A Wearable Walking Support System to provide safe direction for the Blind

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Abstract

This paper proposes and verifies a Walking Support Device for the blind person. This paper proposes and verifies a Walking Support Device for the visually impaired person. The proposed system is a glasses type wearable terminal with an ultrasonic obstacle sensor and a pare of bone conduction earphone. We confirmed the effectiveness of the system by multi-agent simulation. The proposed system is effective not only for system user, but also for collision avoidance by other pedestrians.

Keywords: Multi-agent simulation, Safe direction, Ultrasonic sensor, Bone conduction earphone.

1 Introduction

Japan Ministry of Health, Labor and Welfare revealed that approximately 312 thousand visually impaired with physical disability certificates live in Japan in 2016[1]. Meanwhile, Japan Ophthalmologist Association predicted that approximately 1.64 million visually impaired persons live in Japan as of 2007[2]. This prediction suggests that in 2016 there were so many visually impaired persons in reality.

Guide dogs and white canes are major tools to support the visually impaired. However, the number of guide dogs is predominantly smaller than, the number of visually impaired persons. On the other hand, visually impaired persons can easily use white canes. However, they have to train sufficiently to master ones. In addition, they can only make a situation judgment only around the feet with white canes.

In addition, BuzzClip is one of the walking support devices[3]. This can detect an obstacle at the height of user's chest and tells the user the presence of an obstacle with its own vibration. However, an user can not walk safety using BUZZCLIP alone, because BUZZCLIP can not detect obstacles on the ground. Therefore, development of a new system effective for visually impaired persons is indispensable.

This paper proposes a walking support system providing action for obstacles, and shows the effectiveness of the proposed device by using multi agent simulation.

2 Walking Support System

This section describes an overview of the proposed walking support system. Fig.1 shows an overall image of system.

The system is a glasses type wearable device. An ultrasonic sensor (yellow circle) attached between two lenses detects obsutacles in the traveling direction of the system user. A bone conduction esrphone (red circle) informs the user of the information detested by the ultrasonic sensor by voice and alarm.

Table 1 shows features of general ultrasonic sensors. Most ultrasonic sensor can be attached to a glasses and detect up to 5 meters

The ultrasonic sensor can detect not only the distance to objects and the presence or absence of objects but also colors of objects to be detected. These characteristics are effective for the use of the system in urban areas.

Table 1: General ultrasonic sensors

Name	Size	Sensing range
HC-SR04	45×20×15mm	2–400cm
MB1013	19.9×22.1mm	30–500cm
USA-S6AN	ϕ60×15mm	40–600cm

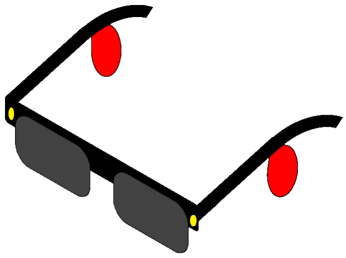

Figure 1: Walking Support System

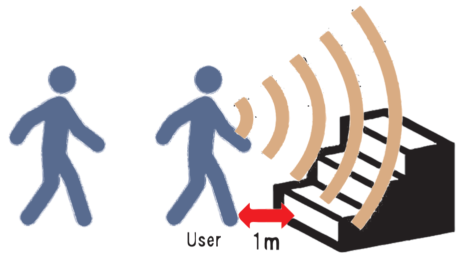

Figure 2: Step on load image

Moreover, bone conduction earphone can transmit information accurately even in the place of great noise.
the microcomputer installed in the proposed system determins the distance to the obstacle and the degree of risk based on the infomation from the sensors. If the risk is high, the microcomputer teaches the user the safe direction through the bone conduction earphone.

- Step on loads (Fig.2)
  Two times transmission when the sensor detects for the first time and approaches 1 meter.
- Passersby and obstacles (Fig.3)
  Tell the distance to a detected object and the appropriate direction of travel.

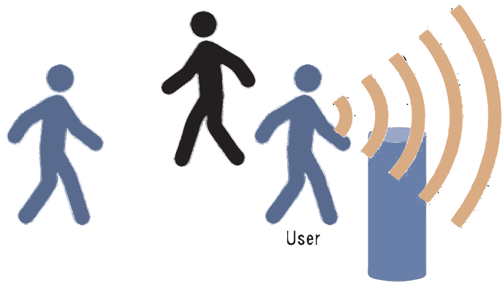

Figure 3: Detection obstacles image

3 Agent Simulation

This section describes a multi-agent simulation to evaluate the effectiveness of our system.

3.1 Field

The simulation field is Sembayashi shopping street with the following features in Osaka city shown. The strict shopping street for visually impaired persons are suitable for evaluating the effectiveness of the proposed system.

3.2 Agent

Passerby in the shopping street are software-agent.
Our simulation introduces three kind of agents, using our system or white cane and healthy persons.
Table 2 shows the properties of the agents.

- Visual field: Range to be conscious while walking, and spread in a semicircle in front of the agent

4 Experiment

In the experiments, we first confired it assuming daily congestion, then confirmed the details of the motion of the proposed system user.

4.1 Experiment1 : Daily Congestion

We generated visually impaored and healthy people at a raito of 1 to 19, assuming one hour daily congestion. Table 3 shows the number of collisions of agents.
Visually impaired persons who did not use the system had many collisions. Visually impaired persons were general collisions each other. However, in many cases they were in slight contact wirh healthy persons.
On the other hand, visually impaired persons who used the system had little conflict, one five-hundredth of the case of without our system. Slight contacts have been expected to be almost gone.

Table 2: Features of each agent

Agent type	Moving speed	Visual field
Healthy pedestrians	1.5 m/s	5.0 m
Visully impaired persons	1.0 m/s	1.0 m*
System user	1.0 m/s	5.0 m

*Recognition area by blind cane

Table 3: Results of Experiment 1

Use System	H-H	H-V	V-V	Total
No	0	3910	926	4836
Yes	0	7	4	11

H:Healthy pedestrians, V:Visully impaired persons
H-H:Collision between healthy pedestrians

Table 4: Results of Experiment 2

Use System	Detection range	Front collision	Contact
No	1.5**	3.1	4.6
Yes	5.0	1.8	2.4

**Recognition area by blind cane

4.2 Experiment2 : Detailed Motion

In the experiments of 4.1, system non-users collided with many healthy persons, and system users could not avoide all collisions. Therefore, this section describes verification experiments of contact and head-on crash rates and collision occurrence conditions.

Table 4 shows the number of contact and head-on collisions when one visually impaired person passed 50 healthy persons. For our system user and non-user, about 40% collisions were head-on crashes. From this results, under daily congestion, hesad-on crashes can be expected to be well below 40%.

Figure 4 shows the details of the system user's conflict.

· [Head-on crash]
When the system user X avoids the healthy person A and turns to the right, the healthy person B approaches rapidly from the front. X contacts B without breaking away.

· [Contact]
When X avoids the A and turns to the right, B approaches from the front. Then when X moves to the left again, X contacts A, if A dose not move forward very much.

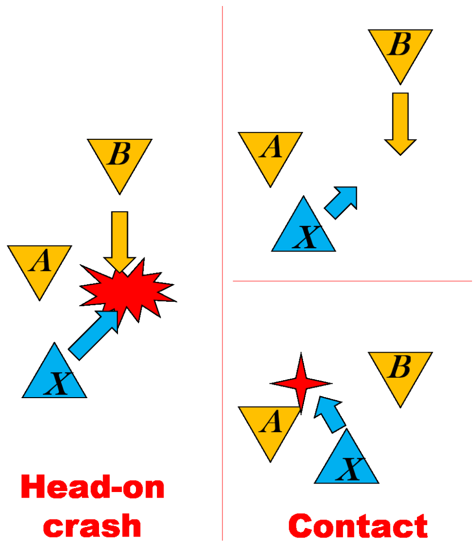

Figure 4: Collision detaile

These results show that the proposed system is focusing too much on the immediate person. The system should further extend the area of verification in order to enhance the convenience.

5 Conclusions

This paper proposed a Wearable Walking Support System to provide safe direction for visually impaired person. By multi-agent simulation, we confirmed that the proposed system is for the visually impaired and clarified the improvement point of the system.

References

[1] Ministry of Health, Labour and Welfare, "Number of working dogs in auxiliary dog ", Dec. 2017.

[2] Kansai Guide Dogs for The Blind Association, "What is a visually impaired person", 2017.

[3] Indiegogo.com, "BUZZCLIP", https://www.indiegogo.com/projects/the-buzzclip-wearable-mobility-tool-for-the-blind#/, 2017.