Implementation of a Human-Centric GUI for Next-Generation Intensive Care Unit

Tsung-Che Lu, Shang-Hwa Hsu*, Sing-Jia Tzeng, Che-Ming Chang, Lan-Da Van
Department of Computer Science, National Chiao Tung University, Hsinchu, Taiwan
*Department of Industrial and Management, National Chiao Tung University, Hsinchu, Taiwan
e-mail: tclu@viplab.cs.nctu.edu.tw, sshsu@mail.nctu.edu.tw and ldvan@cs.nctu.edu.tw

Abstract—In the intensive care unit (ICU), the situations of the critical patients vary rapidly. To give the patient the necessary medical treatment, the medical staffs need to respond in no time. However, making the diagnosis is not easy since there is tremendous information to be processed in ICU. In this paper, a prototype human-centric graphical user interface (GUI) based on ecological interface design (EID) is implemented by C# that is compatible with Microsoft Windows system. The human-centric GUI integrates the necessary information and will help the medical staffs to interpret them efficiently. The waveforms of artificial vital signs are displayed to show the variations of those signs instantly. Besides, the GUI can display the heart/lung/kidney indicators in radar charts to assist medical staffs aware of abnormal indicators in a visual way.

I. INTRODUCTION

In the hospital, the intensive care unit (ICU) serves as a dedicated department to provide the critically ill patients the necessary intensive care medicine. Due to the extremely unstable situation of the critical patient in ICU, the medical staffs need to process large amount of complex information to understand the condition of the patients. The condition of the patient needs to be closely monitored by the medical staffs in order to perform the necessary emergency medical treatments to make their conditions stable. This leads the ICU to a high-pressure environment for the medical staffs.

To ensure the safety of the patient, one crucial issue is the correctness of the diagnosis which is closely related to situation awareness of the medical staffs in ICU [1]-[2]. Obviously, a correct diagnosis leads to an appropriate medical treatment. On the other hand, a wrong diagnosis may lead to the worst result - the death of a patient. The correct diagnosis needs the medical staffs handling various informations from different sources. However, integrating the tremendous information in no time is not easy, especially in a high-pressure environment. In the ICU, heterogeneous indicators are required to be interpreted by the medical staffs to understand the overall situation of a patient. Those indicators include the vital signs, the blood/urine examination results, and the medical images. Since the indicators are separated, the medical staffs need to obtain them from different sources. This effect makes the diagnosis more difficult.

Considering the above issues, a human-centric design based on the ecological interface design (EID) [3] is proposed in [4] for human-machine interface of next generation ICU. The EID aims to reduce the mental effort of the user for the complex systems. Thus, the cognitive resources of the user can be utilized for the higher cognitive processes. Fig. 1 shows the examples of the interface designs based on the EID concept. In Fig. 1(a), the state of the respiration is displayed. In Fig. 1(b), the risk of the acute myocardial infarction (AMI) [5] can be evaluated by the area of the triangle. Figs. 1(a) and 1(b) represent the respiratory system and the circulation system of the human, respectively.

Based on the design in [4], the implementation of graphical user interface (GUI) for ICU is developed in this work. The vital signs, the heart/lung/kidney indicators and the medical images are integrated in one GUI. The human-centric display of those indicators offers the user a natural way to receive the necessary information for the diagnosis. Using C# on the Microsoft Windows system, the prototype GUI for ICU is implemented and demonstrated. The rest of this paper is organized as follows. Section II describes the prototype GUI implementation, and the conclusion is remarked in Section III.

II. IMPLEMENTATION OF THE PROTOTYPE GUI

According to the discussion in the previous section, our goal is to implement the human-centric GUI design for ICU to help the medical staffs monitor the conditions of the patients effectively. The GUI for ICU should integrate the necessary information to enhance the situation awareness of the medical staffs [6]-[9], and must be intuitive to help the medical staffs understand the indicators easily without interpreting the indicators exhaustively.

To develop the prototype GUI, the C# programming language with Microsoft Windows system is targeted. C# refers to an object-oriented programming language with the elegant and type-safe features [10]. For the C# programming, the visual studio provides the programmers a user-friendly environment to develop the program. In addition, plenty of the resources and tutorials can be found in Microsoft Developer Network (MSDN) [11]. Those features make the combination of C# and Windows favorable for the implementation of the GUI of ICU in this work. In this paper, since it is not easy to obtain complete vital/medical signals from a person, we only use artificial signals/information to show the waveforms, numbers and images in order to test the prototype GUI functions in Fig. 2. Note that Fig. 2 is the screenshot of the

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controls provide the capability of displaying various charts. Fig. 3 shows the simplified code for the radar chart display in C#. As can be seen, the radar chart type is specified for \texttt{series1.ChartType}. Accomplished with other attribute settings, the radar chart can be displayed through the C# program.

In the radar chart, the green zone and the red zone are used to specify the indicators in normal range and abnormal range, respectively. As can be seen in Fig. 2, the colors of the abnormal indicators lying on the red zone are changed to red to warn the medical staffs. For the heart and the lung indicators, the corresponding medical images are integrated with them. The thumbnails of the medical images are placed next to the radar charts. By clicking the thumbnails, one window will be popped up to show the enlarged medical image.

### III. Conclusion

In this work, a prototype human-centric GUI based on EID for the next-generation ICU is implemented. The patient’s basic information, vital signs and indicators are integrated in the prototype GUI. In addition, the GUI has the 4-channel EEG display function to provide the necessary brain monitoring for the next-generation ICU. To offer an intuitively way for the medical staffs’ situation awareness of the heart/lung/kidney indicators, the radar chart is utilized in the prototype GUI. As a result, the prototype human-centric GUI can aid the medical staffs to process the information in ICU efficiently and makes the diagnosis and medical treatments easier.

### REFERENCES


