A **Development of Human Emotion Interaction Platform in Smart Environments**

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Abstract. The emotion UX technology is user's interaction technology augmented recognition and response for services from the user perspective to maximize the value of services which includes user's subjective experience, emotion, intent and use, convenience, and efficiency etc. In order to implement the emotion UX technology, it is necessary that analyzing the change in physiological variables due to a variety of changes in circumstances and reprocessing services by recognizing the user's emotional state. In this paper, we developed the algorithm of the multimodal emotion reasoning regarding the user's internal physiological variables and external environmental variables in mobile environments, and then implemented the mobile devices embedded the emotion reasoning engine which consists of the FPGA Chip and software modules, hardware platform mounted the function management and application software for functional verification.

Keywords: human emotion, multimodal human-computer interaction, affective computing, emotion reasoning engine, emotive mobile services

1 Introduction

By the advent of smart times, HCI(Human-computer interaction) research is accelerated, particularly various attempts are being made for the development of emotion UX(User eXperience) services that provide customized services through the medium of a cognition and emotion in terms of the interaction between human and computer. This field of HCI has recently witnessed an explosion of adaptive and customizable human-computer interfaces which use cognitive user modeling, for example, to extract and represent an user's knowledge, skills, and goals, to help users find information in hypermedia applications, or to tailor information presentation to the user[1]. The emotion UX technology is user's interaction technology augmented recognition and response for services from the user perspective to maximize the value of services which includes user's subjective experience, emotion, intent and use, convenience, and efficiency etc. In order to implement the emotion UX technology, it

is necessary that analyzing the change in physiological variables due to a variety of changes in circumstances and reprocessing services by recognizing the user's emotional state. And then by providing emotion's services to user, customized services are also available.

In this paper, we describe the development of the emotion reasoning engine supported multimodal interface based on mobile environments, which is the core technology of emotion UX technology. We developed the algorithm of the multimodal emotion reasoning regarding the user's internal physiological variables and external environmental variables in mobile environments, and then implemented the mobile devices embedded the emotion reasoning engine which consists of the FPGA Chip and software modules, hardware platform mounted the function management and application software for functional verification.

2 A human emotion interaction platform 2.1 A

Classification of Rule Based Set based on THI

In order to extract human emotions, the proposed multimodal emotion reasoning model calculated the current temperature and humidity index using the external environmental conditions of temperature, relative humidity for extracting human emotions, adapted the emotion recognition model to two-dimensional states(pleasant-unpleasant, arousal-relaxation) due to the environmental context information based on THI[2,3].

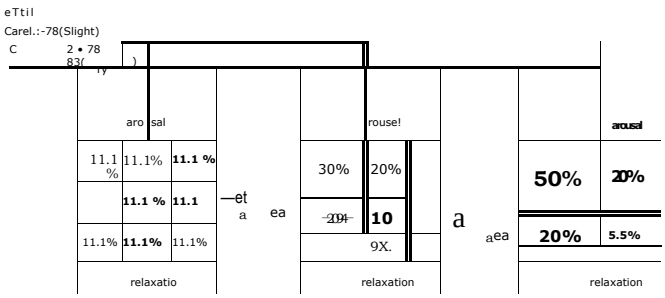

Fig.l. Classification of Rule Base Set based on THI

As shown in Fig. 1., we used the temperature and humidity index for indexing a temperature and relative humidity, and then classified into three kinds of rule base tables. When THI index less than or equal to 78, we applied the rule base table without weights for unpleasant and arousal because of being affected by slight heat stress. When THI index from 78 to 89, we applied the rule base table weights of 30% for unpleasant and arousal because of being affected by severe heat stress. And when THI greater then 89, the 50% level of unpleasant and arousal with the weight of the rule base is applied because very severe heat stress is affected by it. So depending on the level of the external environment variables, we applied case-by-rule base and then proposed the method which is able to be measured accurately the changes of the user's emotional state.

2.2 Architecture of the multimodal emotional reasoning engine

The presented emotional reasoning engine based on mobile user situation is based a context-aware and multimodal emotional reasoning model taking into account the internal physiological variables(SKT, GSR, PPG, Movement) and the external environment variables(Temperature, Humidity, illumination). To ensure that the reproduction of your illustrations is of a reasonable quality, we advise against the use of shading. The contrast should be as pronounced as possible. We adopted the obtained environment information from the user space and time, the physiological variables(SKT, PPG, GSR, HR, HRV), USN sensing nodes as a multimodal elements [3 ,4]

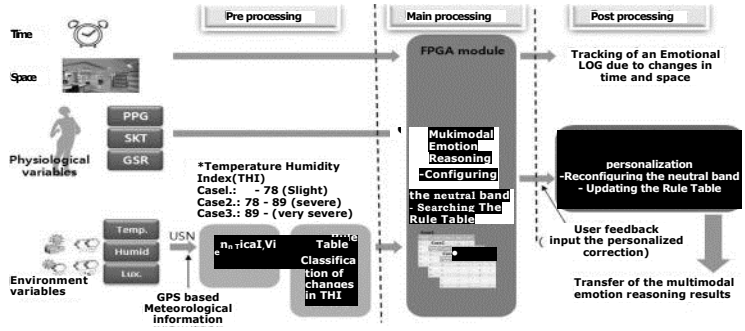

Fig. 2. Architecture of the multimodal emotion reasoning engine

The proposed multimodal emotional reasoning model takes the characteristics, **which is integrated the multimodal emotional signals adaptively** and performed the **emotional reasoning using the internal and external context** information of mobile **users. It is used the environment context information and** physiological signals of **mobile users for the multimodal emotional reasoning. Time** information is derived the **time by requesting a multimodal emotional reasoning on** the top of the emotion **content services in real time, and then it used as data for** analysis of the emotional **change timely. Space information means the spatial location** of the current user. If **indoor, it is determined by ID of USN sensor node for** recognizing environmental **conditions, and if outdoor, it uses the GPS information of** emotional reasoning **HW devices. The environmental information makes use of temperature,** humidity, and **illumination, which is obtained through USN sensing nodes.** As shown in Fig. 2., we **were composed of three blocks for developing multimodal** emotional reasoning **platform based on the above-mentioned information; pre** processing block, main **processing block, and post processing block.**

Pre processing block has the ability to select the Rule base tables based on **environmental variables, main processing block has the** ability to process the **multimodal emotion reasoning for extracting human emotions** with physiological **variables, and post processing block has the functionality** to process the accumulation **of emotional LOG, reconfiguration of the neutral band, and** updating the rule base **table for personalizing.**

3 **Implementing the human emotion interaction platform**

We implemented the multimodal emotional reasoning engine based on the above proposed core modules by extracting human emotions. To implement this chip, we implemented it into the FPGA, verified the functionality of the multimodal reasoning engine through the functionality and integration testing.

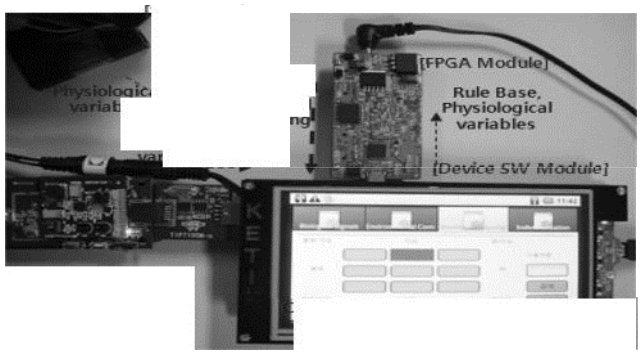

Fig. 3. Implementing of the multimodal emotion reasoning engine

For the functional verification of the multimodal emotional reasoning engine, we performed the functionality and integration testing through wireless interfaces, Bluetooth and WiFi, between sensing device for extracting physiological variables and smart device embedded the emotional UI framework. The integration test is equivalent to Fig. 3., and the checklist for the main works set the communication interface between devices, Bluetooth-based real-time bio-signal acquisition, the display of the multimodal emotional reasoning results, and transfer the results deduced to the device equipped with the emotional UI framework.

As shown in Fig. 4., we implemented the application to verify the results of reasoning and displayed for the functional verification of the multimodal emotional reasoning engine, and we expressed it was all on one screen that a temporal and spatial information, external environmental variables, and the user's physiological variables. Especially, we have improved the intuitive for identifying the user's emotional state by expressing as an icon by a user's emotional state. We designed and implemented GUI as shown below Fig. 4 for providing various emotion services and supporting various functionality. We implemented to blink our emotional state of nine regions according to the inferred state domain and perform the subjective emotional evaluation via the touch screen depending on the user's emotional state. If touch screen events does not occur for a period of time, this system recognizes that there is no user feedback, and then it is currently considered to be satisfied with the results of emotional reasoning. If the user's subjective evaluation of the results derive do not match, it is feedback the area of user's emotional states on the touch screen, and then by sending the feedback value to the FPGA module, we implemented the personalized functionality of sub-software modules, which process updating the rule base table and setting the min/max value for individual users.

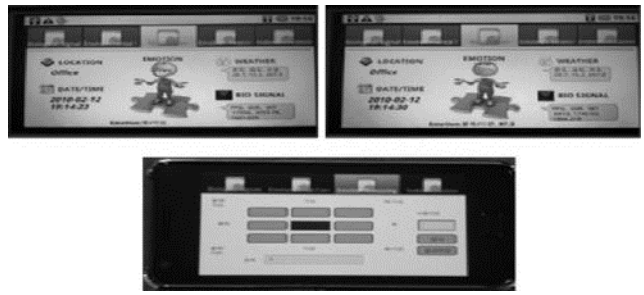

Fig. 4. Results of the multimodal emotion reasoning engine

4 Acknowledgments

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5 Conclusions and Future Works

In this paper, we developed the algorithm of the multimodal emotion reasoning regarding the user's internal physiological variables and external environmental variables in mobile environments, and then implemented the mobile devices embedded the emotion reasoning engine which consists of the FPGA Chip and software modules, hardware platform mounted the function management and application software for functional verification.

Recently, we are implementing the chipset embedded the emotional reasoning engine and have developed a variety of emotional services. Future, through the development of this technology, we are expected to be developed the emotional UX services by applying to products with a vested interest in Korea such as mobile devices, smart appliances, next-generation PC, and display products.

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