A Smart Ambulance with Information System and Decision-making Process for Enhancing Rescue Efficiency

Abstract — The system is employed to enhance the rescue efficiency of an ambulance or a rescue car using information technology and decision-making. It aims to support emergency medical services (EMS) by improving the communication between staff at the incident location and competence centers such as hospitals. The increasing number of missions, especially car accidents, in Thailand has created huge problems for the public health care system. Higher cost efficiency and treatment quality could be achieved by sharing both tactical and medical data. Medically relevant data such as medical signals, auscultation, and video material are transferred from the emergency site to the competence center via the telematic support system. Also, traveling distance relative to traffic management can improve patient survival during transfer using global positioning system (GPS) tracking.

Tracking incident locations and monitoring the patient's biomedical signals are achieved using portable GPS and medical devices. Smart glasses are employed in the video conferencing system. Application software including the decision tree algorithm has been developed to be used with cloud computing to manage video material, GPS, medical devices, and decision-making for transferring a patient in this prototype system. The telematic support system can utilize both Wi-Fi and cell phone. The crucial requirements and the proposed hardware and software system architecture of the system for EMS are presented.

Methodologies

The workflow diagram for the information system for enhancing rescue efficiency is shown in Fig. 1. Medical emergencies and adverse events are transmitted to the relevant institution or hospital. After receiving the information related to the event, the patient's location and the initial symptoms of the patient are transferred to the paramedic ambulance team which then responds to the event. When the paramedic ambulance team arrives at the emergency site, paramedics can use both audio and video systems to send medical information such as vital signs to the competence center in order to receive directions from the EMS physician. The competence center can help the paramedic ambulance team by coordinating with traffic police to facilitate traffic flow via the global positioning system. The (GPS) tracking is installed in the ambulance or rescue car. The competence center can also advise the paramedic team on which hospital the patient is to be transferred to, depending on the EMS physician's diagnosis and decision-making process. Before transferring the patient to the destination hospital, all tactical data are transferred so that the appropriate treatment can be initiated during the critical interval. The competence center will also help to optimize workflow by communicating with the healthcare facility to which the patient will subsequently be sent.

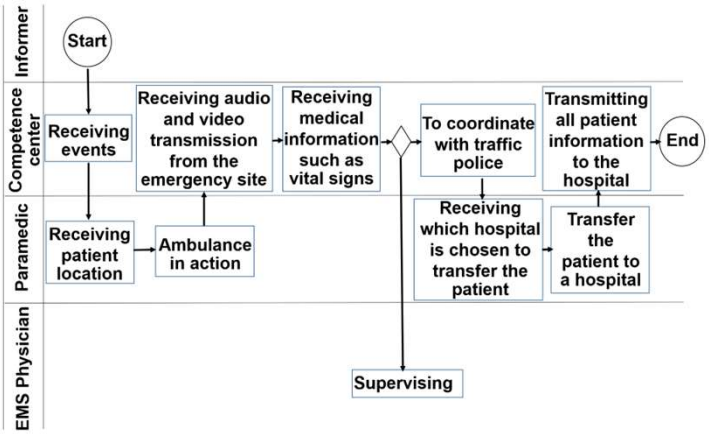

Fig. 1 Workflow diagram of the information system for enhancing rescue efficiency

The application software has been developed for both personal computers and smart mobile phones to enable users to collect and use data as organized on the advanced ambulance rescue system. The software architecture and design of the information system for enhancing rescue efficiency is shown in Fig. 2. The uniform resource locator or universal resource locator (URL) is addressed as "swu-ecmms.com" and on mobile applications, and it is designed to use the application programming on Amazon Web Service (AWS) to improve solutions and services.

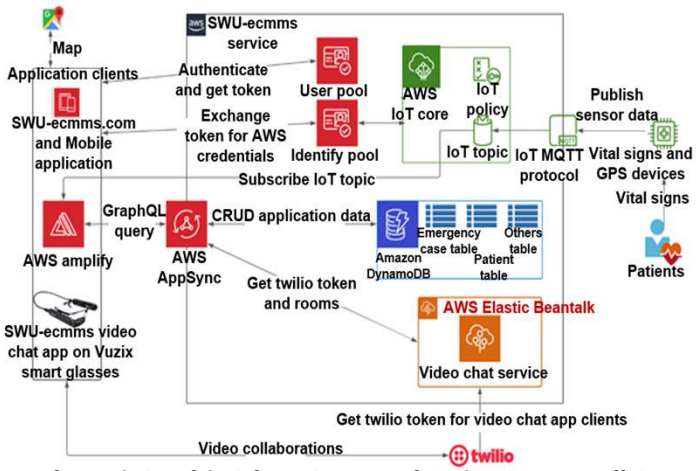

Fig. 2 Software design of the information system for enhancing rescue efficiency

Results

The portable monitoring devices for electrocardiogram (ECG), pulse oximetry (SPO2), heart rate (HR), and GPS are shown in Fig. 3. A portable device designed with a 3500mAh 10A lithium battery is included in the circuit. This battery enables the device to function without the necessity of any charging wires.

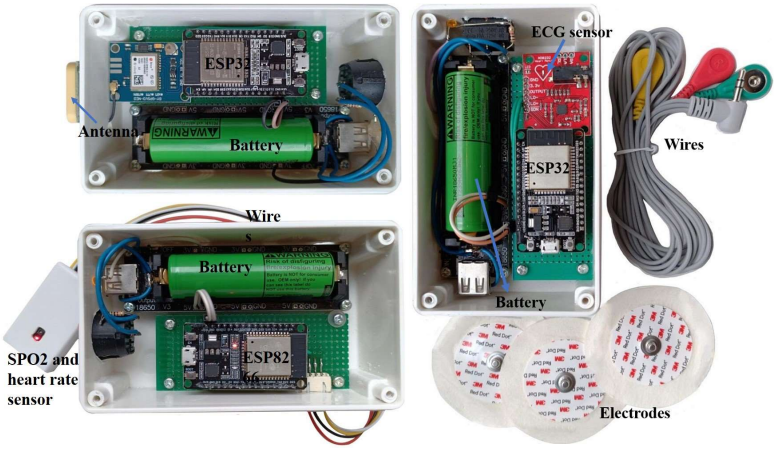

Fig. 3 Examples of portable monitoring devices for ECG, SPO2, HR, and GPS

The application software screen is shown in Fig. 4. Measurement results of medical signals, GPS, and conferencing screen (using a pair of smart glasses) are shown in Fig. 5.

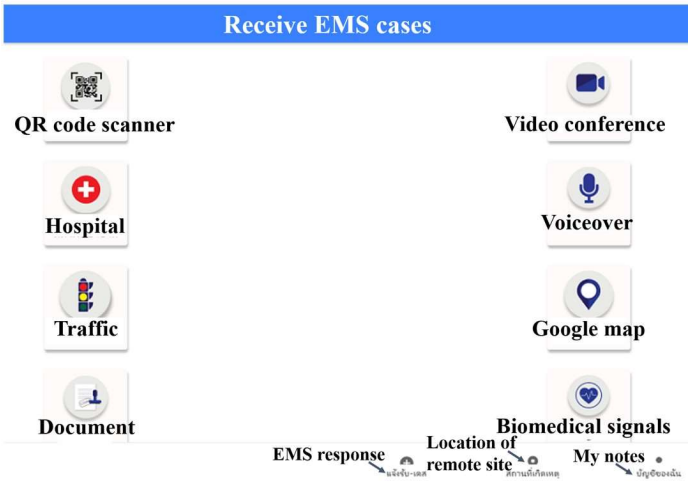

Fig. 4 Examples of medical signals, GPS, and conferencing screen

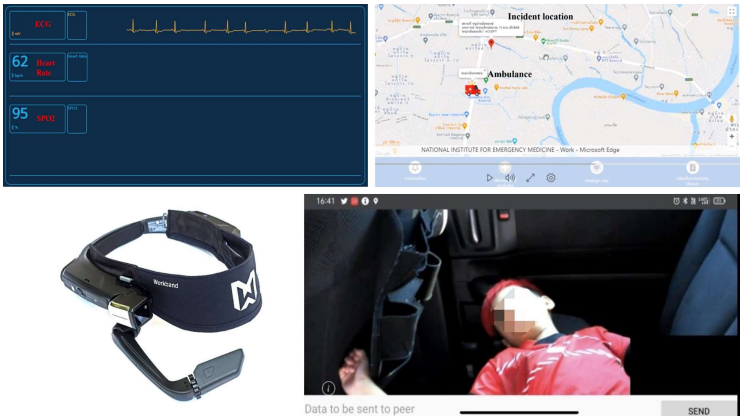

Fig. 5 Examples of medical signals, GPS, and conferencing screen

Conclusion

Monitoring devices for medical signals have been developed to improve patient care during emergency medical situations. The portable electrocardiogram (ECG), pulse oximetry (SPO2), and heart rate (HR) monitors are simple to use and free the paramedics to concentrate on patient care. Body temperature and blood pressure are measured using medical devices, and the medical signals are transmitted from the remote site to the competence center via Wi-Fi and cell phone systems. The GPS device is a portable device and the video conferencing system enables the communication between the paramedic team at the remote site and the physician team at the competence center using a personal/notebook computer, a smartphone, and a pair of smart glasses.

EMS documentation was developed to use cloud services to provide a documentary record of patient assessment and treatment which can be used to plan pre-hospital and in-hospital medical services. This typically involves a wide variety of interdependent and distributed activities that can be interconnected to form emergency care processes within and between emergency medical service (EMS) agencies and hospitals. The decision-making process is successful in choosing which hospitals a patient should be transferred to.