

Interaction between Human & Robot using Blue Eye Technology

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Abstract— It is possible to create a computer which can interact with us as we interact each other. For example imagine in a fine morning you walk to your computer room and then it tells you Hey friend Good Morning you seem to be in a bad mood today. It seems to be a fiction but it will be the life lead by BLUE EYES in very near future. The basic idea behind this technology is to give the human power. We all have some perceptual abilities. If we add such these abilities to a computer would enable computers to work together with human being as ultimate partner's friend. Malware is also detected before the time of downloading.

Key words: System Overview, Emotion Computing, Types of Emotion Sensors, Manual & Gaze Input Cascaded, Artificial Intelligent Speech Recognition

I. INTRODUCTION

Imagine yourself in a world where humans interact with computers. You are sitting in front of your personal computer that can listen, talk, or even scream aloud. It has the ability to gather information about you and interact with you through special techniques like facial recognition, speech recognition, etc. It can even understand your emotions at the touch of the mouse. It verifies your identity, feels your presents, and starts interacting with you. You asks the computer to dial to your friend at his office. It realizes the urgency of the situation through the mouse, dials your friend at his office, and establishes a connection. Human cognition depends primarily on the ability to perceive, interpret, and integrate audio visuals and sensing information. Adding extraordinary perceptual abilities to computers would enable computers to work together with human beings as intimate partners. Researchers are attempting to add more capabilities to computers that will allow them to interact like humans, recognize human presents, talk, listen, or even guess their feelings. The BLUE EYES technology aims at creating computational machines that have perceptual and sensory ability like those of human beings. It uses non-obtrusive sensing method, employing most modern video cameras and microphones to identify the user's actions through the use of imparted sensory abilities. The machine can understand what a user wants, where he is looking at, and even realize his physical or emotional state

II. SYSTEM OVERVIEW

Blue eyes system monitors the status of the operator's visual attention through measurement of saccadic activity. The system checks parameters like heart beat rate and blood oxygenation against abnormal and triggers user defined alarms. Blue Eyes system consists of a mobile measuring device and a central analytical system. The mobile device is integrated with Bluetooth module providing wireless interface between sensors worn by the operator and the central unit. ID cards assigned to each of the operators and

adequate user profiles on the central unit side provide necessary data personalization so the system consists of

- 1) Mobile measuring device (DAU)
- 2) Central System Unit (CSU)

A. The Hardware

1) Data Acquisition Unit

Data Acquisition Unit is a mobile part of the Blue eyes system. Its main task is to fetch the physiological data from the sensor and to send it to the central system to be processed. To accomplish the task the device must manage wireless Bluetooth connections (connection establishment, authentication and termination). Personal ID cards and PIN codes provide operator's authorization. Communication with the operator is carried on using a simple 5-key keyboard, a small LCD display and a beeper. When an exceptional situation is detected the device uses them to notify the operator. Voice data is transferred using a small headset, interfaced to the DAU with standard mini-jack plugs. The Data Acquisition Unit comprises several hardware modules Atmel 89C52 microcontroller - system core Bluetooth module (based on ROK101008) HD44780 - small LCD display 24C16 - I2C EEPROM (on a removable ID)

B. Central System Unit

Central System Unit hardware is the second peer of the wireless connection. The box contains a Bluetooth module (based on ROK101008) and a PCM codec for voice data transmission. The module is interfaced to a PC using a parallel, serial and USB cable. The audio data is accessible through standard mini-jack sockets to program operator's personal ID cards we developed a simple programming device. The programmer is interfaced to a PC using serial and PS/2 (power source) ports. Inside, there is Atmel 89C2051 microcontroller, which handles UART transmission and I2C EEPROM (ID card) programming.

III. EMOTION COMPUTING

Rosalind Picard (1997) describes why emotions are important to the computing community. There are two aspects of affective computing: giving the computer the ability to detect emotions and giving the computer the ability to express emotions. Not only are emotions crucial for rational decision making as Picard describes, but emotion detection is an important step to an adaptive computer system. An adaptive, smart computer system has been driving our efforts to detect a person's emotional state. An important element of incorporating emotion into computing is for productivity for a computer user. A study (Dryer & Horowitz, 1997) has shown that people with personalities that are similar or complement each other collaborate well. Dryer (1999) has also shown that people view their computer as having a personality. For these reasons, it is important to develop computers which can work well with its user.

A. Theory

Based on Paul Ekman's facial expression work, we see a correlation between a person's emotional state and a person's physiological measurements.

Selected works from Ekman and others on measuring facial behaviors describe Ekman's Facial Action Coding System (Ekman and Rosenberg, 1997). One of his experiments involved participants attached to devices to record certain measurements including pulse, galvanic skin response (GSR), temperature, somatic movement and blood pressure. He then recorded the measurements as the participants were instructed to mimic facial expressions which corresponded to the six basic emotions. He defined the six basic emotions as anger, fear, sadness, disgust, joy and surprise. From this work, Dryer (1993) determined how physiological measures could be used to distinguish various emotional states. The measures taken were GSR, heart rate, skin temperature and general somatic activity (GSA). These data were then subject to two analyses. For the first analysis, a multidimensional scaling (MDS) procedure was used to determine the dimensionality of the data

B. Result

The data for each subject consisted of scores for four physiological assessments [GSA, GSR, pulse, and skin temperature, for each of the six emotions (anger, disgust, fear, happiness, sadness, and surprise)] across the five minute baseline and test sessions. GSA data was sampled 80 times per second, GSR and temperature were reported approximately 3-4 times per second and pulse was recorded as a beat was detected, approximately 1 time per second. To account for individual variance in physiology, we calculated the difference between the baseline and test scores. Scores that differed by more than one and a half standard deviations from the mean were treated as missing. By this criterion, twelve score were removed from the analysis. The results show the theory behind the Emotion mouse work is fundamentally sound. The physiological measurements were correlated to emotions using a correlation model. The correlation model is derived from a calibration process in which a baseline attribute-to emotion correlation is rendered based on statistical analysis of calibration signals generated by users having emotions that are measured or otherwise known at calibration time.



Fig. 1:

IV. TYPES OF EMOTION SENSORS

- For Hand

- 1) Emotion Mouse
- 2) Sentic Mouse
 - For Eyes:
 - 1) Expression Glasses
 - 2) Magic Pointing
 - 3) Eye Tracking
 - For Voice
 - 1) Artificial Intelligence Speech Recognition

A. Hand

1) Emotion Mouse

One proposed, non-invasive method for gaining user information through touch is via a computer input device, the mouse. This then allows the user to relate the cardiac rhythm, the body temperature, electrical conductivity of the skin and other physiological attributes with the mood. This has led to the creation of the "Emotion Mouse". The device can measure heart rate, temperature, galvanic skin response and minute bodily movements and matches them with six emotional states: happiness, surprise, anger, fear, sadness and disgust. The mouse includes a set of sensors, including infrared detectors and temperature-sensitive chips. These components, User researchers' stress, will also be crafted into other commonly used items such as the office chair, the steering wheel, the keyboard and the phone handle. Integrating the system into the steering wheel, for instance, could allow an alert to be sounded when a driver becomes drowsy.

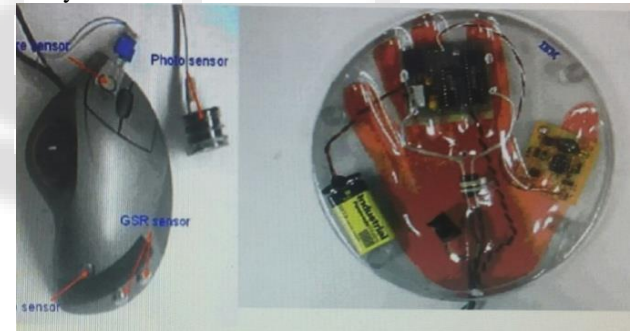


Fig. 2: Sentic Mouse

It is a modified computer mouse that includes a directional pressure sensor for aiding in recognition of emotional valence (liking/attraction vs. disliking/avoidance)

B. Eye

1) Expression Glasses

A wearable device which allows any viewer to visualize the confusion and interest levels of the wearer. Other recent developments in related technology are the attempt to learn the needs of the user just by following the interaction between the user and the computer in order to know what he/she is interested in at any given moment. For example, by remembering the type of websites that the user links to according to the mood and time of the day, the computer could search on related sites and suggest the results the user.



Fig. 3:

V. MANUAL & GAZE INPUT CASCADED (MAGIC) POINTING

This work explores a new direction in utilizing eye gaze for computer input. Gaze tracking has long been considered as an alternative or potentially superior pointing method for computer input. We believe that many fundamental limitations exist with traditional gaze pointing. In particular, it is unnatural to overload a perceptual channel such as vision with a motor control task. We therefore propose an alternative approach, dubbed MAGIC (Manual & Gaze Input Cascaded) pointing. With such an approach, pointing appears to the user to be a manual task, used for fine manipulation and selection. However, a large portion of the cursor movement is eliminated by warping the cursor to the eye gaze area, which encompasses the target. Two specific MAGIC pointing techniques, one conservative and one liberal, were designed, analysed, and implemented with an eye tracker we developed. They were then tested in a pilot study.

This early stage exploration showed that the MAGIC pointing techniques might offer many advantages, including reduced physical effort and fatigue as compared to traditional manual pointing, greater accuracy and naturalness than traditional gaze pointing, and possibly faster speed than manual pointing. The pros and cons of the two techniques are discussed in light of both performance data and subjective reports.

A. Implementation

We took two engineering efforts to implement the MAGIC pointing techniques. One was to design and implement an eye tracking system and the other was to implement MAGIC pointing techniques at the operating systems level, so that the techniques can work with all software applications beyond "demonstration" software.

B. The IBM ALMADEN Eye Tracker

Since the goal of this work is to explore MAGIC pointing as a user interface technique, we started out by purchasing a commercial eye tracker (ASL Model 5000) after a market survey. In comparison to the system reported in early studies this system is much more compact and reliable. However, we felt that it was still not robust enough for a variety of people with different eye characteristics, such as pupil brightness and correction glasses. We hence chose to develop and use our own eye tracking system [10]. Available commercial systems, such as those made by ISCAN Incorporated, LC

Technologies, and Applied Science Laboratories (ASL), rely on a single light source that is positioned either off the camera axis in the case of the ISCANETL-400 systems, or on-axis in the case of the LCT and the ASL E504 systems. Illumination from an off-axis source (or ambient illumination) generates a dark pupil image. When the light source is placed on-axis with the camera optical axis, the camera is able to detect the light reflected from the interior of the eye, and the image of the pupil appears bright. This effect is often seen as the red-eye in flash photographs when the flash is close to the camera lens. When the light source is placed on-axis with the camera optical axis, the camera is able to detect the light reflected from the interior of the eye, and the image of the pupil appears bright. This effect is often seen as the red-eye in flash photographs when the flash is close to the camera lens. Bright (left) and dark (right) pupil images resulting from on- and off-axis illumination. The glints, or corneal reflections, from the on- and off-axis light sources can be easily identified as the bright points in the iris. The Almaden system uses two near infrared (IR) time multiplexed light sources, composed of two sets of IR LED's, which were synchronized with the camera frame rate. One light source is placed very close to the camera's optical axis and is synchronized with the even frames. Odd frames are synchronized with the second light source, positioned off axis. The two light sources are calibrated to provide approximately equivalent whole-scene illumination. Pupil detection is realized by means of subtracting the dark pupil image from the bright pupil image. After thresholding the difference, the largest connected component is identified as the pupil. This technique significantly increases the robustness and reliability of the eye tracking system. After implementing our system with satisfactory results, we discovered that similar pupil detection schemes had been independently developed by Tomonoetal and Ebisawa and Satoh. It is unfortunate that such a method has not been used in the commercial systems. We recommend that future eye tracking product designers consider such an approach.

Once the pupil has been detected, the corneal reflection (the glint reflected from the surface of the cornea due to one of the light sources) is determined from the dark pupil image. The reflection is then used to estimate the user's point of gaze in terms of the screen coordinates where the user is looking at. The estimation of the user's gaze requires an initial calibration procedure, similar to that required by commercial eye trackers. Our system operates at 30 frames per second on a Pentium II 333 MHz machine running Windows NT. It can work with any PCI frame grabber compatible with Video for Windows.

C. Experiment

Empirical studies are relatively rare in eye tracking-based interaction research, although they are particularly needed in this field. Human behavior and processes at the perceptual motor level often do not conform to conscious-level reasoning. One usually cannot correctly describe how to make a turn on a bicycle. Hypotheses on novel interaction techniques can only be validated by empirical data. However, it is also particularly difficult to conduct empirical research on gaze-based interaction techniques, due to the complexity of eye movement and the lack of reliability in eye tracking

equipment. Satisfactory results only come when “everything is going right.” When results are not as expected, it is difficult to find the true reason among many possible reasons: Is it because a subject’s particular eye property fooled the eye tracker? Was there a calibration error? Or random noise in the imaging system? Or is the hypothesis in fact invalid? We are still at a very early stage of exploring the MAGIC pointing techniques. More refined or even very different techniques may be designed in the future. We are by no means ready to conduct the definitive empirical studies on MAGIC pointing. However, we also feel that it is important to subject our work to empirical evaluations early so that quantitative observations can be made and fed back to the iterative design-evaluation-design cycle. We therefore decided to conduct a small-scale pilot study to take an initial peek at the use of MAGIC pointing, however unrefined.

D. Implementing Magic Pointing

We programmed the two MAGIC pointing techniques on a Windows NT system.

The techniques work independently from the applications. The MAGIC pointing program takes data from both the manual input device (of any type, such as a mouse) and the eye tracking system running either on the same machine or on another machine connected via serial port. Raw data from an eye tracker cannot be directly used for gaze-based interaction, due to noise from image processing, eye movement jitters, and samples taken during saccade (ballistic eye movement) periods we experimented with various filtering techniques and found the most effective filter in our case is similar to that described in. The goal of filter design in general is to make the best compromise between preserving signal bandwidth and eliminating unwanted noise. In the case of eye tracking, as Jacob argued, eye information relevant to interaction lies in the fixations. The key is to select fixation points with minimal delay. Samples collected during a saccade are unwanted and should be avoided. In designing our algorithm for picking points of fixation, we considered our tracking system speed (30 Hz), and that the MAGIC pointing techniques utilize gaze information only once for each new target, probably immediately after a saccade. Our filtering algorithm was designed to pick a fixation with minimum delay by means of selecting two adjacent points over two samples.

1) Experimental Results

Given the pilot nature and the small scale of the experiment, we expected the statistical power of the results to be on the weaker side. In other words, while the significant effects revealed are important, suggestive trends that are statistically non-significant are still worth noting for future research. First, we found that subjects’ trial completion time significantly varied with techniques: $F(2, 16) 6.36, p < 0.01$. The total average completion time was 1.4 seconds with the standard manual control technique 1.52 seconds with the conservative MAGIC pointing technique (Gaze1), and 1.33 seconds with the liberal MAGIC pointing technique (Gaze2). Note that the Gaze1 Technique had the greatest improvement from the first to the second experiment session, suggesting the possibility of matching the performance of the other two techniques with further practice. As expected, target size significantly influenced pointing time: $F(1,8) = 178, p$

<0.001 . This was true for both the manual and the two MAGIC pointing techniques

VI. THE SIMPLE USER INTEREST TRACKER (SUITOR)

Computers would have been much more powerful, had they gained perceptual and sensory abilities of the living beings on the earth. What needs to be developed is an intimate relationship between the computer and the humans. And the Simple User Interest Tracker (SUITOR) is a revolutionary approach in this direction. By observing the Webpage a netizen is browsing, the SUITOR can help by fetching more information at his desktop. By simply noticing where the user’s eyes focus on the computer screen, the SUITOR can be more precise in determining his topic of interest. It can even deliver relevant information to a handheld device. The success lies in how much the suitor can be intimate to the user. IBM’s BlueEyes research project began with a simple question, according to Myron Flickner, a manager in Almaden’s USER group: Can we exploit nonverbal cues to create more effective user interfaces? One such cue is gaze—the direction in which a person is looking.

Flickner and his colleagues have created some new techniques for tracking a person’s eyes and have incorporated this gaze-tracking technology into two prototypes. One, called SUITOR (Simple User Interest Tracker), fills a scrolling ticker on a computer screen with information related to the user’s current task. SUITOR knows where you are looking, what applications you are running, and what Web pages you may be browsing. “If I’m reading a Web page about IBM, for instance,” says Paul Maglio, the Almaden cognitive scientist who invented SUITOR, “the system presents the latest stock price or business news stories that could affect IBM. If I read the headline off the ticker, it pops up the story in a browser window. If I start to read the story, it adds related stories to the ticker. That’s the whole idea of an attentive system—one that attends to what you are doing, typing, reading, so that it can attend to your information needs.”

VII. CONCLUSION

The nineties witnessed quantum leaps interface designing for improved man machine interactions. The BLUE EYES technology ensures a convenient way of simplifying the life by providing more delicate and user friendly facilities in computing devices. Now that we have proven the method, the next step is to improve the hardware. Instead of using cumbersome modules to gather information about the user, it will be better to use smaller and less intrusive units. The day is not far when this technology will push its way into your house hold, making you more lazy. It may even reach your hand held mobile device. Any way this is only a technological forecast.

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