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Emotional Assistants for Applications

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ABSTRACT

This disclosure describes techniques that provide appropriate emotional responses to users of computing devices, irrespective of the specific interaction context. The techniques can be implemented as an emotional module that is called by an application. In response, the emotional module provides an appropriate response that the application renders. The techniques can learn from various sources of interaction data, such as books, movies, chats etc. and from user behavior after an emotional response is rendered. The techniques generate a database of emotions and appropriate computer responses. The techniques enable computers to provide effective emotional responses and improve human-computer interaction. The techniques can also be used to train certain users, such as autistic children, to understand human emotions.

KEYWORDS

- affective computing
- emotional response
- emotional assistant
- human-computer interaction

BACKGROUND

Users spend substantial time interacting with various applications on their computing devices, such as wearable devices, phones, tablets, computers etc. However, a lot of the user interaction does not include emotional aspects and is not tailored to an individual, which can lead to user frustration. For example, users may perceive interaction with an emotionless computer as unnatural and limiting. Certain users, e.g., autistic children who spend a lot of time interacting with computers, have a need to improve emotional perception.

There are some examples of attempts to provide natural interaction between users and computing devices. Such examples include personal assistants, e.g., assistants that permit users to talk to a computing device as if the assistant software were a person. The assistant software interprets user input and attempts to respond in a manner designed to make the

interaction almost human. Other examples include robotic pets that include sensors and act similar to a pet that learns commands and wants attention. There have also been cars that include tails designed to express emotions similar to pet dogs, e.g., when an owner approaches the car.

However, none of these examples provide a generic mechanism that third party application can use to provide natural interaction.

DESCRIPTION

System Architecture

Fig. 1 shows an example environment in which natural interaction between humans and computing devices is implemented. User computing devices, such as devices 110a, 110b… 110n are shown coupled to a network (190). One or more servers (100) are coupled to the network. The server includes a database (102) and an emotional module (178a).

An example computing device (110a) is illustrated in detail in Fig. 1. The computing device includes a processor (120), storage (130), one or more biometric sensors (140), I/O interface (150), network interface (160), and memory (170) that are coupled to each other over a system bus (180).

When the computing device is in operation, the memory includes one or more third-party applications (171), an operating system (172) and an emotional module (178b). The emotional module includes a biometric module (173), a profile module (174), a learning module (175), and a feedback module (176). The storage (130) includes user profile (132). The user profile includes emotional settings that allow users to specify a level of emotional response for the computing device to provide. While Fig. 1 shows a client-server environment, the techniques described here can be implemented in other configurations. For example, in different implementations, the emotional module is implemented on the user computing device, on the server, or on both the user computing device and the server.

Emotional Module

The emotional module is responsible to interpret user input and provide appropriate emotional output. In different implementations, the emotional module includes one or more modules that perform various functions.

- Biometric Module: The biometric module utilizes data from the biometric sensors and/ or the I/O interface to detect and understand user emotions in the process of interaction of a user with the computing device. User consent is obtained to collect and utilize biometric data of the user. Biometric sensors can include, for example, stress or mood sensors, voice sensor, a camera that captures facial expression and eye movements, sweat sensors, heart rate sensors, etc. The biometric module provides detection of user behavioral biometrics and permit understanding of user behavioral patterns.
- Profile Module: The profile module analyzes and maintains user profile data. The user profile includes various factors that can be utilized by the emotional module, upon user consent. For example, such factors include age, education, history (e.g., interaction history), preferences, language/ dialect, cultural background, etc. In some examples, the profile module can receive such data from the biometric module, as the user interacts with the computing device.
- Learning Module: The learning module learns how users react in various situations. The learning module imitates elements of human behavior in the interaction between the computing device and the user. The learning module is trained to produce effective emotional responses from the computing device. Such responses enable the users to, for example, relieve stress, reduce aggregation, calm down, laugh, or concentrate on a particular task.
- Feedback Module: The feedback module analyzes data from biometric sensors and/or I/O interface, e.g., after a particular response is output to the user by the computing device. The learning module detects the success level of the interaction, e.g., whether the emotional response was viewed as positive by the user. Such data is fed back, e.g., to the learning module. This enables the emotional module to learn appropriate responses based on cross-user data and can be effective in helping improve the generated response.

Implementation of Emotional Module

- Data collection: The emotional module implements machine learning techniques to improve emotional responses. Machine learning techniques are applied to learn from various data sources, such as talk shows, movies, books, or upon user consent, chat transcripts. Figs. 2A-2B show examples of such data collection. As a result of

learning, different words, phrases, or tags are associated with different emotions. Additionally, when users provide consent, the emotional module collects data on user biometrics at a time when an emotional response is output.

- Chat: If users consent to use of the information, data on phone conversations and/ or text messages and chat is utilized. Chat phrases and emoticons are associated with the biometrics data timed with these phrases. Fig. 2A shows an example transcript and the extracted emotion data.
- Books: Written conversations from books are parsed to identify different phrases, and corresponding character descriptions are parsed to associate the phrases with different emotions. Fig. 2B shows an example of a book and the extracted emotion data.
- Movies/ shows: Transcripts of movies and television shows are analyzed in combination with visual and audio clues to determine different phrases and corresponding human emotions.

The data is used to generate or update couplings of various biometric data values with various phrases or emotional responses. Different couplings are linked to each other which permits the emotional module to identify various emotional responses suitable for a particular user context. In some implementations, sequences of phrases and biometrics that lead to effective emotional response are identified.

- Indexing: Pairs of phrases and biometrics are tagged with associated emotions. The pairs are indexed based on words, biometric data values, and emotions, for easy access. For example, such pairs may be stored in database (102) in the server, or in the computing device. Fig. 3 shows examples of such pairs.
- Initialization: The emotional module receives a list of events from an application or third party. The list and/or the emotional module associates the events with words, phrases, or tags.
- Retrieval: The third party application generates an event and invokes the emotional module by sending event data. The emotional module determines an appropriate response based on the event, tag, and user biometrics, e.g., by looking for a match in the database. In some examples, the emotional module identifies multiple responses, and selects one randomly, e.g., to explore the effectiveness of various responses. The

emotional module sends the selected emotional response to the third party application, which renders the emotion.

Provision of emotional response by an application

In operation, the emotional module offers an interface for the operating system and/or the third-party applications to exchange information with the emotional module. For example, such an interface can be an application programming interface (API).

As the user engages in interaction with the computing device, e.g., uses a third party application, the application recognizes a context in which it needs to provide an emotional response to the user. In some examples, the application initializes the emotional module. The application calls the emotional module with contextual information about the interaction. The information provided can include a user identifier, emotional rules, and output configuration. For example, the user identifier permits the emotional module to retrieve user profile information from the storage. The output configuration can include one or more output devices (e.g., a display, a speaker, a tactile feedback interface, etc.) that the application can utilize to provide an emotional response.

As the user engages with the application, the application sends events to the emotional module. For example, such events may include a variety of user interaction events between the user and the application. The emotional module uses the events, the user profile information, and data from biometric sensors to determine the emotional response to produce. The emotional module sends the determined emotional response to the application, e.g., via an API. The application renders the emotional response. Further, the emotional module collects feedback, e.g., from the application and/ or from the biometric sensors, about the effectiveness of the emotional response provided. The learning module utilizes the feedback to improve future interaction, e.g., between various users and computing devices. Different applications can be assigned, or choose, different personalities when providing the emotional response.

Example application: Typing Tutorial

A typing tutorial application utilizes user information, biometric data, and performance on typing tasks to provide emotional responses, e.g., to users as they learn to type. The emotional responses can make the typing tutorial more fun and effective for users.

The application accesses the emotional module, provides events data to the emotional module, implements output of the emotional response via appropriate output devices, and provides user response data to the emotional module.

In operation, the typing tutorial application detects several events as the user types and communicates the events to the emotional module. For example, the events may include the user pressing an incorrect key (event: WRONG), pressing a correct key (event: CORRECT), fast typing (event: FAST), and slow typing (event: SLOW). The third party application specifies emotional rules that specify default emotional responses for different events, that can be used initially. As user data is collected, more effective responses are learned.

For example, the event "WRONG" is associated with the user emotion "frustration," and the application provides an emotional response through phrases such as "Oops" and "Uh-oh." In another example, the event "FAST" is associated with the user emotion "happy, excited, proud" and the emotional response provided includes phrases such as "That's amazing!" or "That's really fast!" The emotional module learns from user biometric feedback to the emotional responses. In different implementations, the emotional module can provide different responses to similar events and learn the effectiveness of particular responses. In such manner, the emotional module develops emotional intelligence.

The application can provide the emotional response as specified by the emotional module, e.g., through a user interface. For example, when the user presses a wrong key consecutively, the application can render an emotional response that expresses irritation, e.g., "Oh no! not again!" The emotional module can provide additional information to the application, e.g., an intensity for the emotional response to be provided to the user, such as a volume level associated with yelling (high intensity) or whispering (low intensity). The application can control output of the emotional response, e.g., it can render a phrase via a specific voice, with certain emotion, or display a face with the emotion, with a text bubble next to the face.

Example use cases

The techniques of this disclosure can be used to provide appropriate emotional responses in various contexts where human users interact with a computing device. The computing device can provide the emotional response in various ways, such as voice,

animated image, a displayed avatar, etc. The interaction can take place when the user utilizes an application provided by the computing device. The application can be a system-provided application or a third-party application. Some example situations in which the techniques of this disclosure can provide a helpful emotional response are described below:

- The user requests a search, e.g., the user enters the phrase “best movies” in a search engine interface. The user then modifies the search to “best movies in 2013”, and further to “best funny movies.” The search engine application expresses a “frustration” emotion, e.g., complains via voice with a phrase such as “Hey, can you make up your mind, please?”
- The user attempts to solve a CAPTCHA ("Completely Automated Public Turing test to tell Computers and Humans Apart"), e.g., to access a website. The user is unable to solve the CAPTCHA correctly and therefore, gets frustrated. The computing device understands the user frustration (e.g., based on biometric sensors, or input from the application that provides the CAPTCHA). The computing device then expresses compassion and responds with phrase such as “That’s a hard one. I’m sorry, let me give you another one.”
- The user performs a voice search for “spaceship” on her mobile phone. The mobile phone interprets her search as “Space Sheep.” The user retries a few times, to no avail, and eventually, performs manual correction to change the word “sheep” to “ship” e.g., using a keyboard. The mobile phone recognizes the user action as a correction and detects that it made a mistake. The mobile phone then provides a user response that criticizes itself, e.g., “Duh, space SHEEP, how stupid is that!” On the contrary, if the detected phrase and the search result is exactly what the user was looking for, the mobile phone gives itself a compliment, e.g., “Uh, how good am I!”
- As the user creates a document (e.g., by typing), the user keeps making the same syntactic mistake. The computer patiently corrects her. When the user finally gets it right, the computer displays an emotion of excitement and pleasure.
- The user seeks driving directions from the computer. As the user is driving, she misses several turns. Upon detecting such an occurrence, the driving directions application attracts the user’s attention to the road and tries to calm the user down, e.g., if the user is detected to be stressed. The application can also attempt to alleviate the situation, e.g., by joking that it is hard to give instructions if the user is not following them.

The techniques described here enable provision of suitable emotional responses to users in any interaction context. The techniques can learn from user behavior and generate a database of emotions. The techniques enable computers to provide effective emotional responses. The techniques can also be used to train certain users who spend a lot of time with computer devices, such as autistic children, to better understand human emotions.

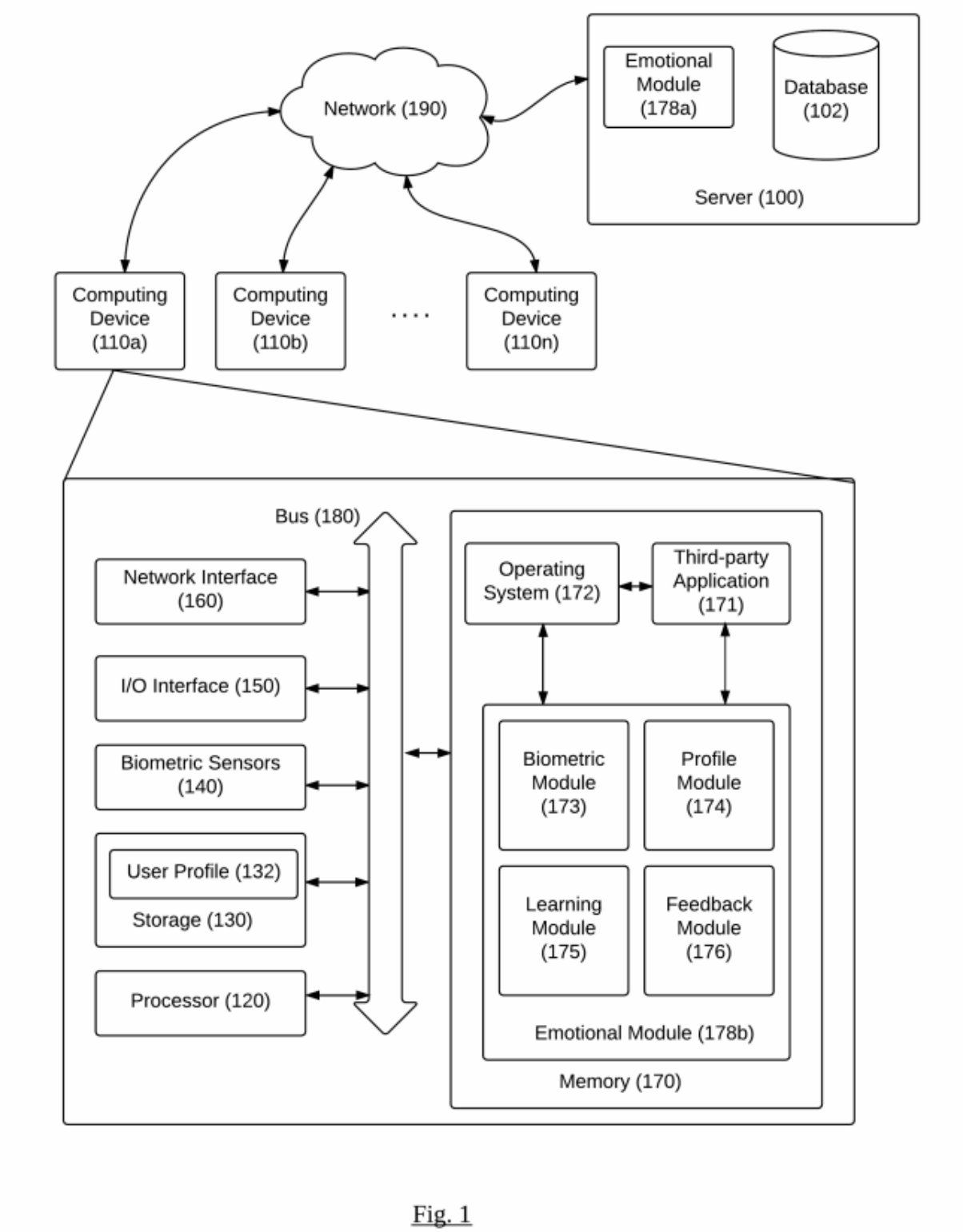
Network (190)
Emotional Module (178a)
Database (102)
Server (100)
Computing Device (110a)
Computing Device (110b)
Computing Device (110n)
Bus (180)
Network Interface (160)
I/O Interface (150)
Biometric Sensors (140)
User Profile (132)
Storage (130)
Processor (120)
Operating System (172)
Third-party Application (171)
Biometric Module (173)
Profile Module (174)
Learning Module (175)
Feedback Module (176)
Emotional Module (178b)
Memory (170)

Fig. 1

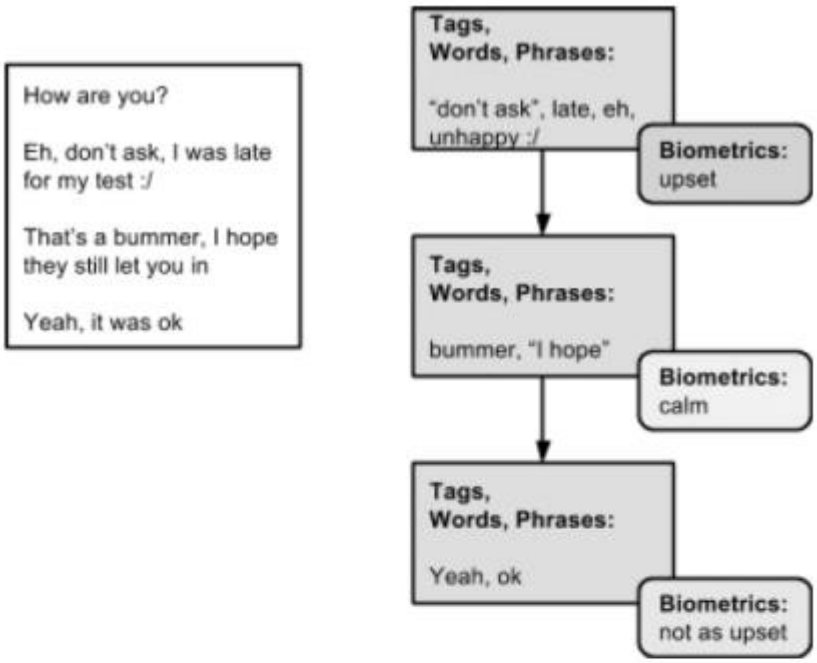
How are you?
Eh, don't ask, I was late for my test :/
That's a bummer, I hope they still let you in
Yeah, it was ok
Tags, Words, Phrases:
"don't ask", late, eh, unhappy :/
Biometrics: upset
Tags, Words, Phrases:
bummer, "I hope"
Biometrics: calm
Tags, Words, Phrases:
Yeah, ok
Biometrics: not as upset

Fig. 2A

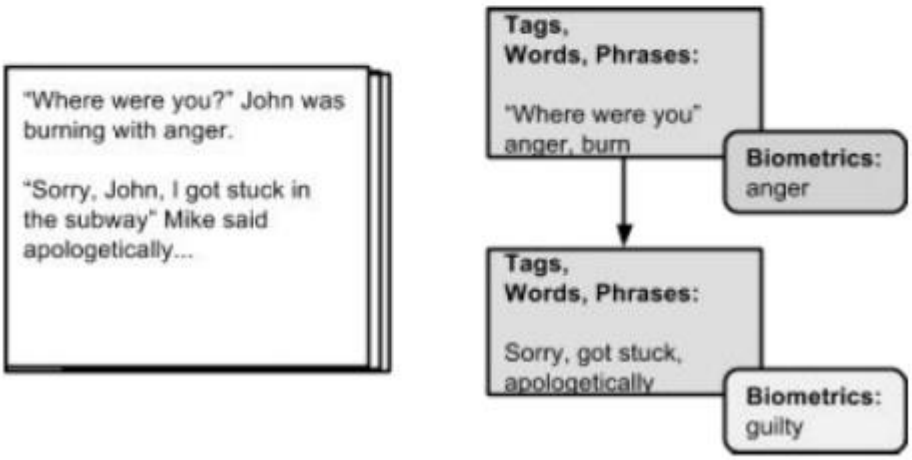
"Where were you?" John was burning with anger.
"Sorry, John, I got stuck in the subway" Mike said apologetically...
Tags, Words, Phrases:
"Where were you" anger, burn
Biometrics: anger
Tags, Words, Phrases:
Sorry, got stuck, apologetically
Biometrics: guilty

Fig. 2B

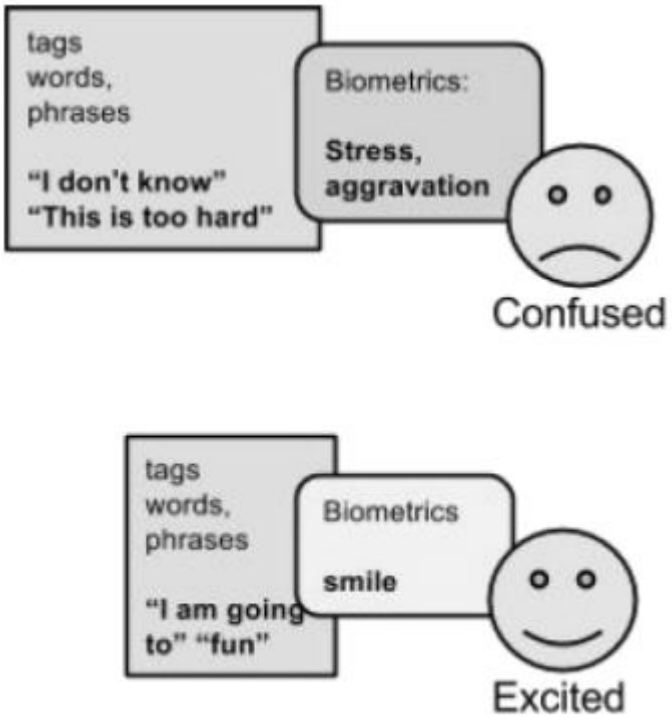
tags
words,
phrases
"I don't know"
"This is too hard"
Biometrics:
Stress,
aggravation
Confused
tags
words,
phrases
"I am going
to" "fun"
Biometrics
smile
Excited

Fig. 3