Raspberry Pi Augmentation: A cost effective solution to Google Glass

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Abstract - *In this paper, we present the concept of using a Raspberry Pi as the main computer. This human enhancement is voice controlled, uses a camera module to interact with the outside world and process the retrieved information for real-time use by the wearer. It uses this augmentation as a brain-computer interface to connect to the web, extract and process information from the physical world. As a forward stride in wearable technology, this device intends to employ the disciplines of speech synthesis, cloud computing and image processing in order to serve the user as a primary portable computer that is voice-enabled and always ready for interaction.*

***Key Words*: Wearable Technology, Augmentation, Wearable Device, Human Enhancement, Brain-Computer Interface, Human-computer interaction**.

1. INTRODUCTION

The terms "wearable technology" refers to electronic devices, particularly computers that are incorporated into items of clothing and more eminent in accessories which can comfortably be worn on the body. Wearable devices are capable of performing many of the same computing tasks as smartphones, tablets and laptops; however, in some cases, wearable technology are proficient enough to outperform these portable devices entirely. Wearable tech tend to be better engineered and often employ cutting edge technologies that are rarely found in hand-held technology on the market today. These relatively new wearable devices can provide sensory and scanning features not usually seen in mobile and laptop devices, such as biofeedback and tracking of physiological function. The wearable is being developed to make it function as a human enhancement. It is engineered to acquire data from the surrounding environment of the user through a camera integrated within the head-mounted augmentation and processing that data in real-time via the Raspberry Pi. The information obtained by processing this data will be then projected onto a semi-transparent glass which would be suspended to the anterior of the augmentation. This augmentation also has an artificial intelligence that responds to the user's voice and performs the instructed tasks. The system has the capability of detecting faces and motion to some degree.

2. LITERATURE SURVEY

According to Kevin Warwick in [1], what constitutes a Brain-Computer Interface (BCI) can be extremely broad. A standard keyboard could be so regarded. It is clear however, that virtual reality systems, e.g. glasses containing a miniature computer screen for a remote visual experience (Mann 1997), are felt by some researchers to fit this category. Certain body conditions, such as stress or alertness, can be indeed be monitored in this way.

In their paper on a wearable personal cloud [2], authors Hasan and Khan describe personal terminal devices as interactive devices capable of wireless communications like WiFi, Bluetooth, ZigBee. Such devices include, but are not limited to, smartphones, smartwatches, tablet computers, smart-glasses, health monitors, and other IoT devices. They even posit that this kind of wearable tech utilizes lower hardware specifications to function as resource constraint devices, in terms of computational power, battery, memory and storage.

Computer vision [3] is the technology in which machines are able to interpret/extract necessary information from an image. Computer vision technology includes various fields like image processing, image analysis and machine vision. It includes certain aspect of artificial intelligence techniques like pattern recognition. The machines which implement computer vision techniques require image sensors which detect electromagnetic radiation which are usually in the form of ultraviolet rays or light rays.

In his paper [4], Ronald T. Azuma describes a unique characteristic of augmented reality; besides adding objects to a real environment, AR also has the potential to remove them. Current work has focused on adding virtual objects to a real environment. However, graphic overlays might also be used to remove or hide parts of the real environment from a user. For example, to remove a desk in the real environment, draw a representation of the real walls and floors behind the desk and "paint" that over the real desk, effectively removing it from the user's sight. This has been done in feature films. Doing this interactively in an AR system will be much harder, but this removal may not need to be photorealistic to be effective.

Furthermore, in [5], Durlach tells us that augmented reality might apply to all senses, not just sight. So far, researchers have focused on blending real and virtual images and graphics. However, AR could be extended to include sound. The user would wear headphones equipped with microphones on the outside. The headphones would add synthetic, directional 3-D sound, while the external microphones would detect incoming sounds from the environment. This would give the system a chance to mask or cover up selected real sounds from the environment by generating a masking signal that exactly cancelled the incoming real sound. While this would not be easy to do, it might be possible as discerned in [6]. Another example is haptics; the science of applying touch (tactile) sensation and control to interaction with computer applications. Gloves with devices that provide tactile feedback might augment real forces in the environment. E.g., a user might run his hand over the surface of a real desk. Simulating such a hard surface virtually is fairly difficult, but it is easy to do in reality. Then the tactile effectors in the glove can augment the feel of the desk, perhaps making it feel rough in certain spots. This capability might be useful in some applications, such as providing an additional cue that a virtual object is at a particular location on a real desk.

In [7], Sin and Zaman used the glasses metaphor to present virtual heavenly bodies on AR markers which they can manipulate in front of them. Students wore a head-mounted display so that both of their hands would be free to handle the markers containing the virtual solar system.

A similar study in [8], by Shelton and Hedley had argued that this visualization is advantageous because students can more easily understand concepts such as day and night when they can test for themselves what happens when one side of the earth is occluded. The Raspberry Pi is a credit card-sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word processing, browsing the internet, and playing games. It also plays high-definition video. It is designed to cost around Rs. 2,600 for the latest model [9].

According to Reaz, et al. in [10], artificial intelligence has played a crucial part in the design and implementation of future houses. Early research focused on the control of home appliances but current trends are moving into a creation of self-thinking home. In the recent years many research projects were performed utilizing artificial intelligence tools and techniques. Also, research projects employing multi-agent system (MAS); is a system composed of several agents, capable of speedy mutual interaction between them, action prediction, artificial neural network, fuzzy logic and reinforcement learning. It is found that the combination of tools and techniques are crucial for successful implementation. A platform for future relative studies between different algorithms, architectures which serves as a reference point for developing more cutting edge smart home technologies has been theorized.

According to Sherri Stevens in her research on the leading voice controlled UIs in [11], a major issue in the marketing research industry is the fact that the majority of surveys are not well suited to a mobile device. In many cases, it is difficult to see all of the answer choices on a small screen device, as answer choices on a second page are less likely to be selected. Using the text to voice feature on mobile phones may be a solution to this problem. We tested several long answer lists – resulting in sensible data. This area of research should be explored further as a way to obtain reliable research data from respondents using a small screen device when long answer lists are unavoidable.

3. SYSTEM DESCRIPTION

3.1 Raspberry Pi

Raspberry Pi (4× ARM Cortex-A53, 1.2GHz) is used as the primary computer. Raspberry pi is a credit card sized computer that runs a Linux distribution. It is used to connect the camera module and perform processing for object recognition. It is also used to set up the hands-free prototype of Alexa Voice Service by registering as a developer and creating a client token.

3.2 Raspberry Pi Camera NoIR v2

The infrared Camera Module v2 (Pi NoIR) has a Sony IMX219 8-megapixel sensor (compared to the 5-megapixel OmniVision OV5647 sensor of the original camera). The Pi NoIR offers everything the regular Camera Module offers, with one difference: it does not employ an infrared filter. (NoIR = No Infrared.) This means that pictures taken in daylight look decidedly curious, but gives us the ability to see in the dark with infrared lighting.

3.3 Augmented Reality Display

The augmented reality display is composed of a LCD display screen that is projected on a semi-transparent mirror through a Fresnel lens. The LCD display is connected to the Raspberry Pi via GPIO pins. The "/boot/config.txt " file is modified to display the contents of -+the screen as a mirror image; so as to project the original content onto the semi-transparent mirror seamlessly.

3.4 Intelligent User Interface

Verbal commands are interpreted by a voice processing module. Amazon's Alexa Voice Service (AVS) is used to take user input and produce results in the form of auditory or visual information. AVS is Amazon's facility to provide voice control to any device or electronic product.

3.5 Head-mount

The head-mount is a mechanical framework on which all the components will be physically installed. It functions as a helmet of sorts which can be strapped on to the user's head. All hardware components are fit over and around the head-mount to maintain coherence of the augmentation.

4. SYSTEM ARCHITECTURE

The primary processing is done on the Raspberry Pi which also serves as the core module to the rest of the modules. A screen is connected to the Pi via GPIO pins, or secondarily via a VNC server connection.

The contents of the screen are displayed onto the semi-transparent mirror which serves as a real-time heads-up display for the user.

During boot-up, the camera module is initialized and some scripts have to be run manually on the Linux terminal after boot up. These scripts are used to initialize the AVS API to the camera module.

Upon successful execution, the camera can be controlled vocally. The captured image can be reverse-searched on the Internet to identify objects or scenes from similar images on the internet.

The entire hardware setup is powered by a 10,000 mAh power bank. The augmentation can be supplied power consistently for almost 14 hours. All constituent modules including the Raspberry Pi, the headset, camera module and peripherals (if any) are supplied power from the same source.

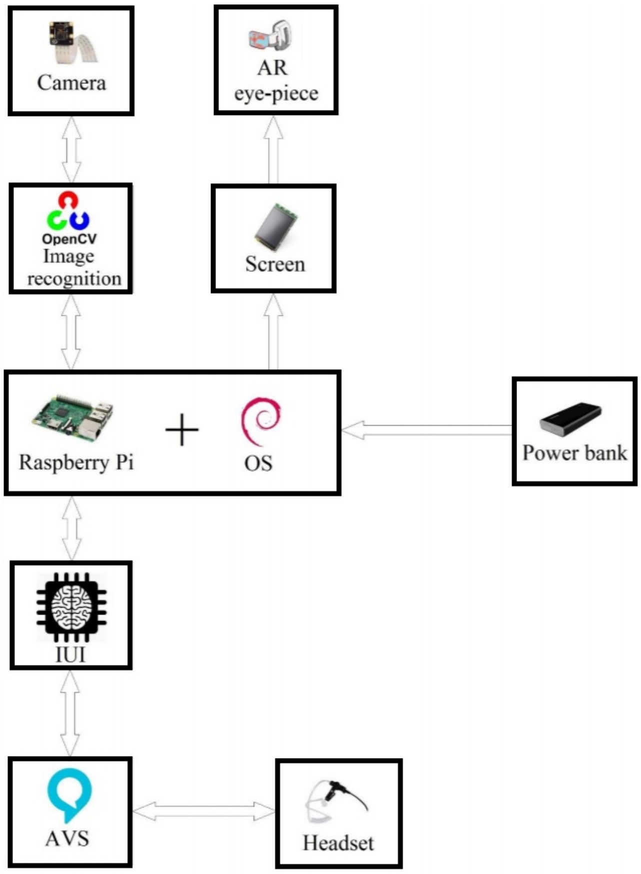

Fig -1: Architecture of Raspberry Pi Augmentation

5. CONCLUSION

The augmentation is a cost-effective solution to available wearable technology. Even its battery backup is more than 10 hours which is significantly ahead of current wearable technology.

Besides low cost and high energy efficiency, the augmentation is nowhere as disruptive as its competition. It does not bother the user with unnecessary information and its updates, backups are made when the device is being charged.

The overall design of this wearable device has six modules; the Raspberry Pi 3, which is the main processing unit of the augmentation. The second module consists of the display screen and the augmented reality display. The third module is the intelligent user interface that responds to the user's requests via the fourth module; i.e. voice automation, which will be effectuated using Alexa Voice Service. The visual data acquisition will be done by the fifth module, consisting of a camera without an infra-red filter. A minor module to facilitate voice input will be a headset with a microphone that will be used to receive vocal feedback from the IUI in addition to controlling the wearable via vocal commands.

The wearable acquires data from the user's surroundings and process it to provide information that will help the wearer make better decisions. It works as an assistive human enhancement by providing real-time information, generated by processing the visual data from the user's surroundings and vocal commands given by the user using the augmentation's intelligent user interface.

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