

Obstacle Recognition System using Ultrasonic Sensor and Duplex Radio-Frequency Camera for the Visually Impaired Person

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Abstract— In this paper, we design the obstacle recognition system using ultrasonic sensor, DRFC (Duplex Radio-Frequency Camera) and GPS technique for the visually impaired person. We configure low cost system because now cost of assistance tools for visually impaired people is highly expensive. So we improve portability of system, though making simple hardware. We apply function determining image information using camera because existing system has not the function. When we use DRFC, data transport is better freely than existing web camera. Therefore the system can move freely. We measure the distance of obstacles using ultrasonic sensor, because ultrasonic sensor is low cost, low interference and has relatively accurate measurement. And we receive color data of image information using DRFC. After we determine measured distance and received color data, proposed system announce to visually impaired person through Bluetooth speaker. Proposed system show that this system help blind people more conveniently through experimental result.

Keywords— Obstacle Recognized, Ultrasonic Sensor, DRFC, Distance, Color data

I. INTRODUCTION

Visually impaired people are lived in inconvenient compared to ordinary people. They do not get information through eyes. It is true that visual part in the people life is one of the important things. Visually impaired people use assistant device and different method for reducing in convenient in their life. For example, they use well trained animals like dogs, tools such as staff and Braille. But they are still uncomfortable using assistive devices because devices are expensive cost or inconvenient. Therefore, it is necessary that improving performance of assistive devices.

Many people are researched to make assistant device which blind people can use more conveniently. Walking navigation is one of map information provided services by using GPS. This technique provides user position information in the real time through mobile device. Some people are research about technique combine assistive devices with information provided technology for blind people [1]-[5]. But, there are transmission problems of environmental information in this technique occur because this technique transmit only voice signal to blind people. Also, system comes to pass data mapping error by GPS. It is important that solution of this problem is for safety of blind people.

The white stick with ultrasonic sensor is researched one of safety assistive devices that are comfortable movement. Nevertheless, using the white stick with ultrasonic sensor can only use in the near distance because white stick is forward on the ground. Accordingly, blind people cannot recognize obstacle in front.

In this paper, we proposed system by using color information through DRFC. This system can notify caution alert when there has been an obstacle or unexpected situations. Thus, blind people are provided environment information through GPS technology and looking sudden obstacle in sight by DRFC. By the received short and long range information from GPS navigation and ultrasonic sensor, blind person can perceive the nearby environment information.

Positioning information is found by the GPS and transmitted to PDA. Another advantage of proposed system has made the price of a low cost and raised portability for commercially available.

II. ALGORITHM OF PROPOSED SYSTEM

We propose the intelligent and walking navigation system by using DRFC and Ultrasonic Sensor. Proposed system use to provide the information of surrounding environment. GPS will be used to display user position information on user PDA. By the received short and long range information from GPS navigation and ultrasonic sensor, blind person can perceive the nearby environment information. This proposed system will announce about the environment as voice message by using GPS technology enable using the visually impaired. Range information and the surrounding environment are delivered to the Bluetooth earphone. And then we make a decision of whether there is obstacle or not using ultrasonic at bottom of watch. Blind person gets information about close obstacles using proposed white stick on which ultrasonic sensor is attached to obtain the short range information. Ultrasonic sensor is connected with vibrator on handle of white stick.

Front of barriers is judged using DRFC. Also with system that recognize color. If some color that is not saved are detected, the system sends a warning signal. They can aware distance to the obstacle through a period of vibration.

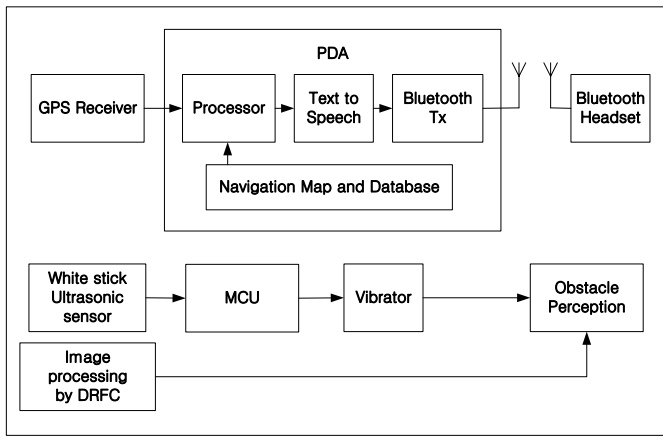


Fig. 1. Block diagram of proposed system.

Figure 1 shows block diagram of proposed system. This system gets information of around environment using GPS and distance data using ultrasonic sensor. And then inform to user. DRFC is used to judge situation of the front of user as color. Especially, when there is traffic light at front of user, it can make a decision about that situation and speak to user. In case of short distance obstacle, Vibrator transmits sound and vibration to user. And Bluetooth is used as transmission device.

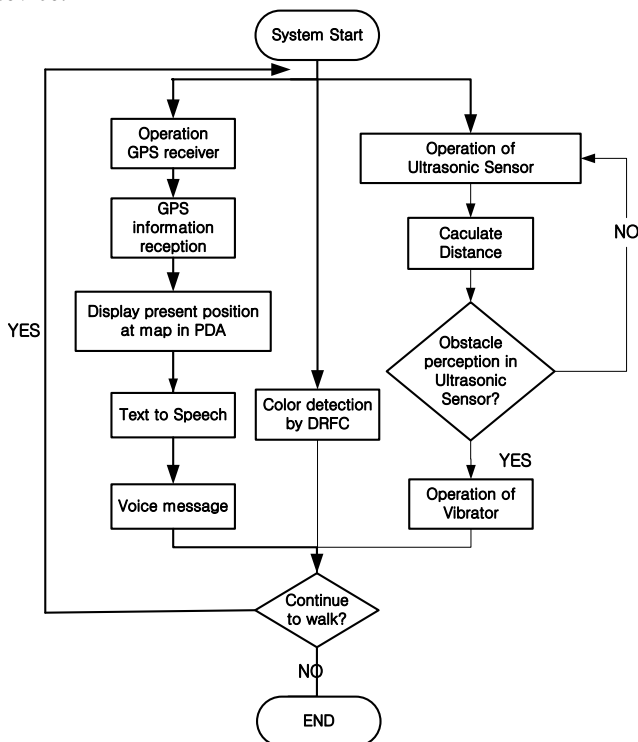


Fig. 2. Algorithm of proposed system.

Figure 2 shows algorithm of proposed system. Firstly, GPS receiver is received local information. Then, the system announces by Bluetooth Headset. Secondly, Obstacle is recognized by ultrasonic sensor. If measured distance is less than determined range, the system operates each other via vibration depending on distance. Thirdly, DRFC detects the

color data. Then the system informs the color data to blind person. Finally, repeat first step again.

III.SYSTEM CONSTRUCTION

A. GPS Receiver and PDA



(a) GPS receiver

(b) PDA

Fig. 3. GPS receiver and PDA.

Figure 3 shows GPS receiver and PDA. PDA (personal digital assistant) is a personal digital information unit and is almost like small PC. So program languages, flash memory and a lot of applications can be applied to the PDA. Current PDA can do wireless communication using Bluetooth technique. Navigation is also included in the PDA. Navigation is electronic map that includes the regular area information like streets, buildings and public institutions etc.

The GPS receiver receives the clock information and the latitude and longitude of satellites and calculates the present position. The GPS receiver sends this information to the PDA. The navigation map and database in PDA guide the information like current position, and environment to blind person in real time. Basically, the output information is the text style. So, the text is converted into the voice sound by TTS (Text to Speech) in PDA for blind person to understand.

B. White stick using ultrasonic sensor

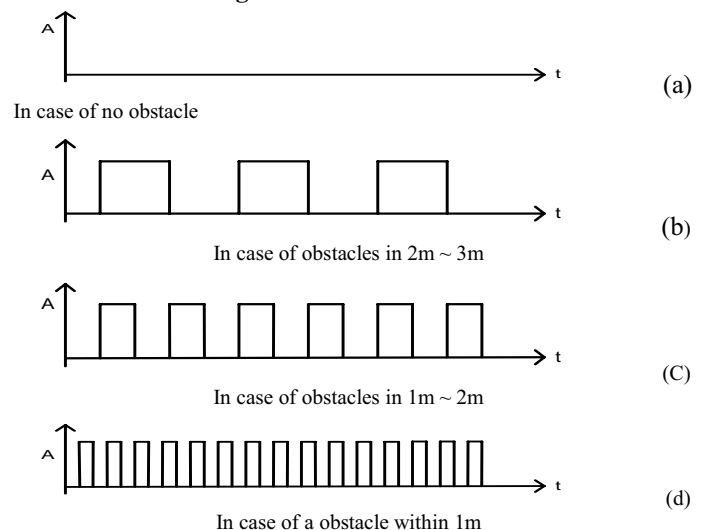


Fig. 4. Different time periods in vibrator.

Compared with existing white stick, proposed white stick has an ultrasonic sensor to detect obstacles in short range. When blind person walks, if there are obstacles, ultrasonic sensor detects and informs via vibration.

As in Figure 4, the vibrator produces different frequency periods depending on the obstacle distance. Ultrasonic sensor measures the distance between a sensor and an obstacle and changes a period of vibration according to the distance. It makes blind person feel this vibration quickly. By the existing white stick, they heavily depend on the touch sense and blind spatial cognition. But proposed white stick can extend the radius of action of blind person safely and widely.



Fig. 5. The white stick using ultrasonic sensor.

Figure 5 is the white stick using ultrasonic sensor. We set the white stick with ultrasonic sensor. The sensor is a device to measure distance. We set the sensor placed at the bottom of white stick. Blind people can avoid using via vibration of vibrator when the system detects obstacle.

C. Duplex Radio-Frequency Camera (DRFC)



Fig. 6. Station of Duplex Radio-Frequency Camera

Figure 6 shows DRFC. DRFC use 2.4GHz frequency band and 2Mbps data rate. DRFC support MPEG and JPEG format. DRFC is used wireless communications. We separated color information data from picture using digital image processing. We determine the obstacle using this technique. DRFC use the wireless transmission, so this device has advantage without line.

This camera is used detecting color data in front of obstacle when blind people walking. At this point the detected color information is determined as color of obstacle. If there is obstacle, the camera notices information.

IV. EXPERIMENTS USING PROPOSED SYSTEM

A. Performance measurement of sensor and DRFC

TABLE 1. DISTANCE MEASURE BY ULTRASONIC SENSOR

Real distance (cm)	Measure distance(cm)
100	98~101
200	198~201
300	297~303

Table 1 shows real distance and measure distance different. This result contains a little error about 1%. We can ignore some errors. This result of experiment is shown that it has very low errors. So measured distance is accuracy. That measured distance had been calculated by travel time between ultrasonic sensor and obstacle.



(a)Detection wanted color (b) Decision color data
Fig. 7. Image detection by DRFC.

Figure 7 shows actual detection wanted color data. If DRFC finds wanted color data from captured image, the system processes the color data. If detection color data and wanted color data correct, the system informs to blind person. This function can apply to the crosswalk and traffic lamp. If detected color is Red, the system announces warning. Contrary, if detect color is Green, the system allows cross the road. Figure 7 (b) is used decision color data. This technique is object recognition. Proposed system is used image processing technique to recognize through received color information.

B. Experiments of Proposed System

In this paper, we consider two cases in experiment. First, we test that in complex area where there are many people and building. We have to move more carefully because there are many obstacles in the region. Second case is that we are moving in campus where there are fewer obstacles. So this area is more safety than region of first.

TABLE 2. EXPEIMENTAL ROUTES

Route	Distance	Route circumstances
A	About 480m	From Middle gate to Sachang-dong office
B	About 630m	Inside Campus (round course)

We experiment in place of Figure 8 and 9. Firstly, Figure 8 shows that there is much obstacle in place. In case of A route, We walk from middle gate to Sachang-dong office as blindfolded condition. There are lots of men and building in this case. Figure 8 shows that there is not lots obstacle in a university campus. This place is not in danger than in Figure 9.

We experiment real measurement with proposed system to analysis performance of system.



Fig. 8. Walking experimental route A.



Fig. 9. Walking experimental route B.

A and B in Table 2 are show experimental result. When comparing the two results, the more try several times the more good performance show because of familiar with assistive devices. Also, in the case of A route, we can confirm a long time than B route case. The system we proposed can't get similar pace like normal person but can go destination where we want to go with GPS and DRFC. And we confirm that it is possible to move smoothly to the destination with white stick.

TABLE 3. EXPERIMENT IN ROUTE A

	Time	Proposed System
1	15'22"	Not used
2	13'58"	Used (trial 1)
3	12'44"	Used (trial 2)
4	11'11"	Used (trial 3)
	5'12"	Normal Person

TABLE 4. EXPERIMENT IN ROUTE B

	Time	Proposed System
1	19'36"	Not used
2	16'08"	Used (trial 1)
3	14'57"	Used (trial 2)
4	12'22"	Used (trial 3)
	6'16"	Normal Person

Comparing the walking time, it takes longer than normal person who has no impairments. But, using proposed system is more convenient and faster than not used. We can say that proposed system offers convenience and safety. Therefore, proposed system is useful for visually impaired person.

V. CONCLUSIONS

We proposed very convenient and safe obstacle recognition system for visually impaired people. This system is accepted information data through GPS, ultrasonic sensor and DRFC. The proposed system can announce information of obstacle in real time. This system has merits that can notify different situation according to the distance. The system can recognize obstacle with color data from captured picture using wireless camera. Also, the system gets short distance data using white stick after obtaining long distance information using GPS. This system provides safe and accurate guideline for blind people.

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