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Wearable Sensitive Human-Robot Interaction using Raspberry-Pi

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***Abstract*: This paper will provide a better service at both input and output of some of the applications like as we proposed for library system. Initially, the user will be give some voice input which they needed to recognize and input voice is converted into text format. The input image which is captured by web camera, it will be converted to text using raspberry pi. The pi will be having the database of all the details of books in this system. The database in which image will be converted to text in raspberry pi controller. After getting input from the user, the controller will be checking the input with its database, if both the input text and camera text are equal in matching, then the processor will automate by developing the robot mechanism with the help of motor driver which will able to find out the book and then pick and place it to the user. If not matches, it will through an error indication. Human-robot cooperation experiments are performed where the robot senses the affective state of the human and responds appropriately.**

***Keywords*: Raspberry-pi, Human-Robot Interaction, Wireless system, Affective sense.**

1. Introduction

The main focus of this paper is on human-robot coordination based on implicit communication from human to robot. Implicit communication, in the context of this paper, is defined primarily as affective communication where the affective state of the person is interpreted by the robot. We include implicit states such as frustration, anxiety and fatigue within the domain of affective states. Such a capability, alone or in conjunction with other capabilities that allow explicit instructions from a human, is expected to provide a new paradigm for human-computer (and human-robot) interaction that will be intuitive, smooth and efficient. The capability of the robot to alter its autonomy level (or in some cases, task priority) based on human interaction is another hallmark of

A successful human-centred robotic system. Consider several human-robot exploration scenarios in space, underwater, Antarctica, inside a dormant volcano and in other similar risky. Environments where a human can often encounter dangerous situations. A robot that is capable of sensing these internal psychological states can immediately take meaningful actions to help the person. A similar situation may arise in human-robot search and rescue operations or in firefighting. Robotic aid for rehabilitation could also use affect-sensing capability to provide exercise sequences that are comfortable for the person. All these potential applications will eventually lead to the development of personal robots, which will act as understanding companions of humans in the future The physiological signals from the human engaged in some task, are recorded. These signals are then processed to determine the affective state of the human. The affective state information along with other environmental inputs is used to decide the next course of action. The controller instructs the robot to perform the desired action. The human who is working in cooperation with the robot is influenced by the robot's action. In other words, the more human-like a robot is, the stronger emotional response we will have to it. The intelligent robots are mainly divided into social robots, affective robots, and wearable robots. Combining a traditional service robot with a virtual assistant, a social robot, which has the ability to imitate one or multiple cognitive competencies, such as natural language interaction, is created. The traditional social robot is a type of the social robots. Through a mobile application, it can interact with humans and other robots [1].

Due to the growing aged population coupled with limited medical facilities and healthcare in most developing countries, the traditional healthcare system meets challenging problems caused by its high operating cost and unscalability. Compared to the conventional healthcare system, a wearable computing-based solution is advantageous in many ways by upgrading the healthcare model from the traditional on-spot mode to in-home mode [2].

Most contemporary affective computing prototypes, however, make use of inflexible sensors, and still tether the user to their computers in an unnatural, obtrusive manner. Lack of comfortable, unobtrusive physiological sensors has limited widespread use of affect-sensitive systems. However, recent advances in the field of wearable technology can facilitate monitoring physiological signals in real life settings over extended periods of time [3].

The utilization of such digital conversations from the hand activity and gestures can go beyond human communication interfaces by involving robotic assistance that can be operated on the effective classification of gestures without fault.

However, controlling robots technologically advanced equipment, poses a great demand of clarity in given commands since there involves complex interfaces and is not user-friendly.

The proposed experiment was carried out using a system that we introducing a voice input for the following steps has to be followed to interact in some of the applications we specifically addressed the system such as library system such as Library has many connotations, it is a collection of information resources and services, organized for use and maintained by a public, institution or private individual. Typically, there is a need of librarian to pick the book and handover it to the person. This might be easy task in case the library is small. Also, to search for the books by humans take a lot of time as many a times the books gets overlooked the human eye and it gets more difficult to do the task. Recently, the idea of using robots in library application has become more interesting. Book picking robot is a service robot which perform tasks such as book finding, picking and delivering it to the reader.

2. Related work

[1] Affective Recognition Algorithm based on AIWAC Smart Box. The AIWAC smart box in a Fitbot has the ability of accurate voice affective cognition. Through daily voice interactions with a user, a Fitbot collects user's voice data and realizes voice affective analysis by using the attention based recurrent neural network algorithm. A recurrent neural network (RNN) can effectively remember the relevant feature information in a long context. By introducing an attention mechanism into the RNN algorithm framework, a new weight pooling strategy is introduced into the network, which puts special attention on the part expressing strong affective characteristics of the voice [2].

User Behaviour Perception Based on Brain Wearable Device: The brain wearable device can realize the perception of user's subtle expression change. On the one hand, the detection of these subtle behaviors enables the perception and analysis of user's behavior patterns; on the other hand, some high-efficiency human-computer interaction patterns may be perceived by virtue of these accurate behaviors.The perception of user behaviors by a brain wearable device can be introduced by a blink detection example. We design an algorithm to realize such a detection [2].

Algorithm: Realization of blink detection based on the amplitude difference. The general process of Algorithm 1 is to determine the first order difference in the original EGG signal, then, the amplitude smoothing is performed, and lastly, the judgment on the smoothing result is conducted. The Algorithm 1 uses the time-domain data and draws the signal waveform wherein it can be seen that such a signal experiences a significant amplitude changes during the blinking, which can be directly used to judge whether a user blinks or not. First, the first order difference in the original signal is determined to obtain the change rate information of the time-domain signal. To amplify the peak feature, the amplitude smoothing is used [2].

[2] Physiological Indices for Affect Recognition: There is good evidence that the physiological activity associated with affective state is differentiated and systematically organized. The transition from one affective state to another, for instance from a relaxed to anxious mental state, is accompanied by dynamic shifts in physiological activities. By combining these multiple indicators of emotion in a multivariate manner, we will be able to provide the affect recognizers we will be developing with a rich array of information from which to infer the person's affective state. In our paper we have achieved the more challenging task of identifying the person's affective state online while the person is actively engaged in a task and then designing a robot a controller that is sensitive to human affect.

Affect Recognition: Our next step was to design a robust and reliable decision making system that could take in all the values of the physiological parameters and generate an anxiety index. This index would then be used to infer the state of the human companion. Several techniques were investigated for this purpose. A series of tasks involving sensory-motor coordination was designed for the human companion. These included anagram solving, mathematical problem solving and auditory discrimination tasks. Using these experiments initially, we obtained pilot data to design and train a 5-input 1-output fuzzy logic system.

Input set = $\{S_p, P_p, T_m, P_r, C_m\}$, Output set = $\{\textit{anxiety index}\}$

The membership functions used: Gaussian or sigmoidal (depending upon the kind of variation these variables showed with the change in affective state.) The experimental results coupled with the self-reports of the human companion as well as the vast research that has been done in the field of psychophysiological analysis was used to formulate a set of rules for this fuzzy system.

[3] Wireless wearable set of physiological sensors designed for affect-sensing applications. This device can measure either heart rate or SC, as well as environmental temperature and physical activity. In the version of iCalm which measures SC, instead of typical metal electrodes, conductive fabrics have been used. Conductive material facilitates comfortable integration of the electronic parts and the sensing circuitry into various wearable garments such as a wrist band, ankle sensor band, or sock [3].

[4] *Real-time analysis:*

Due to the dynamics of the affective state and behavior of human beings, the effective value of emotional data tends to attenuate over time; hence, real-time data processing and analysis are needed to accurately extract value from changing emotions. Obviously, traditional affective computing can no longer meet these challenges for computation-intensive sentiment analysis and emotional interaction [2]. Emotion monitoring for a long-term closed environment: Scientists working on deep-sea exploration and space exploration, as well as other specific areas, need to stay in a closed environment over a long period of time, running a high risk of emotional turmoil. Monitoring their emotions efficiently is beneficial for the successful completion of their tasks.

Affective disorder assistance: For example, people suffering from social autism with the shadow of social phobia can be assisted via sensing their abnormal mental states. Rehabilitation aids: For patients who have just been discharged from hospital and are suffering from both physical and psychological pressure, personalized rehabilitation strategies based on physical information and emotional status can help them to recover faster with higher efficiency.

3. Architecture

This has to be intends to build a new-generation intelligent emotion interactive system based on wearable devices, cloud computing, and big data to provide users with healthcare in both physiological and psychological aspects as shown in Fig 1.

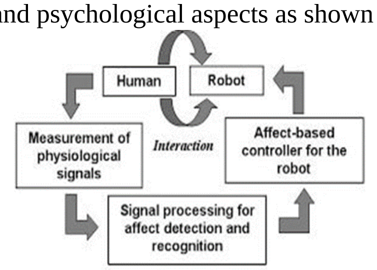

Fig. 1. Architecture for Human-Robot cooperation system

The acquisition module is used to collect physiological data, while the transmission module is responsible for sending collected data to the sink node and receiving control signals. When the user is emotionally stable, only a few devices are activated to collect the key physiological data and monitor a user's emotional changes. Once a user's emotion fluctuates, the emotional weak deduction receiving layer sends a control signal to the wearable device layer and activates related devices for collaboratively collecting more data in order to improve the accuracy of sentiment analysis, or deactivates unrelated devices in order to save energy [1].

A. Affect-sensitive control architecture

We aimed at designing a behavior-based architecture for a mobile robot system working with a human companion in an unknown environment. In this case the robot was expected to behave as another human to its human companion.

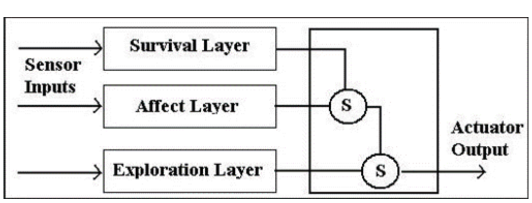

Fig. 2. Affect-Sensitive Control Architecture

We have used subsumption architecture to execute these tasks in a priority-based manner, allowing one behavior to be executed at a time. Fig. 2 shows that in the absence of any affective signals from its human companion and any danger-to-robot signals, the robot remains in the wandering or the exploratory mode, moving around and navigating the workspace. This system helps us to do the work efficiently and quickly. It saves time and this system addressed with the controlled system i.e., raspberry pi. With the help of voice input the robot moves and to help human.

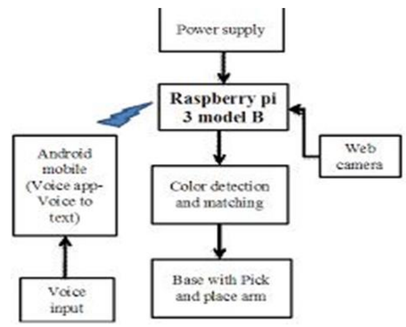

Fig. 3. Design of voice controlled system Model

A user's emotional trends are dedicated in real time through emotional data analysis. Once a user's emotion fluctuates, weak deduction is enabled based on the existing emotional model to determine which devices are indispensable for data acquisition. Fig.3 shows that similarly, if the user is emotionally stabilized, unrelated devices are deactivated. The design of voice controlled mechanism of wearable devices is as shown in Fig 3.

In particular, the core of this layer consists of the following components.

- *Vitals model:* According to a user's physiological and psychological information in different emotions, a personalized vitals model is established for extracting features to provide a reasoning machine with support.
- *Reasoning machine:* Once the reasoning machine receives physiological and psychological data fluctuation, it immediately deduces appropriate user emotional change based on the vitals model and pushes the result to the weak result receiver.
- *Weak result receiver:* The weak result receiver activates some wearable devices to collect essential data for accurate affective computing and de activates other unnecessary devices to save energy.

The single type of emotional data may be physiological data, social emotional data, facial video contents, or another type, which are typically collected in an isolated data space. Given the shortcoming of isolated data space oriented sentiment analysis, we consider the multidimensional affective data collected in CPS-Spaces.

4. Methodologies and Modules

A. Characteristics of wearable affective robot

Intelligence and Autonomy: A real intelligent robot should have the intelligence and autonomy and should be able to refuse an unhealthy or an immoral request from a user. For instance, if a user requests from an affective robot to buy a junk food, the affective robot should refuse that request and explain the harmful effects resulting from the consumption of such a junk food, which will promote the establishment of trust between the affective robot and user, and improve the health surveillance effect on the user.

Comfort and Portability: The entity robot other than the virtual robot basically has limited movement ability, so it can accompany user with a space limitation. Its operation scenes are limited, and a user is often required to spend extra care to carry or maintain such an interactive robot. By virtue of the Wearable 2.0, a Fitbot is integrated into a wearable device in a natural way. The robot accompanies a user as a part of user's clothes, providing good portability to the robot. Meanwhile, a Fitbot provides convenient and various human-computer interaction modes, which make the user have good comfort.

B. Diversified human-computer interaction:

Current social robots are mainly based on voice interaction, while a Fitbot conveniently integrates tactile interaction on the basis of voice interaction, which expands the form of human-computer interaction, and provides available human-computer interaction means for some specific groups (such as the deaf-mute). Context Awareness and Personalized Tracking Service: The collection of context data is conducive to the personalized services for a user. Generally, users having the social affective robots are also equipped with a smartphone. The context awareness data collected by a smartphone is closely related to a user and applies only to himself. A Fitbot can collect the context awareness data from the third-person (spectator) perspective, and can achieve more accurate identification of user activities. Such user data can be shared with multiple users such as family members or friends who are in the same room. In addition, an affective robot can collect data from the first person perspective and communicate with others on behalf of a user.

C. Application range

On the basis of the affective recognition and interaction, a Fitbot imitates human behaviors and interacts with users through the voice interface.

Model Evolution — Analysis and prediction results are verified using social network data, which further enhance the accuracy of the existing model. In addition, data with the time-space label can be updated to the existing tensor model to enhance its accuracy. Thus, we need to efficiently manage the network resources and elaborately design the data processing method.

Emotion-driven available resources perception and allocation: Since a user's emotions are affected by many factors, the data should be collected as broadly as possible by wearable devices in order to make a timely and accurate judgment. Furthermore, it is challenging to evaluate which kind of data is useful for sentiment analysis. Theory and method of dynamic controllable emotional interaction: A user's physical location usually dynamically changes, but carriers (PC, mobile device, home appliance, robot, etc.) and media (image, audio, lighting, etc.) used for emotional interaction are relatively static. Results of sentiment analysis are fed back to the user for emotional interaction with the user by perceiving any available multimedia devices around the user. Intelligence reinforcement theory and method based on an upright walking robot: For humanized and intelligent feedback, emotional interaction should have affinity. With the accurate analysis and prediction of a user's emotions, a variety of humanized ways for emotional interaction will directly affect the user's experience. We intend to build an intelligent upright-walking robot by integrating interdisciplinary study results in many fields. With high bio fidelity, the robot carries multiple sensors that can collaborate work together with other smart devices to sense environmental information. The robot will become one of the most intimate, emotionally dependable front-end carriers for emotional interaction with people.

5. Conclusion

We proposed an innovative theoretical, computational and experimental approach drawing from emerging results from affective computing, psychology, and advanced control theory to develop a human-robot interaction framework that is affect-sensitive and is capable of addressing affective need. We have demonstrated through experiments an implicit communication between a human and robot wherein the robot detects and prompted the robot to take corrective actions would be the next big step towards an advanced level of human-robot interaction. The design of this project tends to help the users and more efficient. It is flexible and have the appropriate design. They increase the safety of the working environment and actually never get tired of doing all the things.

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