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GSM enhances teleambulance services

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Abstract. The phenomenon of Teleambulance is becoming increasingly popular. This awakening technological development is enhancing the quality of healthcare delivery by providing possibilities for remotely assisting the emergency treatment of patients at the scene of incidence or during transportation in the ambulance before their arrival in the hospital wards. Both the mobile (ambulance) and the host (hospital) workstations communicate by sending messages, conveyed through the air by radio frequency (RF) signals. Transmitted data include, the emergency forms, monitored patient physiological measurements, textual remarks and images. The server/host resident software incorporates both a display and a database units for archiving the incoming patients records of incidence.
This paper aims at bringing to the limelight the state of the art in the developing world of Teleambulance. It presents the new GSM-based Teleambulance workstation which was designed and developed by the Laboratory For Biomedical Informatics (LBMI), to replace her previous radiomodem installation. The spectacular inclusions in this newly designed GSM-based configuration are the possibilities of combining the speech, the data and the fax communications in only one channel. More still, the system eliminates the thick-wall hospital screening effect and in no way whatsoever introduces radio frequency interference with the hospital electronic instrumentations. While the installation cost is almost only confined to the mobile station, the modularity of this new configuration boosts the cost effectiveness of a running Teleambulance service.

1. Introduction

The advent of telematics is boosting several research possibilities, hence enhancing applications development in various walks of life including medicine and healthcare. With the ever improving and advancing telecommunication infrastructure, there seems to be a tendency for substantial value added to human existence. This trend of technological development involving information transfer is giving rise to the birth of teleambulance within the healthcare sector.

The MOBICARE project which was carried out under yhe European flag, was initiated to define the strategic actions necessary to promote the health care mobile telematics in Europe (6). In Sweden (Gothenborg), the Netherlands (Amersfoort) and the U.K (Kent), scientists have made efforts to transmit medical information, together with other relevant patient data from the scene of incidence and/or during patient transportation to the hospital. More still, the teleambulance services allow a quick detection of false alarms at the scene of incidence e.g. false heart attack, hence preventing unnecessary cost of transportation or treatment. This approach is meant to effect maximum preparation of the hospital personnel before the arrival of the patient in the hospital. Although this phenomenon is not yet widely spread in the public, however, it is gradually gaining ground both within the policy making sectors as well as among the healthcare specialists.

In this perspective, the LBMI developed her first Teleambulance workstations. Both the

mobile and the host workstations are installed in the ambulance and the hospital respectively. Using a radiomodem initially installed as a communication facility, each of the processor-controlled systems contains a dedicated resident software which runs on the Windows environment. The mobile workstation is further equipped with a physiological monitor which is connected to the computer for the direct acquisition of the patients' physiological measurements.

During the design and the development of the LBMI Teleambulance workstation (1), it was a priori planned to keep the entire configuration flexible and modular. With the nowadays high rate of technological renewing, the obsolete modules or items can easily and optionally be replaced without tears. Furthermore, the methodological and ideological diversities, still prevailing in the ambulance services within the European communities demand the necessity to keep the choice of instrumentation open and optional and to free the developers and the users from the infrastructure proprietary bondage. After exploring the possibilities of the radiomodem and the associated public data Network within the laboratory, LBMI started to embark on the PTT GSM mobile communication service, as a second alternative chosen to accomplish the field operational test. The results of this approach do not only solve the prevailing problems as previously encountered, but serve as eye opener to the unforseen advantages of the GSM data network services which may eventually have a tremendous and crucial impact on implementation, standardisation and policy making , hence paving the way for future development.

This pocket-size Darwin Plus GSM digital communication instrument combines the possibilities of selectively transmitting speech, data and fax messages, by air-borne radio frequency, hence termed wireless. This allows the crew members to retain their usual verbal communication strategy and combine it with effective data transmission. More still, it provides the patient with the possibility of forwarding emergency fax message to the office, home or any destination.

2. Methods

In order to implement the functionality of the new LBMI Teleambulance workstation, amendments were brought to the existing configuration, both in the hardware and software.

2.1 Hard and software re-configuration

The Teleambulance hardware structure of the mobile workstation which is supposed to be installed in the ambulance, now consists of an ESCOM 486 DX2 notebook equipped with a PCMCIA port and a serial port on the one hand and a PTT GSM communication gadget, which includes a pocketline Darwin Plus mobile telephone and a PCMCIA card, replacing the Ericsson radiomodem communication facilities. The notebook is linked to the digital Hellige Monitor SMP for the direct acquisition of the patient's physiological data, particularly the ECG wave form, the saturation (pulse oximetry), the pulse and the heart rates, as well as the blood pressure. Both the notebook and the said physiological monitor are battery packed and can be easily charged in preparation for field operations. The server hospital workstation consists of a 486 DX2 computer, equipped with a coloured monitor and an HP printer. The communication infrastructure includes a standard modem linking the computer to the PTT public telephone network. Neither the antenna nor the battery back up facilities are needed here.

The Teleambulance resident software which operates within the windows operating environment, is now supported by a dedicated home-made communication module, which has been developed to replace the existing commercial one. This LBMI home-made module, which is based on the standard Hayes command set is integrated in both the client and the server

teleambulance software packages in the workstations. The PCMCIA slot is automatically initialised when the computer is booted in the mobile workstation.

With configured operating instructions, including the transmission rate, each of the workstations communicates with the other on the same level. From the calling mobile station, connectivity is established at the receiving (hospital) station after 3 dialling tones by default, followed by data transfer. The number of tones can be optionally altered. Following the transfer of the desired data, the line is disconnected to avoid excessive and unnecessary use of the air-borne data communication network. The special-purpose monitor module, which has a data acquisition (from the physiological monitor) and transmission frequency dialogue box provides possibilities of manual as well as automatic data transmission. One can choose between sending the most recent data set and the accumulated set since the last transmission (See Fig. 1). When the automatic data transmission option is initiated, the built-in timer takes over the control, including dialling, connecting and disconnecting. The Emergency Form module consists of patient personal information, incidence and pre-treatment report, journey report and the crew textual remarks. The graphic as well as picture module is also newly included. This allows the transmission of pictures, e.g head injuries, physical deformation and/or pictures of the scence of incidence. More still, instructive graphical images can be forwarded from the hospital to the ambulance crew, regarding the treatement of some particular patients with physical damages.

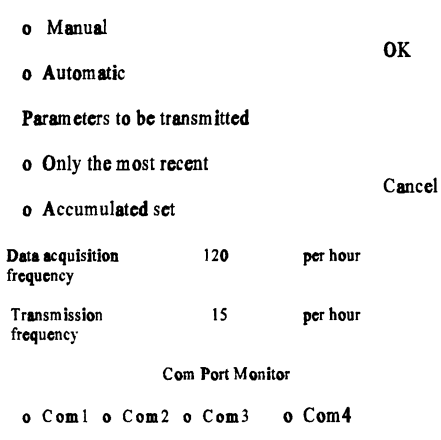

fig.1 Monitor data acquisition and transmission

The resident software in the hospital (host) workstation consists of a display and a database units for archiving and retrieving patients information. This unit issues and forwards the next available patient number after receiving a first contact from a calling ambulance, opens a new case by reserving a 3 kbyte labelled buffer. Incoming data or information concerning the said patient, accompanied by the patient hospital identity number are directly recorded in this reserved buffer. On arrival at the hospital gate, the operating crew member forwards a press-button closing instruction to the server, which in turns empties the buffer in question into the database system.

Both the client as well as the host software packages have the possibilities of optionally choosing the communication ports for the different external devices connected.

2.2 Communication hardware characteristics

characteristics	*radiomodem*	*Ptt Darwin Plus*
weight	*470 gm*	*230 gm*
com port	*serial*	*pcmcia*
transmission speed	*8 kbit/sec*	*9.6 kbit/sec*
data network	*ram data*	*gsm*
sort of message	*data*	*data/speech/fax*

3. Results

We must at this juncture affirm that the possibilities of the radiomodem have only been exploited to the extent of data transmission without extensively investigating the possible remedies to the prevailing problems. Therefore it is absolutely not the intension of this paper to effect a comparative analysis of already employed communication strategies, but to bring to the readers' notice the fact that different technologies present different advantages.

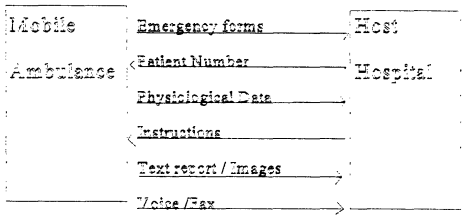

Fig. 2 Two-way teleambulance communication

Both the laboratory and the road tests have resulted in the elimination of the radio transmission interference with the hospital instruments and the problems of screening by hospital buildings. These are due to the fact that the incoming data at the host station enter via the public telephone network and not through the air, contrary to the previous radiomodem configuration. The transmission speed of the GSM network is 9.6 kbit/sec. Fig. 2 presents the 2-way teleambulance communications.

4. Discussion

The GSM network is widely available in Europe and hence simplifies the use of the teleambulance workstations within the European Union. The PCMCIA card eliminates the necessity to provide a third serial port in the processor of the mobile workstation. While trying to exploit the possibilities of these telematics applications and particularly the value of the Darwin Plus added to the Teleambulance initiatives, one can imagine the prospect of forwarding the video coverage of the scene of incidence or images of physical distortion to the hospital, or instructive graphical images from the hospital to the crew. The transmission speed of the Darwin makes it suitable. Currently, the power of the Darwin Plus mobile telephone is limited to 2 watts. However, it is possible to increase the power to 8 watts by virtue of a booster that can be built in the vehicle. This facility provides a stronger affinity for data transmission and reception in the mobile situations. On long term basis, the exploitation cost is negligible. The cost of information transmission, which of course is dependent on the time is minimal and negligible, as the volume of data is reduced to accommodate just the most significant and relevant information. The emergency forms, when completed are sent in a packet once and would cost less than 0.5 dollar per incidence. The intermittently acquired patient physiological data will vary according to the settings in the data acquisition and transmission frequency control unit, but would at most cost less than 2 dollars per occasion. The less than 1% increase in the cost of individual ambulance ride to the hospital, when compared to the significance of the life that may be saved through this telematics infrastructure, will no doubt remind us of the blessings of these technologies. Contrary to the previous LBMI radiomodem option, the GSM network widens the scope and dimension of this application a great deal in the sense that the mobile messages can reach the destination without incorporating special communication gadgets save the resident workstation software, hence reducing drastically the installation cost.

It should be mentioned that the transmission coverage in the Netherlands is not yet complete. This implies that some areas still exist where the GSM mobile system can not be reached by radio communication. It is envisaged that in the summer 1996, this problem will be completely solved.
A transnational experiment was conducted to investigate the functionality of the system across boarders. The results of this initiative will be presented in another paper (8). Contrary to other public data network, the GSM Network is available in every European country, Hong Kong and South Africa. This implies that the LBMI teleambulance configurations was designed with the notion of the wide European dimension and can be used without any modifications whatsoever in all the places for which coverage is established.
Finally, it is worth mentioning that the whole excercise of teleambulance, when adopting the European standard, should still be subjected to legal issues .

5. Future Perspectives

In order to optimise the functionality of the workstation within the evolving ambulance community, it would be necessary to further explore the technologies, the relevant applications within the ambulant and mobile medicine, the socio-cultural and economic impact. As previously indicated, LBMI is contemplating embarking on the European Mobile Service (EMS), a satellite infrastructure scheduled to become operational in the second half of 1996 to provide teleambulance services. Together with its notebook-sized antenna, which can easily be placed on a vehicle, the EMS transmits data at the rate of 2.6 Kbit/sec. Furthermore, the Inmarsat Aero-H satellite workstation (5), which is inbuilt in modern aircrafts and which transmits data at the rate of 9.6 Kbit/sec., is being investigated for delivering similar teleambulance services. Finally, a multi-purpose emergency configuration is envisaged to include optional possibilities for the land-, sea- and air vessels. In order to ensure interoperability, this teleambulance initiative will embark on the Trans European Trunked Radio (TETRA) technology (6), which favours the closed user group networks, e.g. the ambulance fleet. Such networks are expandable according to user needs. A set of 2 generic standards, TETRA manipulates data in packet mode, resultng in better speech and data communication performances at low exploitation rates (7).

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