

CHAPTER 1 - INTRODUCTION

1.1 Background

Road accidents are a fact of life. According to the World Health Organization, as many as 3000 people die in road accidents every day [1]. In Indonesia, the data from the Indonesia Police Institution (POLRI) in 2024 shows that every hour there are 3 people died as a result of road accidents [2]. Total road accident cases occurred in Indonesia is 100,028 only on a year calendar 2020. It is getting worse during 2021, that road accident is increasing by approximately 4%.

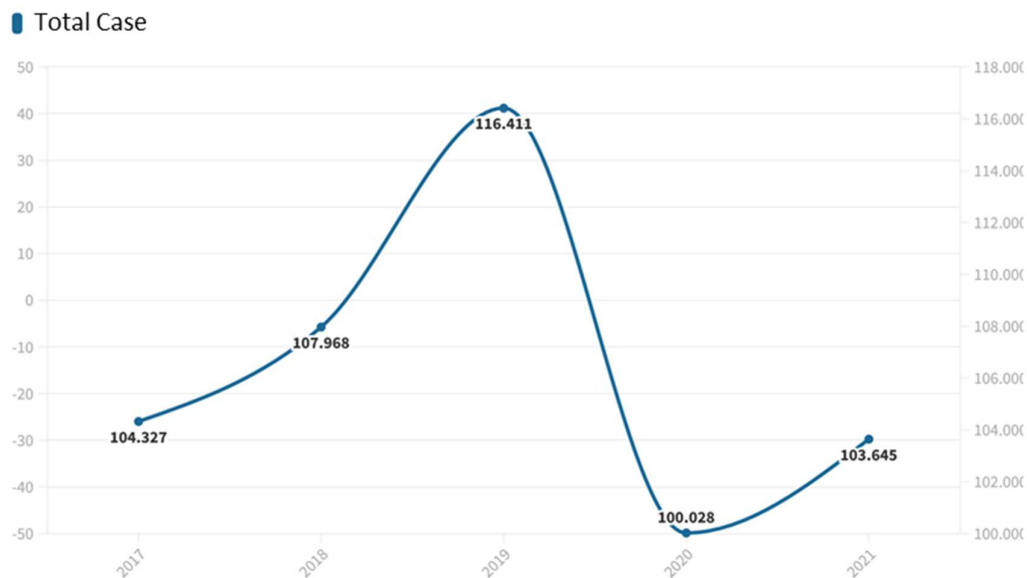


Figure 1.1 Road accident cases in Indonesia, by year [3]

Figure 1.1 shows the road accident cases that have occurred in Indonesia since 2017 [3]. It looks like the cases are going better in 2020, but in actuality, it is affected by the COVID-19 pandemic and also the minimum activity permission. Based on the statistics from Statista, in 2022, the total number of road traffic accidents in Indonesia was roughly 204.45 thousand cases. It is increasing more than 97% of the total cases in 2021 [4].

As the detail of the total cases of road accidents in Indonesia, every year the lives of approximately 20 thousand people are cut short as a result of a road accident and another 10 thousand people suffer fatal injuries, with many incurring a disability as a result of their injury. Road traffic injuries cause considerable economic losses to individuals, their families, and the country as a whole. These losses arise from treatment costs and lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured. As a result of the economic losses, it is reported that material losses in 2021 are estimated at IDR 247 billion (shown in Figure 1.2) [5].

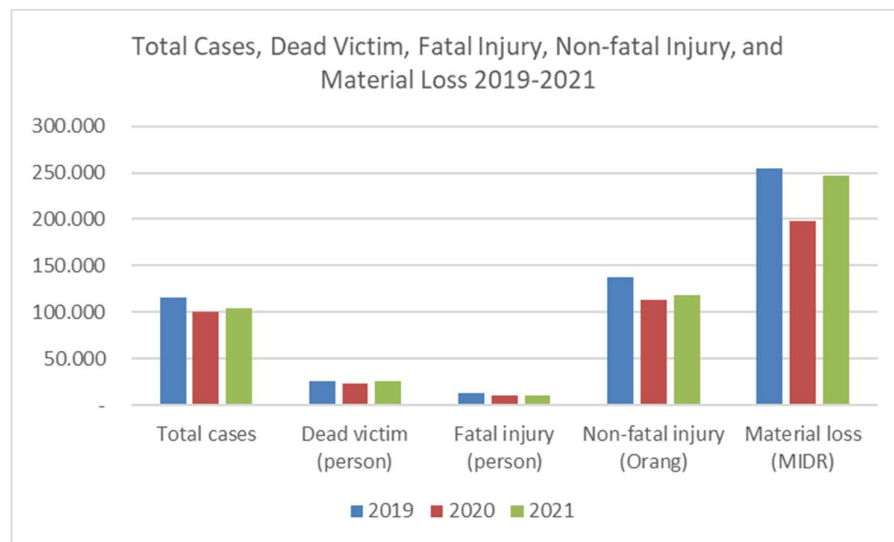


Figure 1.2 Total Cases, Dead Victim, Fatal Injury, Non-Fatal Injury, and Material Loss in 2019-2021 [5]

Based on accident incidents during 2020, car accidents are 8 percent of the total of road accidents in Indonesia. The percentage of traffic accident fatality presented by IRSMS is reflected in the number of road accident cases in Indonesia, then it will be compared to accidents on the toll road by the Toll Road Regulatory Agency (BPJT) [6]. The comparison of the total cases of car accidents and car accidents on the toll road from 2020 to 2021 is shown in Figure 1.3.

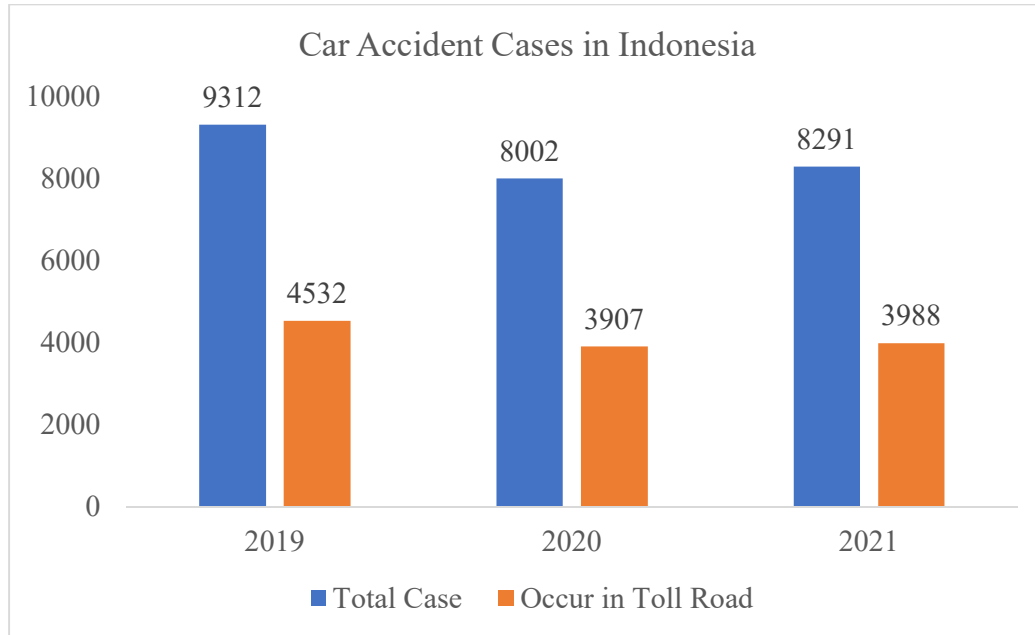


Figure 1.3 Car Accident Cases in Indonesia during 2019-2021

Car accidents that occur on the toll road are around 50% of the total cases year by year. Toll roads, due to their lower traffic volumes and identical user base, present feasibility to approach safety management. Safety control on toll roads is more effective in some respects because of its predictable traffic patterns, this predictability can make it easier to plan and implement safety measures.

Many technologies have been developed in the field of the Advance Driver Assistance System (ADAS) that provide safety features that can help the driver to be safer and reach more comfortable driving. According to a study by the Traffic Safety Researcher, the results of studies based on police-reported crashes are converging, suggesting that VRU ADAS reduces pedestrian crashes by 13%-27% [7]. In theory, the implementation of Advanced Driver Assistance Systems (ADAS) in vehicles should be expected to reduce the occurrence of road accidents. Despite the fact, ADAS systems are currently simply implemented in recent high-end vehicles. The higher the price of the vehicle, as linear the association with the types of technologies utilized for safety systems. These facts do not align with what the consumer needs, as the safety system is crucial for all customer segments.

The research planned a system that focuses on the development of a safer automobile safety system that will be implemented on toll roads, with no limitation on vehicle brand and segment. The system uses sensors and algorithm detection with a simply platform/microcontroller. The safety system only needs a power outlet from the vehicle and just plug-and-play with any vehicle type or brand. It is targeting to provide affordable prices and a global use system to any vehicle brand with no limitation customer segment.

1.2 Research Problems

Many technologies have been developed in the field of Advanced Driver Assistance Systems, but car accidents still occur at a rate of over 8,000 each year, with fifty percent of these accidents happening on toll roads. Therefore, it is crucial to investigate and develop solutions to enhance vehicle collision prevention through a driver assistance warning system that is not limited by vehicle brand or segment.

1.3 Research Objectives

The objective of this research is to design a driver assistance for collision warning system based on the kinematics and perception algorithms that can provide a collision detection warning in order to enhance vehicle safety. Additionally, the system is intended to be universally applicable, with no restrictions of vehicle brand or customer segment.

1.4 Significance of Study

This research on a driver assistance for vehicle collision warning system focuses on an advance vehicle safety system by utilizing kinematics technique in sensor utilization and perception technique through the implementation of fuzzy logic predictive algorithm, hence the integration of kinematics and perception algorithms through the system is expected to have a significant impact on preventing the occurrence of road accidents.

1.5 Research Questions

The research questions for this thesis proposal are elaborated as follows.

- Question #1: What concepts of design enable the collision warning system to be universally applicable, regardless of the vehicle's brand or customer segment?
- Question #2: Which sensors and microcontroller propose the optimal integration of kinematics and perception algorithms for the system?
- Question #3: How could the integration of kinematics and perception algorithms enhance the accuracy of the system?
- Question #4: How can the driver perceive the advantage of the system?

1.6 Hypothesis

- Hypothesis #1: The collision warning system can be used across various vehicle brands and customer segments without requiring specific customization.
- Hypothesis #2: The LIDAR-Arduino collision warning system integrates the utilization of kinematics and perception algorithms to advance the performance of the system.
- Hypothesis #3: The collision warning system provides accurate decision outputs for both the kinematics and perceptual algorithms to provide a reliable decision.
- Hypothesis #4: The collision warning system is well-operated as the driver assistance in vehicles in purpose to give users earlier warning to prevent road accidents.