Abstract

It is proposed a system designed to allow full accessibility of blind people to transport infrastructures. The system guides the blinds using buried wires connected to control panels, by using radio frequency signals received by small receivers carried by the blind users.

Index Terms -- blind; infrastructure; accessibility

I. Introduction

Actual transport infrastructures are modified to allow access to disabled persons, unfortunately it is forgiven that blinds cannot guide themselves in big infrastructure transport hubs, hospitals and any other installations. Blind people usually guide themselves using trained dogs and sticks, being constrained to memorized paths. This can be a problem when they cannot remember a path, or when a previously memorized path has been changed or when they desire going to another non memorized place. Nowadays, large transportation hubs with access to underground, buses, and/or trains are subject to frequent changes to their configuration, due to enlargements, refurbishments or repairs. Large cities have complex interconnections between their railway, bus and underground grids, which sometimes converge in big complexes with layouts almost impossible to memorize. Big airports and stations have large halls with plenty of shops, people, and obstacles, making it almost impossible for blind users to follow by a path by themselves without any help. In order to improve the accessibility of public spaces for visually impaired people a system is proposed for guiding blind users through any transport infrastructure.

II. Operation
When entering a transport infrastructure, the blind person switches on a receiver, and will be guided through corridors by the very low intensity level vibrations generated by it, until reaching a control panel equipped with a relief map and a set of buttons with Braille text. When a chosen button is pushed, a recorded voice message will inform about the selected destination. Then the receiver advises using a long vibration that this destination has been stored in its memory. Afterwards the blind person is guided through corridors, halls, doors, stairs and elevators to the right train, underground or bus platform, airport finger, right exit or any other point of interest. Some paths may finish at stairs or elevators, but the receiver is programmed to connect to the next path of the grid, until reaching the final destination.

III. Basis
The system is based on an alternating magnetic field generated by a signal generator modulated in order to send data related to the path connections:

When the receiver is between both lines of the path, the receiver coil receives the added field from both return and forward lines, but when the receiver is out of both lines it receives the difference of fields from both lines.
Usually magnetic guiding devices must be close to the floor. However, using a resonance antenna, the reception distance can be increased so that the blind person can carry the receiver in a hand, hang it on a belt, etc.

IV. Uses

The system can be used in several indoor transport infrastructures and public buildings such as the following:
- Underground, bus and train stations
- Airports
- Museums and Public libraries
- Hospitals
- Schools and Universities
- Stadiums and sport complexes

It can be used as well in outdoor spaces such as:
- Parks
- Nature paths
- Sports fields,
- University campuses

Furthermore, it could be of help for blind sportspeople at ski areas and athletic tracks.

V. System performance
A 3-floor underground station or a medium airport could be covered just by 3-4 control panels. Depending on the layout of the infrastructure where the system is going to be deployed, a variable number of control panels will be needed. For the configuration of control panels and paths, it shall be considered that every control panel can be connected to up to 5 paths, and each path can be up to 250m long. If the path is longer, another control panel shall be installed in the middle, but it is not necessary that the blind person have to take any further action on the intermediate panel. The system is easy and cost-effective to deploy, it can be installed for instance in about 3 days in a medium underground station. The operating costs of the system are low as well; power consumption is 40 watts for every control panel.

![Example of installation at an underground Station Hall](image)

**VI. Status**

The system has been successfully installed and demonstrated at an underground station in Madrid (Spain). This installation consisted of 3 control panels connected to a grid of 12 paths, one of them buried under the station floor, and the rest deployed on top of the floor and protected with tape. The demonstrator showed how the system can successfully guide people through the station to any platform or to the exit, through the halls, corridors, elevators and automatic stairs.
VII. Benefits of using the system

This system allows blind people to guide themselves in any infrastructure without any previous knowledge of its layout. ACCIONA Infrastructures idea when developing this system was to make blind people free to go anywhere through the city infrastructure instead of being confined to a restricted number of memorized paths.

The use of the system eliminates also the need of sighted people giving support to blinds in order to learn new paths.

One of the main requirements considered during the design of the system was not to disturb the hearing sense of the users, as it is the most important sense for blind people. Therefore the guiding instructions are given through vibration instead of other alternatives such as audible signals.

As a consequence, the operation of the system is completely silent, which is also an advantage because it does not disturb third persons, and the blind users are not stressed by the feeling of being observed by others.
The design of the receiver has been done looking for maximizing the comfort and usability of the end user. Thus, the receiver size is very little, less than the size of a car key. Furthermore, in order to avoid the need of recharging the device continuously, energy requirements have been addressed with high priority. As a result, the consumption of the device is quite low, and with a normal use batteries can last more than six months without any recharge.

Robustness of the system is also one of the key issues, so that it can be potentially deployed in very harsh environments. In fact, the demonstration done in an underground station was an example of an aggressive scenario due to the high amount of people using the station every day, the interferences caused by high voltage lines and electric motors, etc. In order to suit these very demanding requirements, the system uses coded signals, so it is not affected by radiofrequency noise from mobile phones, train electric noise or other jamming signals. It should be highlighted as well that the system can be simultaneously used by more than one user, thus a person can be guided without being disturbed by other blind people in the area.

From the point of view of the installation, a quick deployment process has been developed by using conductive tapes installed on top of the floor and conveniently protected. However, the recommended installation process is to install the wiring of the guiding paths below the pavement, or to cut the latter in order to bury the wires. In this way, the paths will be completely protected from wear-out due to the traffic of people on top of them. The system costs, both of components and installation, are negligible compared to the costs of building one station.

VIII. Summary and conclusion

The system offers full access to blind people to any infrastructures by using a friendly receiver that can guide him through non memorized paths making them to travel freely as no blind persons

As more complex is the urban transport infrastructure, more useful is the system.

IX. References

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Keywords: blind; infrastructure; accessibility