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DESIGN AND IMPLEMENTATION OF A COMPUTERISED REMOTE ALERTING SYSTEM FOR DISABLED PEOPLE

We describe a remote alerting system for disabled people. The purpose of the system is to enable a monitored person to easily request medical assistance by pressing a single button on a wearable transmitter device. It should be noted that the handicapped person does not need to take any other action, such as picking up the phone. Upon triggering, the system is capable of automatically alerting the medical personnel, indicating the location of the alert using a digital transmission system or a speech synthesis module. Our system operates using primarily telephone links of any kind (PSTN, GSM, etc.). The system is intended for use by older or disabled people living alone, who may suddenly require immediate medical assistance, in particular, the people with physical disabilities and cardiovascular diseases.

1. INTRODUCTION

This paper describes a remote alerting system for the disabled people, developed by Institute of Electron Technology Kraków Division (formerly Research & Development Center for Hybrid Microelectronics and Resistors) in 1998. The system has been successfully developed, completed, tested, and submitted for certification with the relevant Polish telecommunication authorities.

The purpose of the project was to create an easy to use and reliable alerting system for use by the disabled people. The system operates over telephone links of any kind (PSTN, GSM, etc.), therefore it does not require any new communication infrastructure.

The system allows a disabled person to alert a central monitoring station, and optionally other people (neighbors, family, etc.) by pressing a single button on a portable transmitter. The system assumes, that the person monitored is within 20m range from a stationary notification device located in her home. It is also assumed that the monitoring station is capable of dispatching a medical team to the location indicated by the system.

The benefits from using such a system are self-explanatory.

2. OVERVIEW OF STATE OF ART

In recent years multiple remote patent monitoring systems have been developed. With the advent of cheap wireless communications (GSM networks in particular), such systems are becoming much more technically feasible, and, conversely, increasingly popular. The systems can be divided into two main groups: (1) alerting systems and (2) telemetry systems. The task of the

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first group of systems is alerting the monitoring station about danger to the patient; whereas the second group focuses on transmitting (usually real-time) vital parameters, i.e. blood pressure, heart rate, temperature etc. Telemetry systems are commercially available from companies such as Telcomed [[10]] or Philips [[3]]. Furthermore, several new systems are (or were) being developed under the EU research grants in Framework Programmes 5 and 6; an example of a such telemetry system is the e-Care project, described in [[2]]. Typically such systems consist of (1) a set of sensors along with (2) a central unit worn by a patient and (3) a base station. Usually, communication over a GSM network is used, sometimes using GPRS capabilities.

A current trend in the design of such systems is moving from GSM communication, via GPRS, towards 3G UMTS solutions, as evidenced in [[1]]. As the bandwidth costs decrease, system designers focus more on telemetry systems transmitting more information. Although this enables whole classes of new and interesting applications, it keeps the system costs up, as the decrease in bandwidth prices is being compensated by increased bandwidth usage. Furthermore, the new generation of systems currently being developed seems to focus on using capabilities of 3G UMTS networks for transmitting large amounts of data. While technically very interesting, the practical usability of such systems is, at the moment, questionable because of much slower than initially expected UMTS deployment by telecommunication operators.

The system described takes a different approach. It is a simple, manually triggered, alerting system. Although the system's simplicity is naturally limiting, it also brings a number of advantages, namely: (1) extremely low bandwidth requirements resulting in (2) practical independence of the type of telecommunication network used, and (3) very low cost. Furthermore, the experience gained during the development of the system forms an excellent basis for developing new, more advanced, systems of this type.

3. SYSTEM DESIGN AND OPERATION

The system is comprised of the following components, as shown in Fig. 1:

- Emergency portable radio transmitters
- Automatic telephone notifiers
- Telephone interface to the computer system
- A computer system

The system can operate over phone links of any kind (PSTN, GSM, ISDN, etc.).

The system operates in the following way. If a monitored person wishes to request assistance, she presses the button on her portable radio transmitter. The transmitter communicates over the short-range radio link with the telephone notifier. The telephone notifier transmit the identification information to the monitoring station using a telephone network. The monitoring station's personnel is then alerted of the event and can take the appropriate actions.

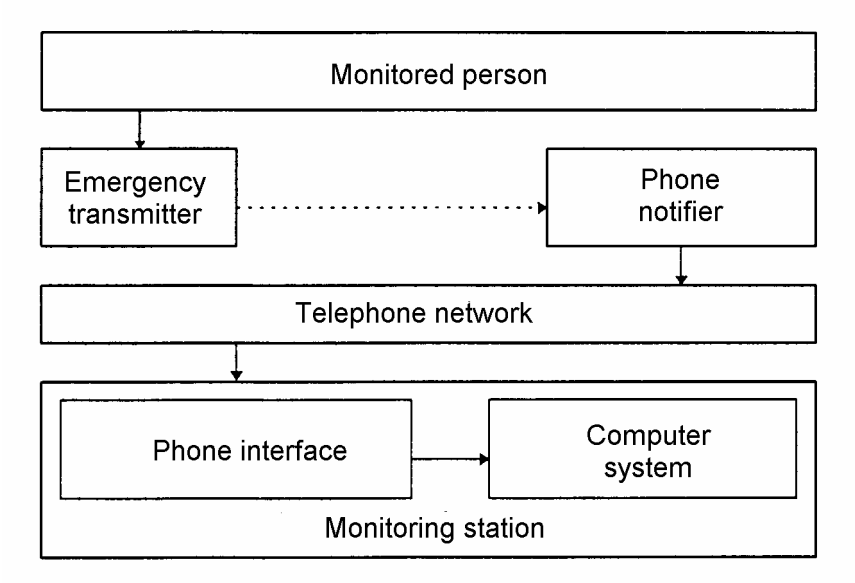

Fig. 1. System components

4. SYSTEM COMPONENTS

4.1. EMERGENCY RADIO TRANSMITTER

Emergency radio transmitter (Fig. 2) is a portable battery-powered device, which is carried by the monitored person. The device does not require any training, or preparation to use. It is equipped with a single alert button, pressing of which activates a built-in radio transmitter which transmits the encoded alert signal to the telephone notifier, usually located in the patient's home. The radio transmitter is switched on only if the alert button is pressed, and it operates no longer than 20 seconds. The minimum radio transmitter range is 20m.

The system operates at 433.92 MHz central frequency with FM modulation, that is in a frequency range reserved by national and international regulations for non-commercial industrial, medical and scientific applications (so-called ISM band) [[6]]. The system has been certified for operation by the appropriate authorities, according to the relevant regulations ([[5]],[[11]]).

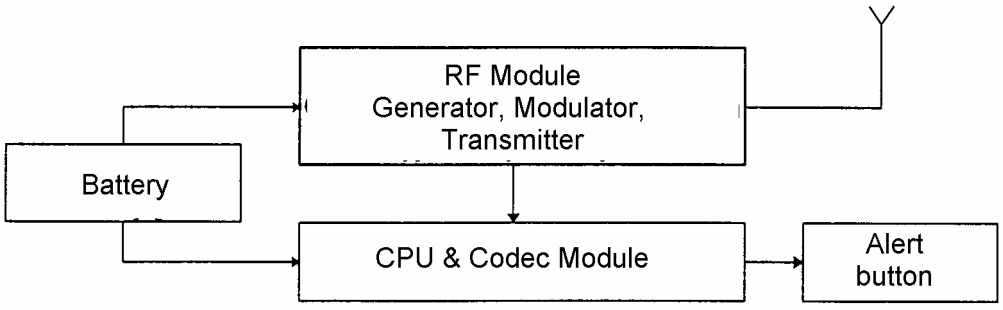

Fig. 2. Block diagram of an emergency radio transmitter

4.2. AUTOMATIC TELEPHONE NOTIFIER

Automatic telephone notifier (Fig. 3) is the crucial element of the system. The device is powered with standard 220V/50Hz mains voltage and equipped with a backup battery power source. The operation is triggered by the reception of a carrier signal from an emergency transmitter. Then, following operations are performed:

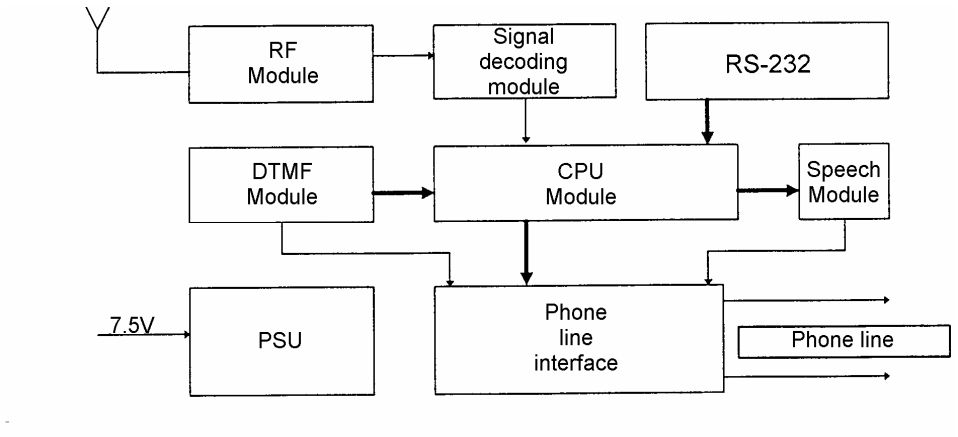

Fig. 3. Block diagram of an automatic telephone notifier

1. The incoming radio signal is amplified, demodulated and converted into a digital form.
2. A check is performed, to verify whether the signal comes from the correct transmitter, i.e. the one associated with the notifier. This eliminates the danger of one person's transmitter triggering several other notifiers in its range.
3. A phone call to the computerized monitoring station is initiated.
4. After the connection is established, access verification procedure is performed.
5. After the access verification succeeds, user identification data is transmitted.
6. The reception of user data is acknowledged by the monitoring station.
7. After the acknowledgement is received, the telephone connection is terminated.
8. Another phone call is initiated, this time with a telephone number predefined by the user.
9. After the connection is established (i.e. the called person picks up the phone), a speech synthesis module is activated, transmitting a voice information about the alert and its location.
10. After the information is fully transmitted, or the called person hangs up the phone, the call is terminated.
11. Optical and sound signals are switched on, informing the alerting person that the alert notification has been transmitted.

Data transmission between a notifier and the monitoring station is performed using DTMF signals, i.e. signals used for tone dialing phone numbers. Therefore the system is not dependent on the quality of the phone lines, as it would be, if it involved use of modem-like devices.

Additionally, a notifier is equipped with RS232 interface, permitting a trained service personnel to reconfigure the device.

4.3. TELEPHONE INTERFACE TO THE COMPUTER SYSTEM

Telephone interface to the computer system, along with the computer system, are parts of the equipment of the monitoring station. The purpose of the telephone interface is to enable the communication between the computer system and telephone notifiers. The system, as shown in Fig. 4, is comprised of a chassis containing several cards:

– One card containing the power supply unit (PSU), powering the device
– One communication card
– One to eight phone line interface cards

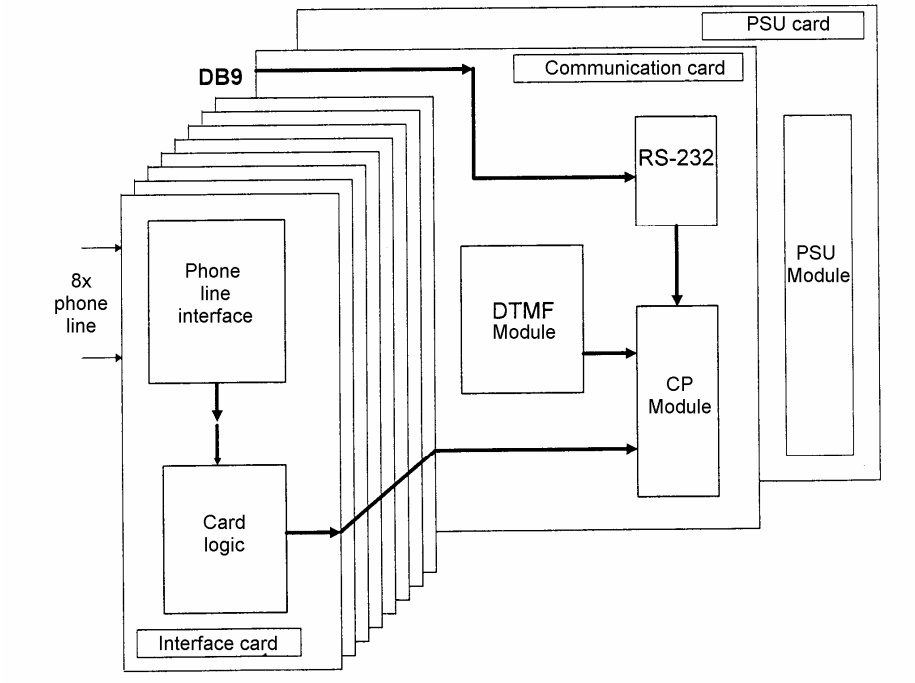

Fig. 4. Telephone line interface system

The purpose of the phone line interface cards is to receive signals from notifiers over the phone networks. These signals are subsequently relayed to the communication card. The communication card performs DTMF decoding and access verification. Next, it transmits the received user data to the computer system using an RS232 interface. After receiving acknowledgement signal from the computer system, it is transmitted to the telephone notifier, again using the phone line interface card.

4.4. THE COMPUTER SYSTEM

The computer system performs control and monitoring functions. Upon receiving the identification code of the alerting user from the telephone interface described above, the following operations are performed:

1. User code is looked up in the database
2. The event, along with its date and patient's code, is logged.
3. A set of user's data is displayed to the operator. The data include patient's name and address, patient's health history, information about the kind of patient's disability, etc.
4. At this point, the operator is expected to perform requested duties, e.g. dispatch a recovery team to the event scene. After these are done, the operator confirms that to the computer system.

The computer system generates the acknowledgement code, which is relayed to the telephone interface in order to be transmitted to the notifying device.

The system is user friendly and includes both event logging and access control measures. Several access levels can be defined, ensuring that data is not tampered with. In particular, that means that the dispatching operator has read-only access to patient data and cannot alter or delete

information about the events occurred. The system operates using MS Access database running on a Windows NT operating system.

5. FURTHER DEVELOPMENT

Due to its simplicity, the system can be easily extended. For example, because of proliferation of GSM networks in recent years, it is possible to create a portable automated telephone notifier, connected to the standard GSM phone. This would eliminate restrictions imposed by limited range of the emergency transmitter, while preserving other benefits of the system, such as fully automated operation upon triggering by pressing a single button. Another possible improvements could include sensors monitoring patient's state, which would be used for automatically triggering an alert, for example in case of a fall, drop of blood pressure, etc. Other possible applications are also being researched.

6. CONCLUSIONS

In this paper, we have described a system for the monitoring of the disabled people. The system described has been fully developed. The tests performed has determined the system to be suitable for real-world use.

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