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Hot Topics in Medical Imaging in Cyprus

What Kind of Background Does Cyprus Have in Tele-Health?

Telemedicine is evolving in Cyprus, with some forms of telemedicine in common practice in many fields of medicine throughout the country. Our aim is to incorporate telemedicine in everyday practice in Cyprus, especially as the whole island is covered with state of art telecommunications. Health technology projects already implemented in Cyprus include the following:

- RIS/PACS internet gateway system;
- Wireless emergency orthopaedics telemedicine system between Nicosia hospital & rural health centres;
- Mediterranean OTELO tele-echography project, MARTE I, MARTE II and MARTE III projects;
- Echonet ultrasound network;
- Orthopaedic Teleconsultation Paraskevaïdion (CY) & Shriner's Hospital (USA) project;
- Telepathology network (TELEGYN); • Emergency telemedicine (ambulance & emergency - 112) project;
- Oncology radiation therapy and radiation diagnostics (TELEPLAN and VIRTUOSO);
- Collaborative virtual medical team for home care of cancer patients (DITIS);
- Teleconsultation and teleradiology between medical centres in Cyprus in viewing and reporting cases and interactive participation of radiologists during the examinations.

Tell us about your collaboration with the University of Bourges, France, using robots to perform tele-echography.

Our collaboration with the University of Bourges/France began in 2003 as part of the OTELO project which involved satellite connection between Cyprus, France and Spain. My role was as physician operating the robot while specialists in two other countries performed the exam. It was repeated in 2005 with the MARTE I remote examination of patients in the rural hospital of Kyperounta by expert doctors in the radiology department of Nicosia General Hospital (2005) and in 2007 MARTE-II, the remote examination of volunteer patients on a cruise ship in the Mediterranean sea by expert doctors from Nicosia General Hospital and Bourges Hospital in France, using satellite communication (2007).

After the first two phases of the MARTE-I and MARTEII projects both teams decided to continue their cooperation via the MARTE-III research programme. The cooperation between French and Cypriot researchers, expert doctors, partner organisations and sponsors was, from start to finish, of a very high standard. The project's lead organisations were the Cyprus University of Technology (CUT) and the University of Orleans (IUT), Bourges, France, with the University of Cyprus. The project started on January 1, 2008 and was completed on the April 30, 2010. The project was funded by the Cyprus Research Promotion Foundation (ΙΠΕ) under the auspices of the "Programme of Bilateral Protocols for Research and Technological Development" between Cyprus and France.

The MARTE-III project involved applied research in the field of mobile robotic tele-echography. The general aim of the project was to treat emergency patients in a moving ambulance, by the performance of remote ultrasound exams from a central hospital, by clinical radiologist experts in cooperation with the paramedics in the ambulance. The expert doctor examines the patient directly using the MARTE system based on wireless telecommunications. In many cases, the expert concludes that the patient is not at all a patient, or the problem with his health is not so serious. So the MARTE system may act in many cases as a 'carrier of good news' and help streamline otherwise urgent workflow.

The MARTE I project was organised in collaboration between the University of Cyprus, the Higher Technical Institute of Cyprus and the University of Bourges and Nicosia General Hospital. My role in the project was to use a victim probe and conduct a teleradiological examination from Nicosia General Hospital in a patient settled at Kyperounta Medical Centre based in a rural area outside Nicosia. MARTE II in 2008 was similar and the patient was based on a ship outside the country and in 2010, MARTE III involved a patient based on a moving ambulance; in both projects I performed the ultrasound exam through a robot based in Nicosia General Hospital.

Tell us about the system that MARTE III uses. What were the requirements for its architecture & configuration?

The system consists of:

1) A specially equipped medical workstation on the expert's side, situated in the medical centre from where the expert doctor remotely performs tele-echographic exams and gives advice to the medical/paramedical staff in the ambulance for the support and treatment of the patient. The expert station in the medical centre (central hospital) consists of:

- (i) The fictive probe and its accessories,
- (ii) The computer, which is connected to the fictive probe, and
- (iii) Teleconferencing equipment (camera, microphone, screen, loudspeaker), through which there is optical and acoustic communication between the central hospital and the ambulance.

2) The specially equipped mobile workstation (on the patient's side in the ambulance) is used by medical/paramedical staff in the ambulance. This mobile workstation consists of:

- (i) The robot;

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- (ii) The real probe, which is 'held' by the robot;
- (iii) The computer, which is connected with the robot and controls it;
- (iv) The teleconferencing equipment (camera, microphone, screen, loudspeaker), and
- (v) The ultrasound device.

The motion of the fictive probe is transferred via the network which is formed by the expert's computer, the terrestrial and satellite link.

- (3) The system also includes the computer of the robot in the ambulance;
- (4) The robot, and
- (5) The real probe (which is applied to the patient).

The ultrasound applied to the patient is transmitted via the network formed by:

- (1) The teleconferencing system in the ambulance;
- (2) The satellite and terrestrial networks, and
- (3) The screen of the teleconferencing system on the expert's side (central hospital) where it appears on the screen of the teleconferencing system, for the expert doctor to be able to make the examination as if he were next to the patient.

How are Image Acquisition, Transmission and Processing Set Up?

The methodology that was applied was the following: At the beginning an analysis of the various aspects of the project was performed so as to define the specifications and needs for equipment and software. Preliminary experiments were then performed using the vehicular satellite antenna, installation of the mobile unit in the ambulance, installation of the expert site unit in the central hospital (CUT telemedicine laboratory), connection of both systems and testing of the whole arrangement. Then the software was written according to the specifications and design of the new and improved model robot, called Melody. Then the mobile workstation was installed in the ambulance as well as the installation of the necessary equipment in the central hospital, and connection between the two units and testing of the operation of the system made as a whole. Then the software was designed and finally the integrated experiment of examining volunteer patients in the moving ambulance was performed successfully from the telemedicine lab of CUT, which was acting as the central hospital.

Samples of the experiment's results were used for analysis of the ultrasound images and videos recorded during the experiments, giving emphasis on the quality of the transmitted images and videos. The main outcome, the successful operation of the system as a whole, with reception of high quality ultrasound images via satellite links, was achieved with excellent results.

How Does Tele-Echography Compare to Traditional Methods in Accuracy and Image Quality?

The tele-echography system is not the same as traditional ultrasound. The major drawback is the lack of free movement of the probe on the patient's body, which using the robot can only be done in an X/Y axis plane. This limits the ability of the physician to check specific areas compared to the traditional method; however the areas of interest can be reached and diagnosed. The interruption of transmission in some cases during the examination also limits the accuracy of the method in the same time frame as traditional means. Image quality is slightly decreased for technical transmission and acquisition purposes, however it has continuously improved and now compares to the standards of traditional ultrasound machines. Overall the examining physician, if trained, can establish a general diagnosis using these systems, covering most of the scenarios under interest.

Is This New Digital Means of Diagnosis Cost-Effective Compared to Traditional Methods?

This means of diagnosis involves certain extra costs that are not needed for traditional ultrasound exams. Currently the robot system costs approximately 50,000 euros for experiments, while a basic ultrasound machine and the transmission system are also needed at the patient location and the basics (victim probe, etc.) in the diagnostic centre where the examination will be performed. In these terms, teleechography seems not to be cost-effective; however the consideration of the particular circumstances of the use of these methods is imperative since under certain scenarios teleradiology is the only mean of establishing a basic urgent diagnosis and moreover the transfer of every such patient to specialised centres is not only impossible at certain times (e.g. as in the case of ship passengers) but costly as well, as is the cost of hiring expert radiologists in centres located in distant areas.

How is the Patient's Consent Being Obtained, and How is Their Digital Privacy Being Protected?

The patient's consent is a major legal issue in the field, and in our projects was obtained after the remote examining physician informed the patient via teleconference and the patient signed his/her consent form in the presence of an assistant or other physician based at the patient's location (this was only required in the "MARTE I" project where real patients took part at Kyperounta rural medical centre). The patient's privacy is protected as in other medical examinations firstly with the presence of authorised personnel in both places involved in the examination. The digital data are encrypted and protected throughout their transmission.

At this time they are not saved in a system such as PACS but in the future they will be protected with same means as digital CT or other imaging exams stored in PACS, in an encrypted form that needs the authorisation code of professionals in order to be viewed.

Are Physicians and Patients Happy and Confident With this Remote Method?

Physicians seem to be satisfied with this method, and confident that besides various issues in its implementation it is continuously improved and will hopefully reach the standards of traditional practice. Patients are sometimes hesitant about the accuracy of the method, but are willing to participate and are finally happy with the results, especially in those emergency scenarios tested through some of our projects.

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