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A REMOTE MONITORING SYSTEM TO IMPROVE EDUCATIONAL ACTIVITIES OF VISUALLY IMPAIRED STUDENTS

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Abstract − A tool that could improve the quality of the assistance perceived by the visually impaired students, during a PC laboratory teaching session, is presented in this paper. The work of qualified supporting teachers could be highly improved by the use of suitable software and hardware facilities allowing for remote monitoring of students' physical and working condition. This could highly reduce the need for a continuous presence of a tutor, that might downgrade students' self estimate.

Keywords: sensors, RF-ID, educational aids.

1. INTRODUCTION

The didactic activities oriented to visual impaired people have always played an important role, form a social point of view as well as a scientific one, on account of their complexity, but also for the difficult relations between such people and the tutors [1,2].

Qualified supporting teachers certainly can greatly improve the effectiveness of the didactic activities. A good relationship between the teacher and the student suffering from sensorial deficit can enable the student attaining results comparable to the ones attained by the other students.

During the teaching activity on informatics and training on computer use, the visually impaired student should be provided with useful kinds of assistance; moreover, the environmental condition and his health conditions should be continuously and in real time monitored in order to evaluate the development and the difficulties.

Anyway the continuous presence of either an assistant (social worker?) or a tutor can depress the student. Specially during the test in the classroom it is very important that the student doesn't feel the proximity of the tutor, sometimes embarrassing: indeed, he can be afraid of mistakes.

For this reason, there is a need of remotely monitoring the working condition of the student, in order to catch sight of possible difficulties happened to the user, with the purpose of arranging suitable assistance.

The interaction between the student and the personal computer should be evaluated on the basis of both the status of the PC station adopted and the values of some biophysical parameters of the student himself.

The problem of carrying out an efficient teaching assistance in a classroom of informatics can be based on:

- solutions able to automatically adapt the working environment to the requirements of the visually impaired user;
- a distributed monitoring system: in particular, the system should be able to transfer to the monitoring PC-server the information concerning the state of the PC-client and also the values of some biophysical parameters of the students.

Researchers with the Department of Electric and Electronic Engineering of the Catania University are deeply involved in the development of electronic aids based on Advanced Sensing Strategies for the Visually Impaired with particular regards to mobility aids and environmental sensors [3-6].

In this paper a research activity aimed to the design and the realization of an educational aid for the visually impaired is presented.

The system allows for implementing the self-configuration of the working station (PC) and the remote monitoring of the performances of the user. In particular, the idea behind this strategy, motivations and the adopted methodologies will be addressed through this paper.

The architecture developed must be intended as a monitoring system which produce information on the stress level of the user working at his PC station and, in case of a high stress level is observed, allows for understanding if it is due to a user failure or to a PC station malfunction. In particular, the following points must be considered:

- developing a RF-ID based system for identifying the user;
- developing a system for the self-configuration of the PC on the base of the requirements of the user;
- implementing a multi-sensorial network for monitoring the biophysical conditions of the user;
- developing a distributed system for the remote monitoring of the user and the PC status.

In [7,8] previous steps of this work have been already presented: as it has been shown, very interesting results have been obtained, which encouraged the development of the work. Indeed, the hardware and the software of the previous tools have been completely re-examined, therefore the tool presented here represents a further development and shows improved system features.

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2. THE RF-ID IDENTIFICATION TOOL

RFID (Radio Frequency IDentification) indicates an automatic identification technology that relies on the communication between RFID tags and RFID readers.

Tags and readers communicate through radio-frequency signals, making the identification contactless and highly reliable (there is no need for the tag to be in-sight).

RFID technology is eligible in different applications, where getting information on persons, animals and things for identification, monitoring, tracking and spatial localization purposes it's crucial.

RFID tags are classified by the way they take the power needed to perform their basic operations:

- Passive, they take the power from the excitation field generated by the reader. The information is transmitted through the re-irradiation and modulation of the signal transmitted by the reader, through the integrated antenna.
- Semi-passive, they have a battery for the microprocessor and auxiliary devices being in the place (like sensors) but they behave like passive tags for the transmission.
- Active, completely battery powered, they incorporate a receiver and a transmitter like readers.

In this work we used passive RFID tags: they present a limited operating range with respect to the active ones but they are cheaper and much reliable and, above all, they don't require any maintenance (like periodical battery replacement).

We use RFID tags to uniquely identify visually impaired students within a classroom, during a normal laboratory session.

The RFID system is essentially made up by using three fundamental elements:

- RFID Tag, a small sized radiofrequency transponder, which consists on a microprocessor that performs simple logic operations linked to an antenna and usually put into a smart card or a key. The only functionality of the tag is to transmit it's unique ID (typically an hexadecimal code) stored in its memory (Fig.1)
- RFID Reader, a microprocessor-based transceiver that queries the tag and receives its code.
- Management system, the software subsystem that communicates with all the RFID readers present in the network and pre-processes their information for following use.

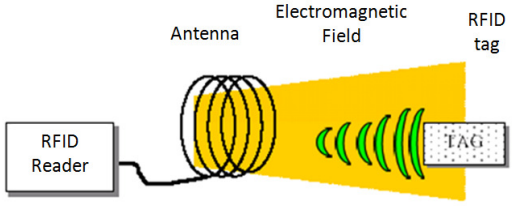

Fig. 1. RFID identification of a passive tag

3. THE SYSTEM ARCHITECTURE

For the realization of the software a client-server architecture has been implemented, therefore in the laboratory for training in informatics a server will be connected to a number of clients, as it is shown in Fig. 2.

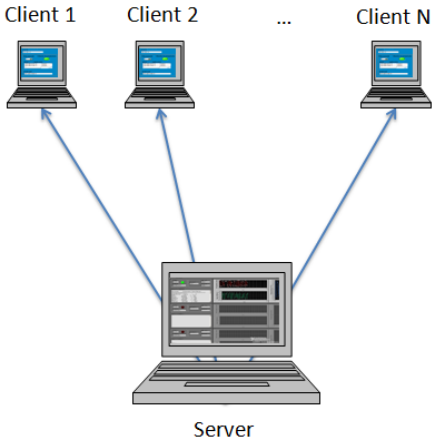

Fig. 2. Server-client system architecture

The Labview G-Language has been used for this version of the software, for both client and server implementations. This choice ensures high flexibility, while maintaining programming easiness.

Moreover, this makes the entire system suitable for didactic purposes in Labview training based courses, especially for undergraduate students in informatics and electronic engineering.

In particular, it represents a very good example of realizing a complex TCP-IP communication in Labview environment.

3.1. Client

The client architecture, schematically shown in Fig.3, has the following main features:

- Automatic recognition of the user through his personal RFID tag.
- Interaction with system applications at operating system level for both launching and state monitoring purposes.
- Periodic sampling and transmission of user's biological parameters, measured with a suitable bio-probe
- Audio feedback subsystem.
- Efficient identity and access management.

The audio subsystem highly improves the quality of the assistance perceived by the students by allowing the system administrator (that could be the teacher himself) to directly communicate with a particular student or providing him with other form of audio feedback.

User login/logout procedures must be extremely simple and efficient, because of the limited capability that students have in interacting with the client pc.

The login procedure is based on a RFID tag system. Each student has a personal smart card that uniquely

identifies him; the tag reader is placed near the pc and somehow indicated to be easily identifiable by touch.

When students need to log-in, they simple bring their tag near the RFID reader device until an audio message will notify the success of the access.

At any moment, students can log-out with a simple keyboard shortcut.

Bluetooth earphone has been used for the sake of convenience of using a wireless device; this feature justifies this choice over a traditional cabled headphone.

The software implemented in Labview interacts with the operating system to launch the applications that the student has to use and to monitor their state to detect possible anomalies that the student can't manage himself (software crashes, unintentional closing of the running application etc.)

Applications launch can occur basically in three ways:

- Automatically on student log-in.
- Remotely by system administrator.
- On demand by students, through keyboard shortcuts.

Client graphical interface has few essential features because the visually impaired student doesn't actually operate on it. Indeed, it is a facility for the system administrator. It must be perfectly transparent to the user, thus running in background.

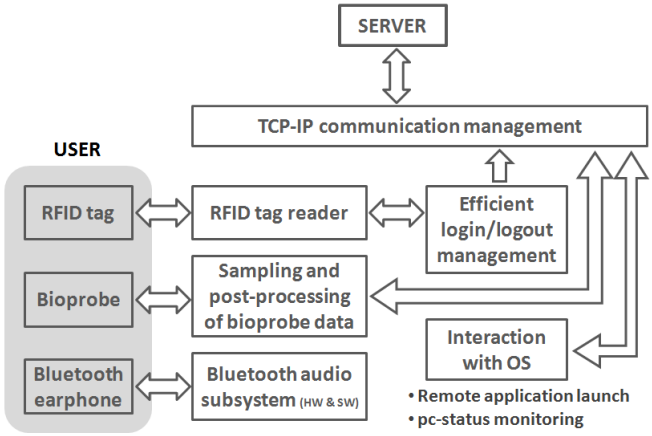

Fig. 3. Simplified block-diagram of client architecture

3.2. Server

Server architecture is schematized in the block diagram shown in Fig. 4.

The main feature of the server-side software is a functional graphical user interface that assists the system administrator in every stage of laboratory session (Fig.5).

The most important aspect of a laboratory session involving visual impaired students is the monitoring of students' actions and state.

Each student is constantly monitored starting from the log-in procedure.

The information that server acquires from each student through the point-to-point TCP-IP connection is:

- Values of bio-parameters.
- Real time list and state of processes that run on client pc.

The raw data obtained from the bio-probe are elaborated by a particular expert system core that provides an indicator, strictly related to the level of physical stress that a single student is experiencing.

When this indicator overcomes a certain threshold, the system administrator is suddenly notified.

Anomalies in bio-parameters values can indicate either a malfunction in client pc (and the consequent difficulties experienced by the students that actually don't have a visual feedback on the OS failures) or the students' inability to accomplish the assigned task.

When this kind of situation occurs, the system administrator can easily identify the cause of the anomaly in student's bio-parameters, thanks to the data fusion between the bio-monitoring and the information related to the state of the applications running on client pc.

The presence of a suitable Bluetooth audio subsystem makes possible a communication between the student and the teacher, that could be particularly useful to improve the assistance perceived by students.

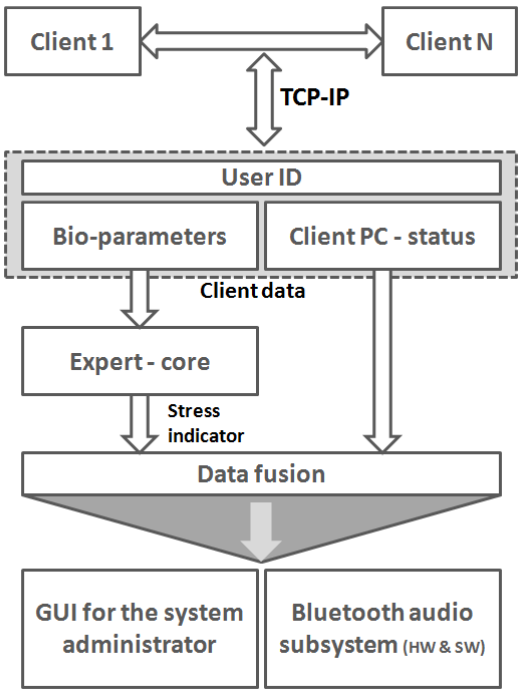

Fig. 4. Simplified block-diagram of the server architecture

4. CONCLUSIONS

The tool presented in the paper, based on advanced hardware and software technologies, represents an attempt to provide visually impaired students and teachers with useful assistance, during normal laboratory sessions.

The student's working condition is constantly monitored through an intuitive and functional graphical user interface, so the development of the training activity and the difficulties encountered by each student in the room of informatics can be evaluated. This improves both the quality of assistance perceived by students and the effectiveness of the work done by the qualified teacher.

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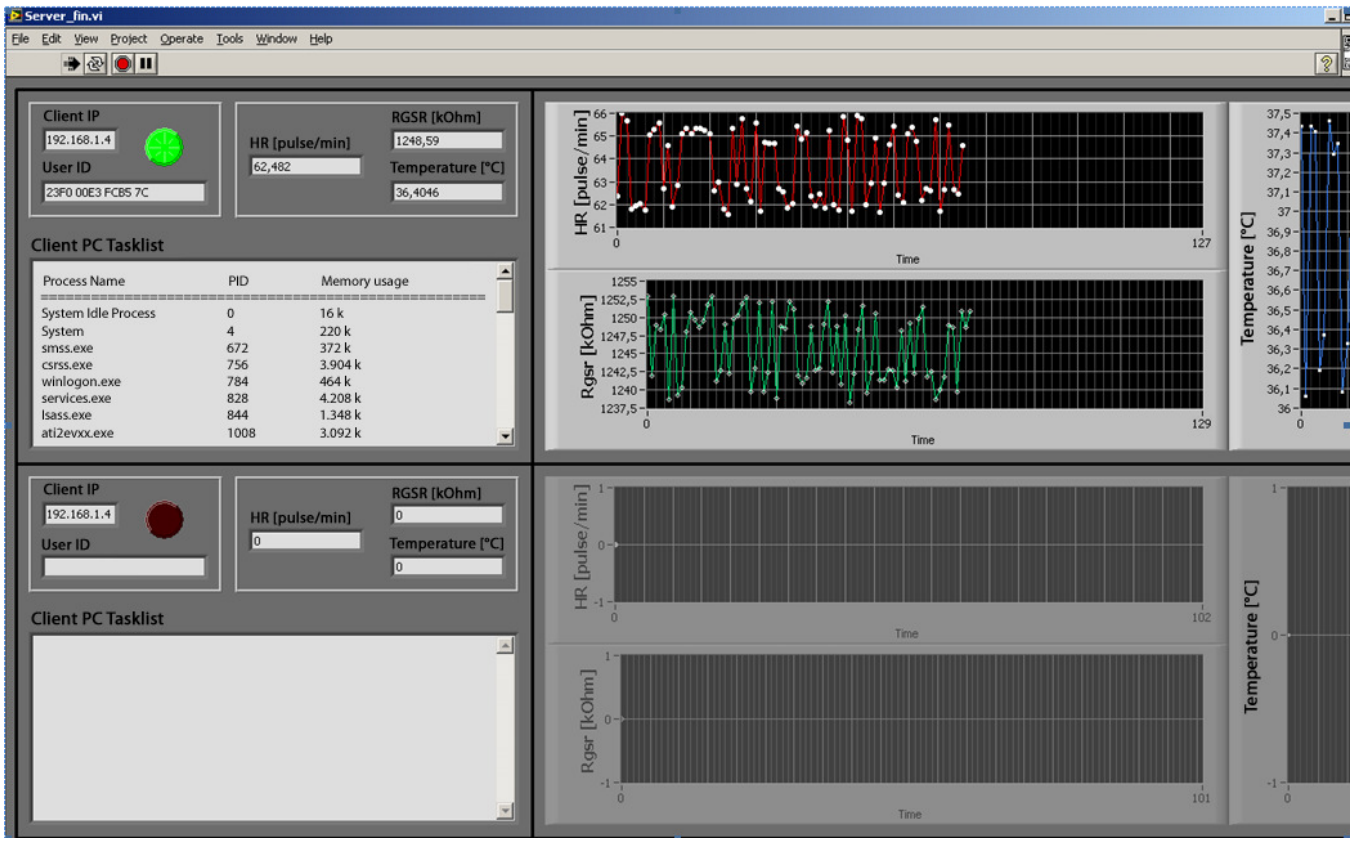

Fig. 5. Server GUI for the system administrator