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The QoE Oriented Synthetically Evaluation for Personal Information Achievement in WBAN

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Abstract

The design of personal information achievement for sensors in wireless body area network (WBAN) has begun to draw much attention recently. The WBAN would be widely applied in medical area, military area and the internet of thing, and the quality of experience (QoE) of users is critical for the success of the design. Among much factors, the information achievement from the display screen is important to the QoE of the Human-computer interface [1]. This paper proposes a QoE oriented synthetically evaluation approach for the personal information achievement for intelligent apparatus in WBAN, by using the multiple attribute evaluation analysis approach. The proposed approach could be applied in the complex factors scenarios, and the quantitative evaluation result could be given out [2]. The evaluation result could effectively reflect the users' QoE during achieving information from the sensor in WBAN and provide the basis for the design and optimization.

Keywords: WBAN; Quality of Experience; Apparatus Information Optimization; Multiple Attribute Evaluation; Personal Information Achievement.

Introduction

Wireless body area network (WBAN) is currently an important research hotspot [3]. It can be applied to real-time monitoring and family health care in hospitals and has wide application prospects and huge market potential. WBAN is a communication system that is placed on people's body [4]. The WBAN would be constituted by some micro sensors which can be moved. The sensors in WBAN almost could communicate with others, especially with the main station. Wireless body area network is an important method for healthy monitoring and obtaining human health signals [5]. Some typical early applies are is mainly to successive monitor and data obtaining of chronic diseases and the health data of people, in order to present a approach of automatic control therapy. Taking an illustration, if the level of insulin in diabetic people falls, the wireless body area network on his body can start a pump immediately and put in insulin for people. As a result, people could keep the insulin level without the help of doctors.

The remote wireless medical monitoring by deploying a wireless body area network in the patient's body, the various physiological parameters of medical staff need wirelessly transmitted to the monitoring instrument, which can avoid the influence of the circuit, but also solve the instrument impact on patients' space at the same time, in some specific groups, such as athletes. Can be detected by monitoring the temperature and velocity rhythm, intensity and other message, to prompt the athletes to control the intensity of training, in the invisible monitoring system also plays a role in health fitness coach [6]. With the maturity and development of technology, the wireless body area network in the future can also be widely applied to consumer electronics, entertainment, sports, environmental intelligence, animal husbandry, ubiquitous computing, military or safety and other fields. The message display of wireless body area network is an important part of human-computer interaction, and it is also the key to the user evaluation. In wireless body area network, the display screen of sensors needs to display various comprehensive message, including the body and the outside world (Figures 1-3).

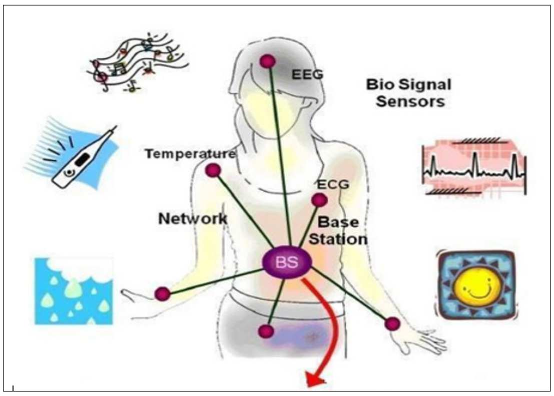

Figure 1: The Wireless Body Area Network.

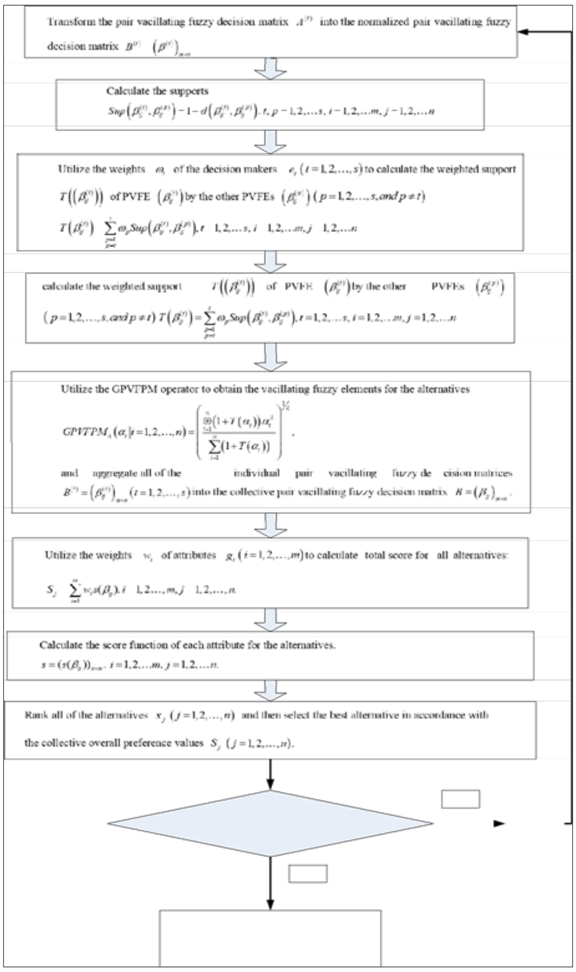

Figure 2: The Process of QoE Evaluation Based on the Fuzzy Analysis.

	H_1	H_2	H_3	H_4	Total score value
QoE_1	0.0731	0.3578	0.1309	0.2964	0.2734
QoE_2	0.5464	0.5947	0.5258	0.5023	0.5734
QoE_3	0.6489	0.5971	0.4854	0.7607	0.7105
QoE_4	-0.2121	0.4009	0.3476	-0.3522	-0.0367

Figure 3: The QoE Evaluation Result.

Note: QoE Evaluation Score.

Users need to provide key message to users as much as possible. However, limited to the size of the display screen, message display is prone to such problems as too dense message, unfriendly interface, poor user evaluation, and so on. Therefore, the scientific and rational design of wireless body area network instrument display, is an important content of the need to pay attention. With the development of the intelligent sensors, the sensors' display is more likely to combine multiple information. The problem is that the multiple information might confuse people, especially for the patients who have some diseases. With the patients, the quality of experience during obtaining information from the sensors' display is important. The speed of obtaining the information, the precision of recognizing the information and the pleasant feel in the course are all important factors. Authors in [7-8] stated that effectiveness, visibility and comfortable operation are significant for the sensors' information display. The goal of multi-factor evaluation research is to choose the best alternative from the candidate candidates, according to the evaluation of some set of experts [9].

There are many existing works about the multi-factor evaluation, and the main researches focus on the operator design and the weight optimization. Also, different multi-factor evaluation approaches have also been proposed, among which the fuzzy computing approach is an important one. Some fuzzy set definitions have been proposed in [10] for the computing method based on the fuzzy theory. Some authors made researches on some operating calculators, including the weighted geometric calculator, the weighted geometric calculator and the hybrid geometric calculator [11-15]. In reference [16], authors proposed some operating functions for different fuzzy sets. Authors in [17] presented calculators of trapezoidal intuitionistic fuzzy data, power mean calculator, the power ordered weighted mean calculator. In this paper, we proposed the QoE oriented synthetical evaluation method for the people's information obtaining for sensors in wireless body area network. We use the fuzzy analysis for the evaluation of people's information obtaining. The main character of this approach is that multiple factors of different users would be taken into consideration, and the analysis would be quantitative. The data analysis result shows that the presented method can effective evaluation people's QoE and give the proper direction of the display design.

The Fuzzy Evaluation Approach

In this part, the fuzzy analysis to solve the QoE oriented display design would be proposed. According to some fuzzy analysis from existing works [11-16], we propose the following definitions:

Definition 1: Supposing $f:[0,1]x[0,1] \Rightarrow [0,1]$ meets rules:

1) f (0, m)=m
2) f (m, n)=f (n, m).
3) f (m, f (n, k))= f(m, n),k).
4) If $m \le m'$ and $n \le n'$, then $F(m,n) \le F(m',n')$.

For two pair indecisive fuzzy sets (PVFEs) γ_1 and γ_2, the distance $D(\gamma_1,\gamma_2)$, would meet the following rule:

1) $0 \le D(\gamma_1,\gamma_2) \le 1$;
2) $D(\gamma_1,\gamma_2)=0$ if only if $\gamma_1=\gamma_2$;
3) $D(\gamma_1,\gamma_2)=D(\gamma_2,\gamma_1)$.

Supposing α_1 and α_2 two PVFEs:

$$(1)\alpha_1 \oplus \alpha_2 = \{U_{\gamma_{\alpha1}\in h_{\alpha1},\gamma_{\alpha2}\in h_{\alpha2}}\{\frac{\gamma_{\alpha1}+\gamma_{\alpha2}}{1+\gamma_{\alpha1}\gamma_{\alpha2}}\},U_{\eta_{\alpha1}\in g_{\alpha1},\eta_{\alpha2}\in g_{\alpha2}}\{\frac{\eta_{\alpha1}\eta_{\alpha2}}{1-(1-\eta_{\alpha1})(1-\eta_{\alpha2})}\}\};$$

$$(2)\alpha_1 \otimes \alpha_2 = \{U_{\gamma_{\alpha1}\in h_{\alpha1},\gamma_{\alpha2}\in h_{\alpha2}}\{\frac{\gamma_{\alpha1}\gamma_{\alpha2}}{1-(1-\gamma_{\alpha1})(1-\gamma_{\alpha2})}\},U_{\eta_{\alpha1}\in g_{\alpha1},\eta_{\alpha2}\in g_{\alpha2}}\{\frac{\eta_{\alpha1}+\eta_{\alpha2}}{1+\eta_{\alpha1}\eta_{\alpha2}}\}\};$$

$$(3)n\alpha = \{U_{\gamma_\alpha \in h_\alpha}\{\frac{(1+\gamma_\alpha)^n-(1-\gamma_\alpha)^n}{(1+\gamma_\alpha)^n-(1-\gamma_\alpha)^n}\}, U_{\eta_\alpha \in g_\alpha}\{\frac{2\eta_\alpha}{(2-\eta_\alpha)^n+\eta^n{}_\alpha}\}\};$$

$$(4)\alpha^n = \{U_{\gamma_\alpha \in h_\alpha}\{\frac{2\gamma_\alpha}{(2-\gamma_\alpha)^n+\gamma^n{}_\alpha}\}, U_{\eta_\alpha \in g_\alpha}\{\frac{(1+\eta_\alpha)^n-(1-\eta_\alpha)^n}{(1+\eta_\alpha)^n+(1-\eta_\alpha)^n}\}\}.$$

Definition 2: Supposing $\pi_i = \{h_{\pi_i}, g_{\pi_i}\}(i=1,2,...,n)$ are PVFEs, define the computing as follow:

$$GPVFPM_\lambda(\alpha_i \backslash i=1,2,...,n) = \left[\frac{\bigoplus_{i=1}^{n}(1+T(\alpha_i))\alpha_i^\lambda}{\sum_{i=1}^{n}(1+T(\alpha_i))}\right], \quad (19)$$

By using the proposed pair indecisive fuzzy power integration calculators, we could develop approaches to evaluation the information achievement: A={a_1,a_2, ..., a_3} let denotes the different candidates which would be evaluated, H= {h_1,h_2, ...,h_m} denoted the focused factors which would place effect on the evaluation. The different weights' value would be descripted by, $\varpi = (\varpi_1, \varpi_2, ..., \varpi_m)^T$, where $\varpi_i \in [0,1]$ for i=1,2, ...,m and $\sum_{i=1}^{m}\varpi_i = 1$. Let $V = \{v_1, v_2, ..., v_s\}$ denoted the evaluators which would show their own evaluations. Certainly, with different background and knowledge, the evaluation weights of different evaluators would also be different, which would be descripted by $\zeta = (\zeta_1, \zeta_2, ..., \zeta_s)^T$, where $\zeta_1 \in [0,1]$ for t=1,2, ...,s, and $\sum_{t=1}^{s}\zeta_t = 1$. Denote $\Delta^{(t)} = (\beta_{ij}^{(t)})$ as an pair indecisive fuzzy matrix. Denote $\rho_{ij}^{(t)} = \{\{\theta_{\alpha_{ij}^{(t)}}\}, \{g_{\alpha_{ij}^{(t)}}\}\} = \{\{\underset{\gamma_{\alpha_{ij}^{(t)}} \in h_{\alpha_{ij}^{(t)}}}{U}(\gamma_{\alpha_{ij}^{(t)}})\}, \{\underset{\eta_{\alpha_{ij}^{(t)}} \in h_{\alpha_{ij}^{(t)}}}{U}(\eta_{\alpha_{ij}^{(t)}})\}\}$ as the factor value provided by the evaluator v_t, where descripts the extend that the alternative a_j satisfies the factor θ_i, while $\{\underset{\eta_{\alpha_{ij}^{(t)}} \in g_{\alpha_{ij}^{(t)}}}{U}(\eta_{\alpha_{ij}^{(t)}})\}$ descripts the extend that the alternative a_j opposes the factor g_i. When the evaluators' evaluation values are obtained, the evaluation matrix $\Delta^{(t)} = (\rho_{ij}^{(t)})_{m\times n}$ could be computed. The proposed QoE oriented synthetically evaluation approach is shown as follow.

Experiment and Result Analysis

In the experiment, we consider the medical instruments' display design, by considering the QoE of different users. The qualification of evaluation with different persons would vary according to the users' preferences. For example, the size of word would be important for some old people, but the dense of message may be more important for young persons. We make the experiment to show that we could make reasonable evaluation according to the choose of different kinds of people with our approach, by considering multiple factors. Define the standard for the QoE evaluation as: number of pages, size of word, dense of message, and cost. Importantly, if the peoples' request vary, the reasonable information display would also vary. In the experiment, we make

the evaluation on four different designs a_i(i=1,2,3,4). Three users' evaluations v_i(i=1,2,3) would be used to make the evaluation at last. The weight value between different evaluators would be set as ζ = (0.4,0.2,0.4)^T. We consider four factors:

(1) number of pages, denoted as (H_1), the less the pages, the more valuable it is;

(2) size of word, denoted as (H_2) measures the facility.

(3) dense of message, denoted as (H_3), measures the capability of message acquisition.

(4) Price refers to a design's cost (H_4).

The weight vector of the factors is ϖ = (0.14,0.27,0.25,0.34)^T. The evaluator value v_k(k=1,2,3) evaluate the design a_i(i=1,2,3,4) The evaluation would be made from different aspect of f a c - tors H_j(j=1,2,3,4), and make the indecisive fuzzy evaluation matrices $\Delta_k = (\beta_{ij}^k)_{4\times4}(k=1,2,3)$. The $\Delta_k = (\beta_{ij}^k)_{4\times4}(k=1,2,3)$ could be transformed into $R_k = (r_{ij}^k)_{4\times4}(k=1,2,3)$. Firstly, we compute the supports as follow: $Sup(r_{ij}^k, r_{ij}^t) = 1 - D(r_{ij}^k, r_{ij}^t), i, j = 1,2,3,4, k, t = 1,2,3$; Secondly, we compute the weighted support $T(r_{ij}^{(k)})$ of PVFE $r_{ij}^{(k)}$. Thirdly, we compute the weights of PVFE $r_{ij}^{(k)}$. Fourthly, we apply the calculator to aggregate all of the $R^{(k)} = (r_{ij}^{(k)})_{4\times4}(k=1,2,3)$ with evaluation matrix $R = (r_{ij})_{4\times4}(k=1,2,3)$. Fifthly, we compute the value of r_{ij} and aggregate all of the score function to form the QoE value. From the fuzzy analysis QoE score, it is shown that the more reasonable design would be the third one.

Conclusion

Wireless body area network can be applied to real-time monitoring and family health care in hospitals and has wide application prospects and huge market potential. In this paper, we focus on the message acquires from the sensors' display, to direction the design. We provided the QoE oriented evaluation approach by using the fuzzy analysis for the assessment. The main character of this approach is that multiple factors of different users would be taken into consideration, and the analysis would be quantitative. We show an experiment example to verify the provided approach's resonation. With the provided approach, the sensors' information display could be evaluated by multiple people and the total evaluation could be computed. The information display design could be directed by the precisely data analysis.

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