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An Anti-Collision System for Pedestrians and Bicycles

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Abstract

In this paper, we introduce our devised anti-collision system for pedestrians and bicycles, and evaluate the accuracy of a detection program used in the system. The anti-collision system that we proposed is to detect pedestrians and bicycles by a Web-camera as a sensor on a road, to measure their velocity, to calculate their arrival time to a collision prediction point, and to inform them about the risk of collision. By using this approach, the pedestrians and bicyclists that have received the notice are to pass that point more carefully, and it would be possible to suppress the occurrence of accidents. As a result of experiments to evaluate the accuracy, we found that our detection program has sufficient accuracy in indoor environments.

Keywords: Anti-collision system, bicycle, intelligent transport systems, ITS, pedestrian.

1. INTRODUCTION

Today in Japan, bicycles have been commonly used as a means of transportation. But at the same time, we often come across violations of laws and breach of manners by bicyclists.

The number of traffic accidents in Japan in 2010 is over 57 million [1]. And about 20.8% of the accidents are related to bicycles. The most cause of bicycle accidents is “crossing collisions” and “right or left turn collisions”. It suggests a lack of attention in corners and intersections. Despite the current situation, there is no study about an accident prevention system for pedestrians and bicycles.
In studies on road safety, there are “Inter-Vehicle Communication System” [2] to exchange driving information using on-board communication equipment and predict a collision, and SUBARU’s “New Eye-Sight” [3] to detect vehicles and obstacles ahead by an on-board camera and stop an at-risk vehicle. However, to apply these studies to the road safety for pedestrians and bicycles, we have difficulties in terms of installation and equipment costs.

Therefore, this study aims to build an accident prevention system that is simpler and costs lower than the existing systems, and it would be important to diffuse the use of the system.

2. EXISTING RESEARCH

We investigated systems and researches on accident prevention for bicycles, but there were no such systems and researches. So, we looked for accident prevention systems for *vehicles*, and found four systems: “Road-Vehicle System”, “Vehicle-Road-Vehicle System”, “Inter-Vehicle System”, and SUBARU’s “New Eye-Sight”.

2.1 Road-Vehicle System

This system senses vehicles approaching a target intersection by on-road sensors, and then notifies the sensed information to the other vehicles. Fig. 1 gives an overview of the system.

2.2 Vehicle-Road-Vehicle System

In this type of system, one vehicle sends its driving information to another vehicle via an on-road communication device. Fig. 2 gives an overview of the system.

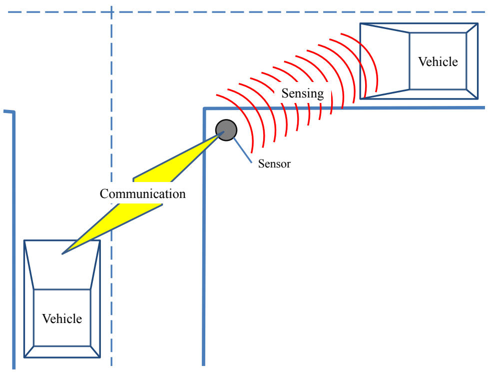

Fig. 1: Road-Vehicle System

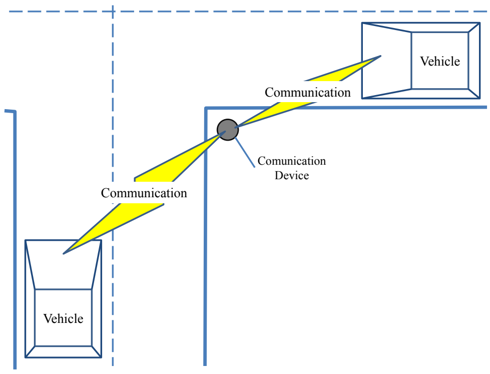

Fig. 2: Vehicle-Road-Vehicle System

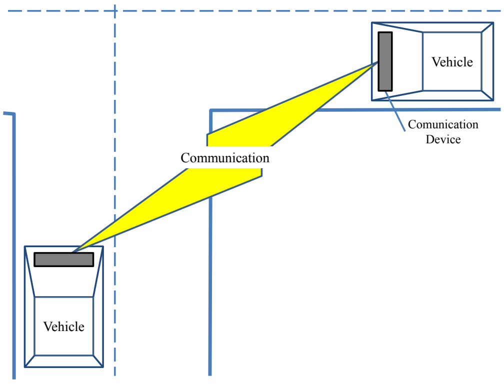

Fig. 3: Inter-Vehicle System

2.3 Inter Vehicle System

In this type of system, a vehicle, which is equipped with a communication device for exchanging driving information, sends its driving information to another vehicle directly. Fig. 3 gives an overview of the system.

2.4 SUBARU's "New Eye-Sight"

In this system, a vehicle is equipped with a stereo camera to monitor on-road obstacles, and is controlled based on its video data. Fig. 4 shows a stereo camera mounted in a vehicle, and how the system detects the target objects.

2.5 Problems of Existing Research

These existing studies have problems of the installation cost of special devices required for each vehicle. In addition, these systems are intended for between a vehicle and vehicles, pedestrians, or bicycles, and there exists no single system and study on accident prevention for pedestrians and bicycles. One reason why any accident prevention system for pedestrians and bicycles does not exist is bad cost-performance and the other is difficulty in equipping pedestrians and bicycles with communication and information- processing devices.

In this study, we aim to build an anti-collision system that has no extra equipment and lower cost than the existing systems.

3. PROPOSED SYSTEM

In this paper, to reduce the number of on-road collisions between pedestrians and bicycles, we aim to build a system that uses a Web-camera as a sensor, detects a target object in its video data, estimates the velocity of the target object, calculates the arrival time to a collision prediction point based on the estimated velocity, and informs the others approaching based on the calculated arrival time. The system consists of the following four steps to transfer information on each other's approaching, as show in Fig. 5.

① Detect moving objects
② Send information to a control system
③ Estimate the velocity and arrival time
④ Provide inform on each other's approaching


Fig. 4: SUBARU's "New Eye-Sight"

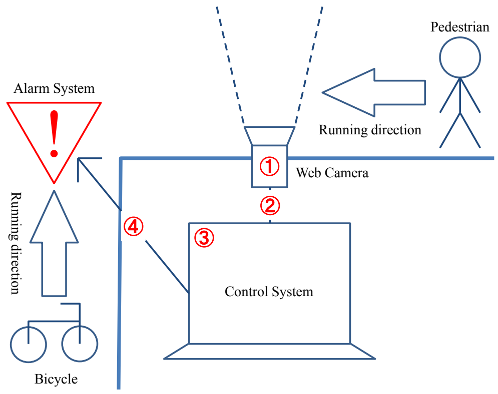

Fig. 5: A Schematic Diagram of Our System

4. SYSTEM MODULES

This section explains the modules used in the system.

4.1 Detection Module

This module is to analyze images sent from a Web-camera by a "Background Subtraction Method", and to determine whether there exist such moving objects as pedestrians and bicycles. If a moving object is detected in the video data, the module gets its transit time from the entry to the exit.

Fig. 6: Experimental Environment

4.2 Calculation Module

This module is to estimate the velocity of a moving object based on its transit time measured by the detection module, and calculate its arrival time at a collision prediction point based on its estimated velocity.

4.3 Notice Module

This module is to notify approaching objects of their collision risks evaluated on their arrival time in the calculation module.

5. EXPERIMENT

5.1 Pre-Experiment

We performed a preliminary experiment to determine the threshold value of color information variation necessary for the detection of moving objects. In the experiment, we ran the program for a few minutes without any moving object in front of the Web-camera. In the main experiment, we used the maximum of color information variation during execution as a threshold value.

5.2 Experiment to Evaluate Accuracy

We created a program to detect and estimate the velocity of a moving object, and conducted some indoor experiments for the accuracy evaluation (Fig. 6).

In the experiment, an author walked through the front of a Web-camera 100 times while running the detection program, and examined whether the program can detect a moving object from its entry to its exit without interruption. The main reason why we have to know whether the program can detect a moving object from its entry to its exit without interruption is that our system must calculate the arrival time at a collision prediction point based on its estimated velocity, and it is very important to calculate its transit time more accurately by detecting it without interruption.

5.3 Result

In this experiment, the program has successfully detected a moving object for any of 100 trials.

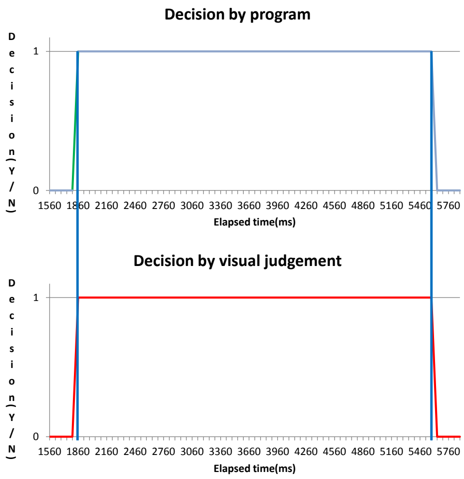

Fig. 7: Comparison of Decisions by Program and Visual Judgment

Fig. 7 shows a graph comparing the transit times by an author's visual judgment and by the program when it detected a moving object for a certain trial.

5.4 Consideration

In this experiment, the accuracy of detecting moving objects was 100%. This means our proposed program is applicable to indoor environment system.

6. CONCLUSION

Our proposed system to avoid collisions requires the transit time to predict the arrival time and the velocity of a moving object. The transit time is calculated from the difference between times of entry and exit. The system would need to detect moving objects from their entry to exit without interruption to calculate as accurate transit time as possible. In this experiment, the program could detect moving objects without interruption in the indoor environment, and so could calculate to some extent accurate transit time. Therefore, this paper could conclude that the program has sufficient detection accuracy for detecting moving objects.

7. FUTURE RESEARCH PLANS

In the future, we will perform more experiments to verify the detection accuracy in outdoor environments, to verify the effectiveness of the system by assuming its practical uses.

ACKNOWLEDGMENT

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