WEB-BASED INTERFACE SYSTEM FOR BEDSIDE MONITOR

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for my beloved parents, brothers and Chee Kiong, may God shower uncountable blessings upon all of you

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ABSTRACT

From face-to-face consultation to medicine at a distance, technology is changing the way medical services are delivered to the people. We are going into an era where the information is being digitized to be stored in a database. This is done in order to reduce information overlap and redundancy that are the main problems the health care sector are facing right now. More hospitals in other more advanced countries are going paperless. In order to provide better services to the critically ill patients in the ICU or CCU, a data acquisition program is developed for the acquisition of vital signs monitored in the critical care units. This work discusses the work done in extracting the data and signal from patient monitor BSM 8800 to the computer. The data are acquired using RS232C Interface Protocol. The vital signs acquired include oxygen saturation (SaO_2), heart rate (HR), electrocardiograph (ECG) signal, non-invasive blood pressure (NIBP), respiration rate (RR), temperature (TEMP) and end tidal carbon dioxide ($PETCO_2$ or $ETCO_2$). Ventricular Premature Contraction (VPC), ST level and arrhythmia information are also acquired and displayed to provide a more thorough information on the condition of the patients. Alarm detection is also programmed so that in critical conditions the vital signs will be displayed in red for extra caution. An ECG user control is designed and embedded in the web page in order to convert and plot the ECG waveform from hexadecimal values sent from the bedside monitor. The user control has been tested its accuracy and proved its validity to reconstruct the original ECG waveform. Basic patient information can also be seen from the graphical user interface (GUI) that has been developed. Physicians and medical practitioners have to register with the system before gaining access to the system and only the physician-in-charge of the patient can see the more intricate details of the patient.

ABSTRAK

Teknologi sedang mengubah cara perjumpaan pesakit dengan doktor secara konvensional kepada cara rawatan dari lokasi lain sedikit demi sedikit. Kita sedang menuju ke era di mana maklumat ditukar kepada bentuk digital untuk disimpan dalam pangkalan data. Ini adalah bertujuan mengurangkan informasi dan maklumat yang sama difailkan dua kali. Sektor perubatan kini sedang menghadapi masalah perlapisan data serta data lapuk yang tidak dikemaskinikan. Hospital di negara-negara maju telahpun lama mengaplikasikan cara penyimpanan rekod secara digital untuk mengelakkan pembaziran kertas. Bagi memberikan rawatan yang lebih baik kepada pesakit-pesakit di unit-unit kecemasan, satu program untuk mendapatkan data pesakit untuk pemeriksaan doktor dan jururawat dibangunkan. Tesis ini membincangkan kerja yang dibuat untuk mendapatkan data tersebut daripada BSM 8800 kepada komputer. Data didapatkan melalui protokol RS232C yang membolehkan komunikasi antara alatan dengan komputer. Data yang didapatkan termasuk kepekatan oksigen (SaO_2 atau SpO_2), kadar denyutan (HR), elektrocardiograf (ECG), tekanan darah (NIBP), kadar respirasi (RR), suhu badan (TEMP) dan kepekatan karbon dioksida dalam darah ($ETCO_2$ atau $PETCO_2$). Kontraksi ventrikel awalan (VPC), tahap ST dan maklumat mengenai ECG yang tidak normal turut didapatkan bagi mengetahui keadaan pesakit yang lebih menyeluruh. Di kala terjadinya kecemasan, data akan terpapar dalam warna merah. Satu program bagi menukarkan maklumat dalam bentuk heksa kepada voltan ECG yang sepatutnya dibangunkan. Ia diuji dalam ketepatannya dan terbukti bahawa ianya boleh dipercayai untuk menghasilkan gelombang ECG yang sama seperti yang sebenar. Maklumat mengenai pesakit serta doktor yang merawat terdapat dalam laman web yang dihasilkan. Doktor haruslah mendaftarkan diri sebelum boleh mengakses laman web tersebut. Hanya doktor yang bertanggungjawab terhadap seseorang pesakit boleh membaca maklumat pesakit yang lebih terperinci.

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LIST OF ABBREVIATIONS

ADO	-	ActiveX Data Object
ASCII	-	American Standard Code for Information Interchange
ASP	-	Active Server Pages
AV	-	Atrioventricular
CCS	-	Critical Care System
CCU	-	Coronary Care Unit
CIS	-	Clinical Information System
COM	-	Component Object Model
CPR	-	Computer Patient Record
CTI	-	Computer Telephone Integrated
DCOM	-	Distributed COM
DICOM	-	Digital Imaging and Communications in Medicine
DSL	-	Digital Subscriber Line
ECG	-	Electrocardiograph
EEG	-	Electroencephalograph
EHR	-	Electronic Health Record
EMG	-	Electromyograph
EMR	-	Electronic Medical Record
$ETCO_2$ or $PETCO_2$	-	End Tidal Carbon Dioxide
GUI	-	Graphical User Interface
HIS	-	Hospital Information System
HL7	-	Health Level 7
HR	-	Heart Rate
IBP	-	Invasive Blood Pressure
ICT	-	Information and Communications Technology
ICU	-	Intensive Care Unit
IIS	-	Internet Information Services

IOM	-	Institute of Medicine
ISDN	-	Integrated Services Digital Network
IT	-	Information Technology
JScript	-	Java Script
LabVIEW	-	Laboratory Virtual Instrumentation Engineering
LAN	-	Local Area Network
LIS	-	Laboratory Information System
NIBP	-	Non-Invasive Blood Pressure
$PaCO_2$	-	Partial Pressure of Carbon Dioxide
PACS	-	Picture Archiving and Communication System
PC	-	Personal Computer
PDA	-	Personal Digital Assistant
PICIS	-	Patient Integrated Clinical Information System
PIS	-	Pharmacy Information System
PM	-	Patient Monitor
PVC	-	Premature Ventricular Contraction
PWS	-	Personal Web Server
RIS	-	Radiology Information System
RR	-	Respiration Rate
RW	-	Reconstructed Waveform
SA	-	Sino-atrial
SaO_2 or SpO_2	-	Oxygen Saturation
SC	-	Strip Chart
TEMP	-	Temperature
USB	-	Universal Serial Bus
VB	-	Visual Basic
VI	-	Virtual Instruments
VPC	-	Ventricular Premature Contraction
1NF	-	First Normal Form
2NF	-	Second Normal Form
3NF	-	Third Normal Form

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CHAPTER I

INTRODUCTION

1.1 Background

In the Intensive Care Unit (ICU) or Coronary Care Unit (CCU) and other critical care settings, patients' physiological state needs to be monitored at all times but medical staff do not have the human resources and technical capabilities to perform this task continuously. Ever since the technology of monitoring astronauts' vital signs in space was transferred to the bedside in the 1960s, patient monitoring systems have become an essential part of critical care [1]. Today, these systems can gather multiple physiological signals simultaneously and derive clinically important parameters. Many monitoring systems are geared towards remote monitoring of patients' physiological signals.

Although the amount of information patient monitoring systems provide to medical practitioners is more than ever before and still improving, the usability and usefulness of the information is less than desirable. The raw data contains measurement errors and noise from biosensors. Corrections for these errors and elimination of noise have to be done for better accuracy of the signals and data acquired. Data integration and multi-parameter data analysis might be able to extract useful information from the imperfect raw data, but the state-of-the-art monitoring systems carried out limited data integration and analysis for effective decision support. Therefore, many manufacturers are improving their products constantly, hoping to give more satisfaction and functionality to the practitioners.

One symptom of this lack of data integration and analysis is the lack of electrocardiograph (ECG) signal analysis. Patient monitors located at the patients' bedside are able to monitor their ECG signals. However, physicians are unable to determine the voltage levels of the P, Q, R, S, and T points of the ECG without the waveform printouts. The same problem also arises for the R-R intervals.

In order to solve these, researchers have been creating web-enabled software to allow the analysis of the ECG waveform and the peak detection features. The ability to monitor the patient remotely is an added value for the physicians so that they do not have to be always on site whenever they want to know their patients' conditions.

Other than wired applications using landlines, researchers from other parts of the world are also looking into wireless and mobile applications for remote monitoring systems. There is little doubt that mobile computing can be a powerful tool to reengineer business processes. The benefits of such reengineering include reduced paper handling, reduced travel, improved data accuracy and timeliness, and reduced need for large central office facilities. Nevertheless, one particularly difficult issue for wireless communications is security. For instance, some wireless technologies are not suitable for applications in which sensitive client information is exchanged between a central database and a remote device because the data signal can be intercepted [2]. Wireless communication is often ruled out due to cost or simply not feasible. In some cases, mobile computing must rely on replication and synchronization of data over landlines. Therefore, it is important to balance the initial and ongoing costs of implementing these technologies, including training and support, against the potential benefits of time and monetary savings.

Before proceeding further into the discussion of the research, section 1.2 will first define the terms of web-based interface system for better understanding the rest of the discussion in this thesis.