Safe Walker–Shoes That Alert the Wearer to a Danger

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Abstract. We propose new device that gives the user a warning against walking in a dangerous area. This device provides the warning to avoid crashing an automobile into a user.

Keywords: Shoes Device, Pedestrian, Warning System.

1 Introduction

We propose "Safe Walker", shoes intended to prevent traffic accidents by warning pedestrians wearing them with sound, vibration and light when entering into a dangerous area.

In 2012, the number of traffic accidents had reached 670,000 cases, which included 70,000 dead and injured pedestrians. The casualty rate from accidents during walking is highest for people over age of 65, with 67.9% dead and 29.3% injured. This is then followed by children below age of 15. As can be seen from this, the accidents during walking occur most often with the aged and the young. The ratio of fatality and injury during walking by age groups are shown on Fig1. And within those pedestrian traffic accidents, traffic accidents while crossing a road outside of pedestrian crossing area, crossing or rushing forward immediately before or after a moving vehicle makes up 20.5% of the total[1]. These accidents occur in the carriage way, beyond the white line of carriage way boundary. Fig2 shows the ratio of pedestrian accident situations.

In the recent years, with the spread of audio players, there are increasingly more pedestrians walking with headphones and earphones. Being unable to hear surrounding noise has a risk of leading to an accident. In addition, there are an increasing number of pedestrians who walk while operating their smartphones. Consequently, there is a risk that these people would walk without looking ahead and step off from sidewalk beyond the white line of carriage way boundary.

Therefore the aim of this paper is to prevent traffic accidents by calling the attention in such a way that warning can be conveyed even when one cannot hear, or when the sight is occupied elsewhere.

2 Traffic Rules in Japan

We learn traffic rules in our childhood as we are growing up. Traffic rules are laws set out by Road Traffic Act. In below, a part of "Rules relating to pedestrians" extracted from [2].

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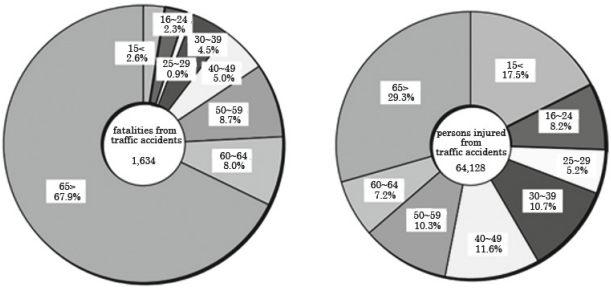

Fig. 1. Number of dead and injured pedestrians by age group (Traffic accident occurrence situation in 2012)

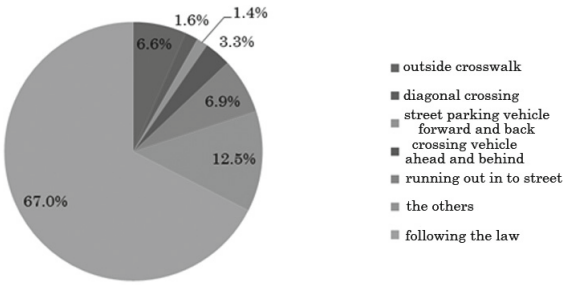

Fig. 2. Ratio of pedestrian accident situations (Traffic accident occurrence situation in 2012)

Table 1. How to walk on a road safely

1 On a road with a sidewalk or sufficiently wide side strip, walk there.
2 On a road without a sidewalk or sufficiently wide side strip, walk on the right side of the road.
3 At an area without clear view, pause and check it is safe.
4 Never rush forward.
5 Do not play around or run while walking on a road.

Table 2. How to cross a road safely

1	Cross at a pedestrian crossing or at an intersection with traffic lights.
2	At an area with a pedestrian bridge or a pedestrian subway nearby, use that.
3	At an area with traffic lights, pause in front of the pedestrian crossing, then after checking that the traffic light has turned green, look right, left then right to confirm safely, then start crossing.
4	While crossing, pay attention to the surrounding situations, such as movements of vehicles.
5	Do not cross at an area with "No Crossing by Pedestrians" sign.
6	At an area without any traffic lights, pedestrian bridge or pedestrian subway nearby, select a place with unobstructed view to both sides and after confirming that no vehicles are approaching, cross at right angle to the road.
7	No matter how much of a hurry you are in, do not cross a road without checking for safety, or cross diagonally.

3 Related Works

3.1 Traffic Safety Tools

Hand-flags for road crossing and reflectors(Fig3) can be counted as backup traffic safety tools that can help pedestrians cross pedestrian crossings safely or walk roads safely in the night. A hand-flag for road crossing is a traffic safety tool that is intended to make the location of walking children known to drivers, by having small stature children carry it. Those hand-flags tend to be fitted on electric poles around pedestrian crossings, and they are not something that one carries around at all times. A reflector is a traffic safety tool that reflects off the light from cars in dark surroundings like a night road, intended to let drivers know of the location of a pedestrian. A hand-flag for road crossing or a reflector sash prevents traffic accidents by helping a pedestrian alert his/her location to drivers. However, they have to be held in hand or slung across the shoulder, so that can be a nuisance.

Fig. 3. Safty goods for pedestrian

Also, there are shoes for children that have whistles in them. Squeaking shoes intended for toddlers who started walking, up to four years old or thereabouts. According to 2010 research, 49% of parents responded saying "they had children wear those shoes"[3]. Children react to the interaction of squeaking noise from shoes that come off in response to movements such as "walking", "running" or "jumping". Even if there are other things within sight that draw attention, squeaking noise from shoes draw the attention of children to the shoes. Also, parents can tell where the children are from that noise, so this can help prevent children moving away too far. In short, this can prevent children wondering off to outside road of a park while supposed to be playing in there. And since these are shoes, it is not a nuisance to be wearing them at all times when going out.

Therefore we focused on "shoes", something that are worn at all times when going outside. To prevent traffic accidents, the shoes themselves would give warning to pedestrians wearing them, to call their attention. Furthermore, by giving an interactivity such as making a noise in reaction to movements like "walking", running and jumping only at safe locations, they can guide their wearers to play in a safe location. Traffic accidents are prevented by drawing attention to the shoes at all times even when there are things of interest in dangerous area near a road.

3.2 RiverBoots

"Safe Walker" would present noise, vibration and light to pedestrians wearing them. From the point of view of sound and vibration, Nomiyama et. al. proposed a shoe device with Haptic Feedbook [4]. This is a VR piece that presents a sensation of river walking. It renders the sensation of walking in a river by giving sound and vibration information to soles and ankles of feet from speakers installed in boot shaped devices.

We use presentation of sound, vibration and light for warning, guidance and interaction. They are linked in one purpose of preventing traffic accidents.

Fig. 4. Revier Boots

4 System Outline

"Cognition ratio of the five senses is made up of visual organ 83%, auditory sense 11%, sense of smell 3.5%, sense of touch 1.5% and lastly, sense of taste 1.0%"[5]. In this paper, by giving warning to pedestrians using sound, vibration and light, warning is conveyed through highest cognition ratio of sight, next highest cognition ratio of hearing, and tactile sense by vibration, to be able to handle the situation even if visual and auditory senses are occupied. Sound, vibration and light would each be presented when a pedestrian wearing "Safe Walker" crosses the white line of carriage way boundary, causing a hesitation to walk over into the carriage way.

"Safe Walker" is composed of "warning system" made up of a speaker, vibration motor, LED, RFID reader and acceleration sensor, and "interaction system" made up of a speaker, LED, color sensor, and pressure sensor. Both systems are controlled using Arduino and powered by batteries. Most instruments would be installed to the shoes as additions, but vibration motors would be fitted to the ankles. Fig5 shows the system configuration design.

4.1 Zoning of a Road

Roads are classified into three zones; grey zone, yellow zone and red zone. Fig 6 shows the zoning of a road. Red zone is carriage way and carriage way boundary, yellow zone is sidewalk near carriage way and pedestrian crossings, and green zone is the rest. The warning system would activate in yellow and red zones. Interaction system would only activate in green zone.

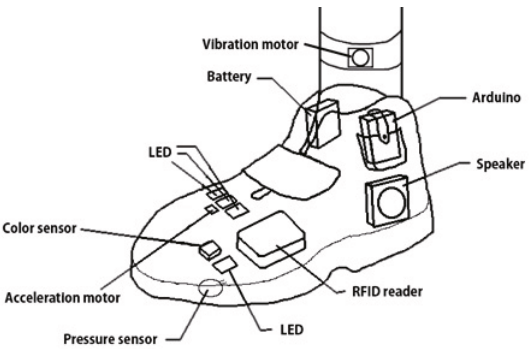

Fig. 5. System Configuration Design

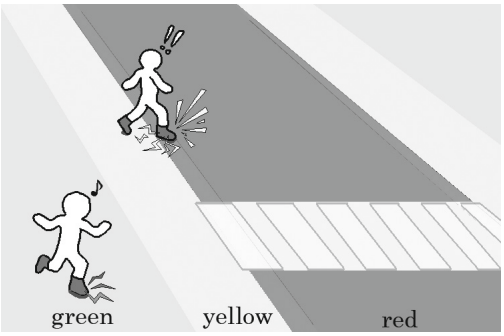

Fig. 6. Zoning of a road

4.2 Warning System

This warning system is a system to warn against going into a carriage way. In yellow zone, in order to respond to rushing forward actions, sudden movements such as running or jumping is recognized using an acceleration sensor and the warning system would be activated. In red zone, the warning system would be activated continuously.

With the current accuracy of GPS which has approximately 1 meter inaccuracy, RFID is used. Prerequisite requirement is to have RFID tags embedded to the ground. Therefore it is assumed that RFID tags have been embedded to the ground. Then soles of the shoes would be equipped with RFID reader, and by having a pedestrian walk on the ground with certain RFID tags embedded, sound and vibrations are presented from speakers. In addition, light will be provided from LED. Thus a pedestrian would be warned of having stepped into a carriage way. LED would function to draw attention not only from the pedestrian but also from car drivers. These warning system actions are shown in Fig7. In order to reduce interference of RFID tags and to improve on detection

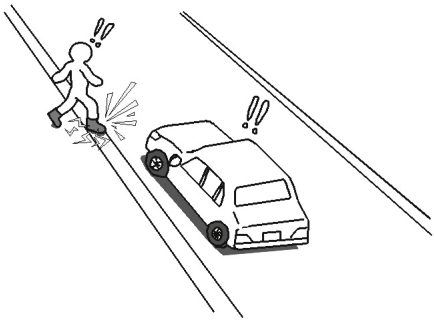

Fig. 7. Warning system actions

ratio at places where pedestrians are moving straight ahead, RFID tags would be placed alternately as shown on Fig 8.

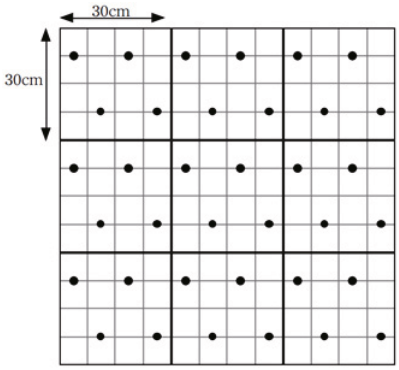

Fig. 8. Placement of RFID embedded to the ground Extracted from User location detection system using RFID[6]

4.3 Interaction System

This interaction system is a system to guide the wearer to a safe green one. Since it is dangerous to play in yellow or red zones, it only activates in a green zone. Therefore in order to play with the interaction system, one has to be in a green zone. First of all, color sensor built into the shoe soles would recognize the color on the ground and determine the sound to be played based on that color. Then when pressure sensor built into the shoe soles sense a load, sound is given out. Since color sensors are on the shoe soles, there is no light source, which makes scanning difficult. Therefore LED would aid the scanning by color sensor.

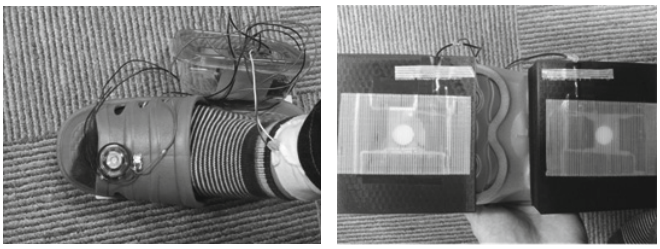

Fig. 9. Prototype of the warning system

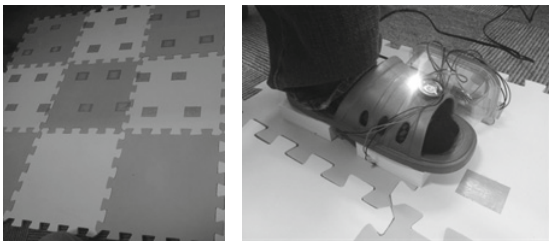

Fig. 10. Walking on RFID tag

5 Conclusion

In this paper, "Safe Walker" is proposed; shoes intended to prevent traffic accidents by giving its pedestrian wearer warnings using sound, vibration and light when he/she steps into a dangerous area.

Currently, the warning system is a temporary assembly but it is functioning. As a matter of fact, when RFIG tags were installed to the ground as shown on Fig9 and walked on, recognition by RFID reader functioned. However, this did not function properly when the distance was greater than 2 cm, so there were times when the recognition did not work while walking over RFID tag. Therefore it is necessary to shorten the installation distance between RFID tags to ensure recognition at landing points, or to increase the recognition scope of RFID reader by increasing its output power. This interaction system is currently in the process of being put together.

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