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APPLICATION AND MANAGEMENT OF MECHATRONIC MEDICAL DEVICES

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Abstract

In recent years, with the rapid growth of high-tech industry, the diffusion of the automation and integrated mechatronics, the intelligent factories has been formed gradually. Intelligent factories not only increase company's competitiveness, but also ensure to occupy the leading position in the industrial development. The purpose of this article is to acquire the computerization, digitization, and somatization experience in manufacturing industry, and then introduce above concept of the intelligent factories, which are characterized by adaptability and resource efficiency, to medical industry.

Hospital is a place to safeguard the life, to restore health. The continuation of life is not only upon the professional medical team's devotion, but also the adaption of the medical devices. The medical device industry is a special sector which involves with variety, technicality and broad range of equipment. This essay is going to explain the device integration by using of interface RS-232 and communication technology. Initially, patient's physiological data collected by the medical devices will be continually and simultaneously captured under the network system, and it allows medical staff to monitor to physiological signals at any time. The enhancement of quality, effectiveness of care and reduction in medical error are to be prospected. Also, it aims to maintain the completeness of medical record and strengthen the mechanisms of medical management. Next, the useful information may be dug out and leads to significant results through practicing data mining techniques to analyze the physiological database. Furthermore, by means of regulatory systems, the device administrators are able to understand the classification, quantity, and utilization rate of the medical devices, and to avoid the idleness of equipment and increase the usage. Finally, to achieve the cost reduction goals.

Key Word: Mechatronics, Medical Device, Management

1. Background

A medical ventilator is designed to provide the mechanism of breathing for a patient and keep he/she alive. And the clinical data generated from the device may help detect patient's abnormality and reduce mortality. For example, it is essential to maintain adequate levels of PEEP while treating Acute Respiratory Distress Syndrome (ARDS). PEEP acts

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to keep the alveoli recruited and stabilize lung volume, and then FiO2 could be decreased accordingly to a safe value. Moreover, after both physiological parameters and patient's condition turn to stable later, patients may wean from ventilator support upon the assessment of ventilator parameters record by respiratory therapists (RT). Nowadays, more and more patients need to reply on ventilators, nevertheless, there is the shortage of respiratory therapists. Under above circumstances, by means of mechatronics integration, the respirator therapists and medical staff are given remote access to ventilator parameters to make the best treatment.

2. Methods

2.1 System Structure

In this article, the information integration system is designed based on the application of ventilator. Information integration allows the medical staff to access to real-time clinical data, to monitor to patient's physiological signal at any time, and which leads medical staff to make the medical treatment decision promptly. The complete ventilator parameters record generated through the information integration is considered to enhance the quality and minimalize the medical error. The full medical record is able to strengthen the mechanisms of medical management. Firstly, connecting ventilator and computer with transmission line RS-232 as shown in figure 1. By using the local area network (LAN), the users could access real-time clinical data from remote location. The development of system is schematically divided into 6 sections as followings, front-end links, ventilator parameters data collection, data integration and display, the respiratory parameters data archiving, integration of system and network, device management.

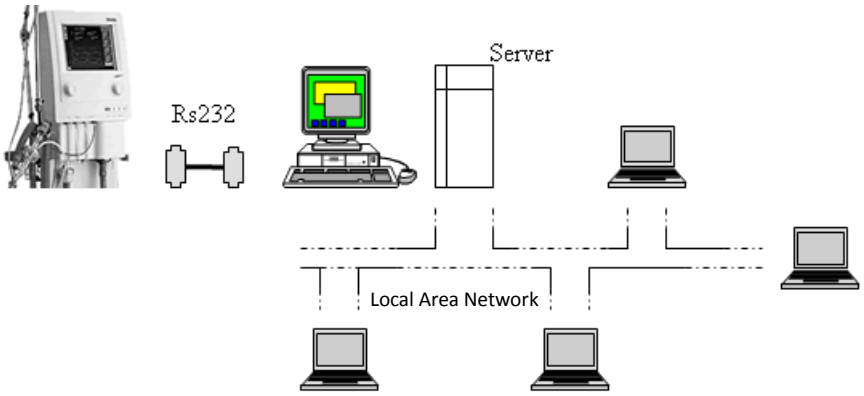

Figure 1. System-constructed conceptual diagrams

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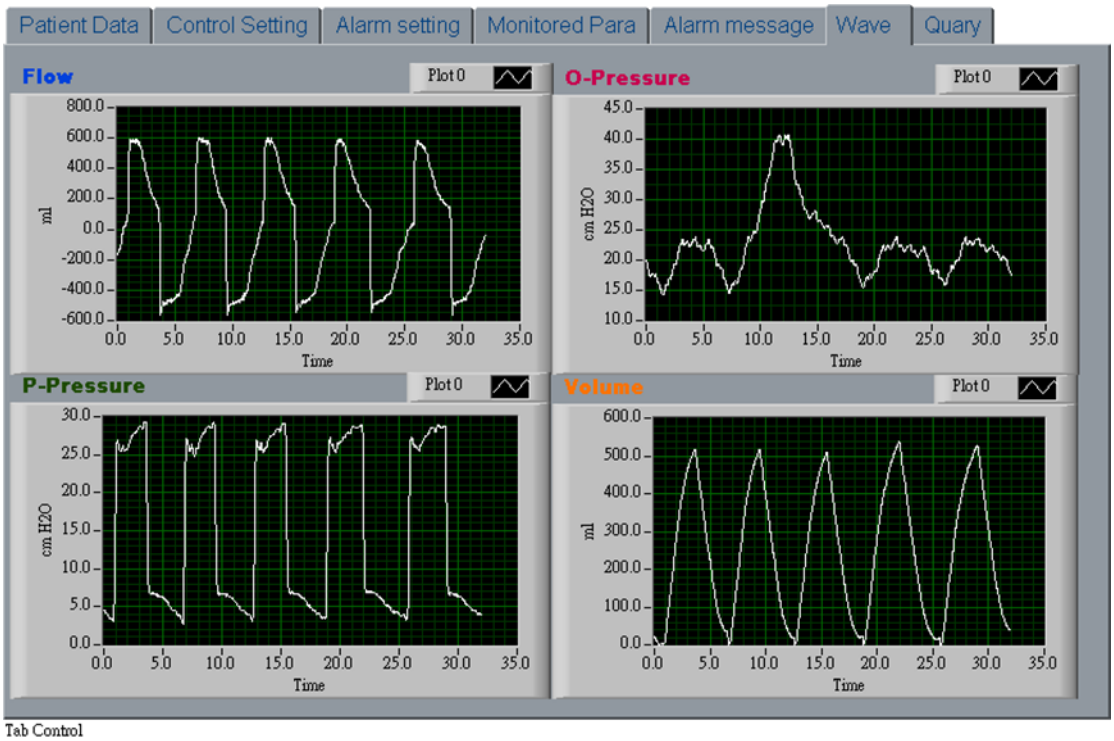
2.2 Software System Development

LabVIEW software is applied in this system development. LabVIEW functions as SCADA (Supervisory Control and Data Acquisition) software and is used in device control, data acquisition and analysis. LabVIEW provides data-flow programming and sequence structure programming. In addition, LabVIEW is inherently cross-platform and which allows to deploy your code to many different computing platforms. From above statements, LabVIEW is required in the system development.

2.3 Ventilator Parameters Data Integration, Display, and Archiving

7 major categories of information are displayed on screen, which are patient information interface (Patient Information), ventilator control settings interface (Control Setting), ventilator alarm settings interface (Alarm Settings), patient's respiratory monitoring (Monitored Parameters), ventilator waveform interface (Wave Form) and query interface (Query). The medical staff are able to monitor and search from Central-Station.



Tab Control

2.4 System and Internet Integration

Connecting the user interface with internet allows the medical staff to access and monitor patient's respiratory status remotely. And the further medical treatment could be quickly given to reduce patient's discomfort. This system is only designed for the remote surveillance. Receiving end is not able to react, response, either provide valid

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input on server side. Therefore, it still needs respiratory therapists and medical staff to be beside to perform medical act and adjust ventilator parameters.

2.5 Device management

Integrating with device administration department bring us a better understanding of the cost of devices, usage, the content and frequency, fees of maintenance.

3. Results

3.1 Performance and Efficiency of System

It is seldom to reset the ventilator parameters and ventilator alarm settings, thus, the updating is only happened when pressing update button. The ventilator parameters data and alarm message are continually updated once per second, ventilator waveform is transmitted 5 times per second.

3.2 Limitations of System

Based on patient safety, medical ethics and RS232 protocol, the vales shown on Front Panel and the other parameters shown on each interface are as display indicator (Indicator) and are locked, expecting patient's name (Name), ID number (ID), gender (Sex), date of birth (Birthday), patient's self-reported (Chief Compliant) on Front Panel and the ID number (ID) on query interface are fillable fields and able to input.

3.3 Restrictions of Database

For some special parameters only shown under certain ventilation mode, whereas, those values appear as empty strings in general ventilation mode. In Microsoft Access, the empty string cannot be stored, such as numeric data type, and then error message appears. Due to above restrictions, all data types in this system are in OLE objects in order to avoid error message.

3.4 Clinical Benefits to Medical Staff

As patient's real-time physiological data and graphs are able to acquire online, medical staff could make medical treatment decision correspondingly and promptly. Moreover, owing to the data archiving and completeness of medical record, those clinical data could be reused and reanalyzed and it provides perspectives on future diagnosis and more effective treatment to medical staff.

3.5 Advantages to Device Administration Department

There are approximately 20%~30% of hospital total expenses spent in medical equipment purchasing. By using this system, device administrators could learn more regarding the cost of medical device purchasing, maintenance expense, productivity, operations and management fee. It is considered to achieve cost control and performance evaluation.

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