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Development of voice navigation system for the visually impaired by using IC tags

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Abstract: There are about 300,000 visually impaired persons in Japan. Most of them are old persons and, cannot become skillful in using a white cane, even if they make effort to learn how to use a white cane. Therefore, some guiding system that support the independent activities of the visually impaired are required.

In this paper, we will describe about a developed white cane system that supports the independent walking of the visually impaired in the indoor space. This system is composed of colored navigation lines that include IC tags and an intelligent white cane that has a navigation computer. In our system colored navigation lines that are put on the floor of the target space from the start pint to the destination and IC tags that are set at the landmark point are used for indication of the route to the destination. The white cane has a color sensor, an IC tag transceiver and a computer system that includes a voice processor. This white cane senses the navigation line that has target color by a color sensor. When a color sensor finds the target color, the white cane informs a white cane user that he/she is on the navigation line by vibration. So, only following this vibration, the user can arrive the destination. However, at some landmark points, guidance is necessary. At these points, an IC tag is set under the navigation line. The cane makes communication with the tag and informs the user about the land mark pint by pre recorded voice.

Ten normal subjects who were blindfolded were tested with our developed system. All of them could walk along navigation line. And the IC tag information system worked well. Therefore, we have concluded that our system will be a very valuable one to support activities of the visually impaired.

***Keywords* — the visually impaired, white cane, IC tags, line of the color**

I. Introduction

A white cane is a typical supporting device for the visually impaired. The visually impaired are able to sense obstacles around them and walk safely by using a white cane. Therefore, in the area where they know well, they can walk safely using a white cane. However, they cannot walk independently in the unknown area, even if they use a white cane. In such cases, navigation of others are necessary. Because, a white cane is a obstacle detecting instrument and not a navigation system. In such situation, a supporter who assists a visually impaired person is imposed much strain. From these reasons, the navigation system for the visually impaired is required.

Many navigation system for the visually impaired are developing. For example, a navigation system by using GPS which support the independent activities of the visually impaired is being developed.[1] However, most of them are for outdoor space and not for indoor space. Our objective of this study is a development of the navigation system which can be used in the indoor space (e.g. underground shopping mall, airport, hospital, etc.) and support activities of the visually impaired without help of others.

In Japan, colored navigation line that is attached on the floor and show the way to the destination is used for a normal person. Each color is assigned for each destination in this system. We can arrive the destination, if we walk along one of these colored lines. Fig.1 shows the example of colored navigation line. In our system, this colored navigation line is used for the visually impaired. In this paper, we will describe about our developed system that supports the independent walking of the visually impaired by

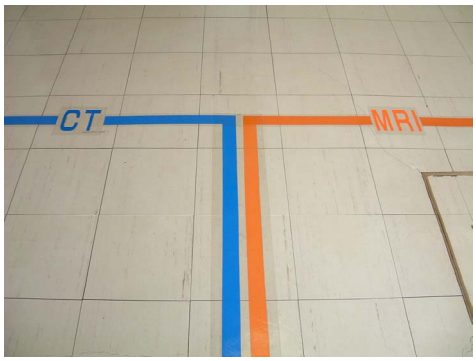

Fig.1 The example of colored navigation line using colored navigation line.

Fig.2 shows the conception of our system. This navigation system is composed of a colored navigation line that is attached on the floor along the navigation route and the intelligent white cane. A colored navigation line is attached on the floor.

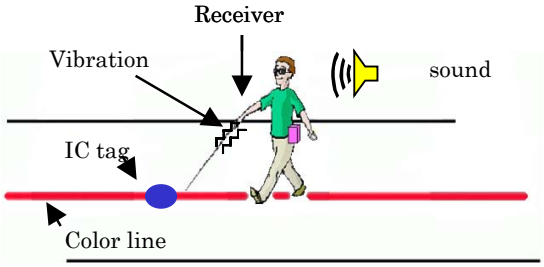

Fig.2 The conception of our system

This line is attached from start point to destination point along the navigation route. If there are many destination, different color is assigned for each route. At the landmark point of the route, an IC tag that indicates area code of this point is set under a navigation line. The user of this system use a white cane that includes a color sensor, a transceiver for IC tags, a vibrator and a voice processor. These devices included in a white cane are controlled by one chip microprocessor. And we called this cane a intelligent white cane. This cane senses the line using a color sensor and informs that the user is on a selected line by vibration. The cane also makes communication with an IC tag at the landmark point and informs that the area information by prerecorded voice. An intelligent white cane is shown in Fig.3. Therefore, the user of this system can obtain the area information and reach the destination, only walking along the selected colored line by using a intelligent white cane.

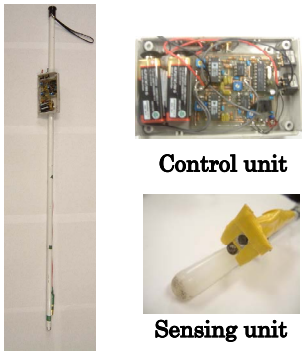

Fig.3 General view of the system

II. Methodology

A block diagram of a colored line sensing system is shown in Fig.4.In this system, RGB color sensor that is attached on the tip of a white cane senses the floor color. This sensor outputs R(ed), G(reen), B(lue) ingredient signal of the inputted color. These signals are amplified and limited their frequency band by a low pass filter, then 8bit analog to digital converted by a A/D converter that is included in one chip microprocessor. These RGB values are transformed to the Yxy notation, and the inputted color is evaluated whether selected color or not by using Yxy notation. The Yxy evaluation makes possible to classify the navigation line color without an influence of the brightness of the floor[2]. When this system finds the target color that indicates the way to the destination, one chip microprocessor turn on a vibrator while 500ms to inform that the user is on the route. This system discriminate 8 or more colored line on the floor.

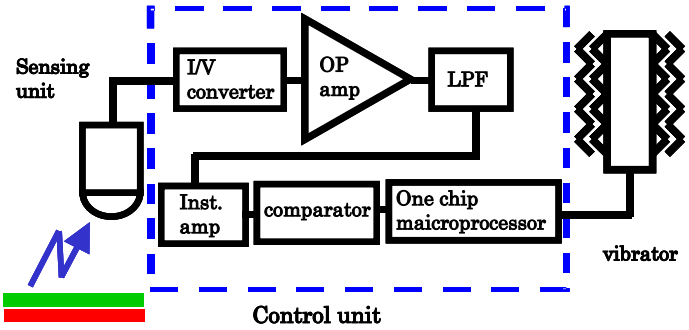

Fig.3 A block diagram of a system by white cane

A conception of the IC tag guidance system is shown in Fig.5. In the navigation route, there are some points where the system has to notify the user of area information. For example, a corner to turn left or right, a entrance to the elevator and so on are the points. In our previous navigation system, optical beacons that were set on the ceiling and a receiver for the beacons were used for this objective.

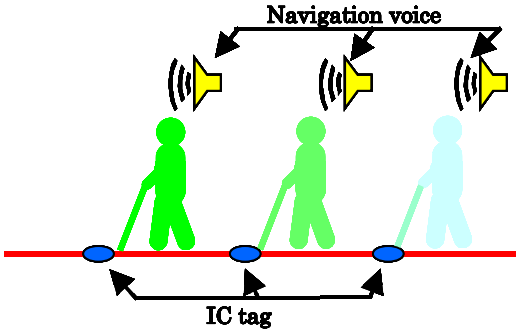

Fig.5 Conception of the system using IC tags

However, an optical beacon consumes electric power continuously to emit the area code as infrared signals. And an user have to have a receiver for the optical beacon in addition to a white cane[3]. So, IC tags are used in our new system. It is not necessary to have own power source for an IC tag. The power for an IC tag is supplied from the transceiver that can make communication with an IC tag by a radio wave. This is the benefit for using IC tags.

Fig. 6 shows an antenna for IC tags that is set on the tip of a white cane and an example of IC tag. A simplified block diagram of the IC tag guidance system is shown in Fig.7. Both receiving sensitivity and output power of ordinary RFID Micro Reader are too small for our system, a pre-amplifier for the receiver and a power booster for the transmitter are developed and equipped in our system. When the white cane finds an IC tag, the system begins to make communication with an IC tag. A transmitter transmits the power for IC tags and instruction codes and a receiver receives an area code where the IC tag is set on. One chip microprocessor analyzes this area code and selects the navigation voice data, then the user can hear the area information from the system speaker.

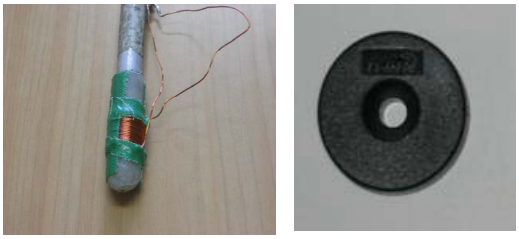

Fig.6 A picture of an Antenna and IC tags

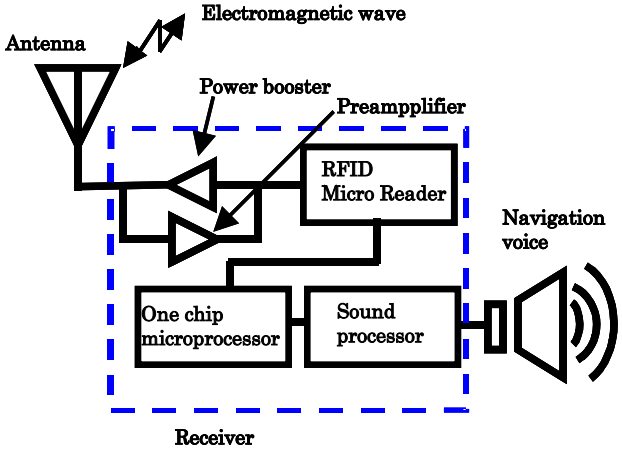

Fig.7 A block diagram of the IC tag transceiver

III. EXPERIMENT

Ten normal subjects were tested with our developed system. All subject were blind folded by the eye mask. Fig.8 shows the schema of experiment route. Every subjects walked from start point to goal point by using our navigation system. At the point C, an IC tag was set under the navigation line. The navigation color of route I and route II were different. From this experiment, we can see the following characteristics of our system. 1) Can the system distinguish the different color line at the cross point of the two different route (pint A)? 2) Can the white cane track the loose curved line (point B)? 3) Can the white cane find an IC tag and inform the user of area information (point C)?

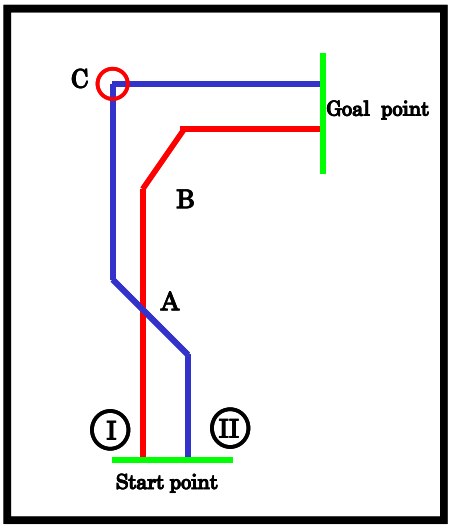

Fig.8 Experiment route

Fig.9 A picture of a experiment

IV. RESULT

All subjects could walk along the navigation line correctly. And all colored line are continuously detected stable. In our experiment route, most of subject will fail to turn right at point C without voice navigation. Because, they lost their route in front of them and cannot fined the line to the destination that is set on their right side at point C. In all cases of the experiment, our system found the IC tag and notify the subject of turning right information, and all subjects turned right and found the line to the destination at point C.

V.CONCLUSION

We described about our new navigation system using colored navigation lines for the visually impaired. The user can track the colored navigation line to the destination leaning on the developed white cane. And at the landmark point where an IC tag is set on, the cane finds the tag and notifies the user of area information. Ten subjects were tested with our developed navigation system. All subjects could use our system well and arrived destination. Therefore we've concluded that our navigation system will be a useful system for the visually impaired.

VI.REFERENCES

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