a communication basis for RTK base and rover station receiver can furthermore broaden the broadcast range of RTK base.

3. The implementation of an additional sensor and back-up power supply mechanism in the electric power steering can benefit the automatic navigation of any vehicle.

1.7 Thesis Structure

This thesis contains five chapters, each contains a different topic that will be discussed:

1. Chapter 1 – Introduction

This chapter gives brief background, purpose, problem, scope, limitation, significance of study, and structure of this thesis.

2. Chapter 2 – Literature Review

This chapter contains information regarding the software and components used in this project, as well as review from previous works and similar concepts and theories that are related to develop this thesis.

3. Chapter 3 – Research Methods

This chapter gives a detailed explanation of the steps taken in order to achieve the objective of this thesis.

4. Chapter 4 – Results and Discussions

This chapter shows the result of the experiments as mentioned in chapter 3 and explanation of resulting data.

5. Chapter 5 – Conclusions and Recommendations

This chapter provides the conclusion of the thesis and also recommendations for further development of the thesis.