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Wearable Cognitive Assistance & Application Development with Google Wearable s

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Abstract

Recently developed wearable devices have opened up new capabilities in human interactions with the world. Home automation is an area of interest for the application of wearable devices. Currently, home automation is performed with home control panels or mobile devices. This paper, on the other hand, presents an implementation of home automation using the Google Glass. With a few simple voice commands or finger swipes, the user can monitor the home and control home appliances, thus bringing a new level of interaction with the home. The Glass communicates with an online server that relays commands to a microcontroller to execute certain tasks. The microcontroller is, in turn, able to communicate sensor information to the Glass through the same server. This framework serves as a prototype that demonstrates the potential for wearable technology to simplify the user's in home experience. In the future, it can be expanded to include more features and more devices for the user to interact with in the home.

Keywords: mobile computing, cloud computing, Google Glass, virtual machines, system architecture, cloudlets, face detection, face recognition, object recognition, OCR, activity recognition, motion classification, context awareness, graceful degradation.

Introduction

Wearable devices such as Google Glass a glimmer of hope to users in cognitive decline. These devices integrate person image capture, sensing, processing and communication capabilities in an aesthetically elegant form factor. Through context-aware real-time scene interpretation (including recognition of objects, faces, activities, signage text, and sounds), we can create software that helpful guidance for everyday life much as a GPS navigation system helps a driver.
Wearable devices solve these problems with constant accessibility and awareness of their context, or the user's surrounding area1. Because it is constantly accessible, the interfaces of most wearable devices are designed to accommodate constant usage5. Google Glass, which focuses on simplicity and efficiency, best fulfills these necessities. It allows users to easily complete daily tasks through advanced voice and motion recognition. In addition, the Google Glass is comfortable, because it can be worn like ordinary glasses, providing an unobtrusive, yet novel experience.

Wearable technology

- These are products that must be worn on the user's body for an extended period of time, significantly enhancing the user's experience as a result of the product being worn. Furthermore, its must contain advanced circuitry, wireless connectivity and at least a minimal level of independent processing capability.
- This definition of Wearable Technology stipulates two tests that products must pass to be considered within the scope of this research.

• **Test 1** - ***Wearable*** – being worn for an extended period of time, with the user experience significantly enhanced as a result.
• **Test 2** - ***Smart*** – having advanced circuitry, wireless connectivity and independent processing capability.

These are forthwith referred to as the two tests of Wearable Technology.

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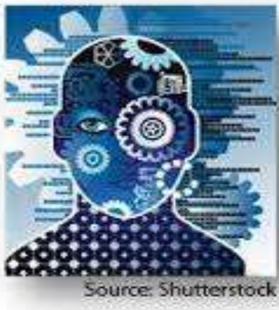

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Assistive smart spaces

Inspired by these early examples, we aim to free cognitive assistance systems from the cones of a purpose-built smart space. Simultaneously, we aim to enrich user experience and assistive value. These goals are unlikely to be achieved by an evolutionary path from generation systems. Scaling up a smart space from a building or suite of buildings to an entire neighborhood or an entire city is extremely expensive and time-consuming. Physical infrastructure in public spaces tends to evolve very slowly, over a time scale of decades. Mobile computing technology, on the other hand, advances much faster. Instead of relying on sensors embedded in smart spaces, we dynamically inject sensing into the environment through computer vision on a wearable computer.

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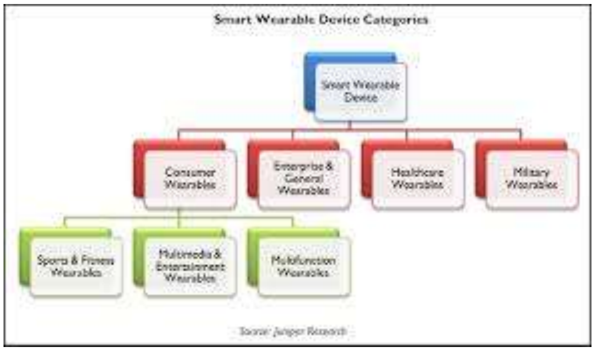


Google App engine

This Paas allows developers to build and run applications through Google. A Paas is a category of cloud computing that allows for the building of applications and of services over the internet. Uses of the App Engine are for applications that have web service components, applications that keep a profile or sync across devices, and applications that need authentication. App Engine Endpoints API parses parameters as JSON (JavaScript Object Notation), a lightweight data interchange format, to translate data between servers.

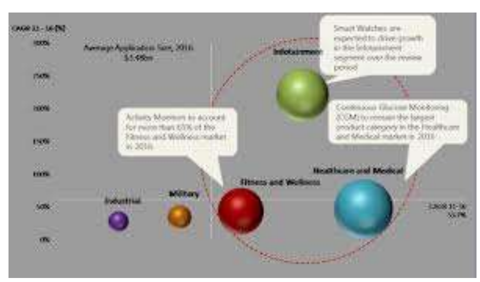
In the case of the application, Google App Engine was used to create servers.

Industrial sequrity

Industrial applications of Wearable Technology include the use of heads-up displays in production lines, hand-worn terminals in logistics and warehousing and smart clothing to track user location and detect industrial gases. The market for wireless devices in industrial applications is forecast to grow at a compound annual growth rate of 18.0% from 2011 to 2015.

Military

HUDs that provide information on maps and routes and improve situational awareness. Programs include US Future Force Warrior (FFW); Project Wundurra in Australia; Israeli Integrated Advanced Soldier (IAS); UK Future Infantry Soldier Technology.



Applications

- Five categories of wearable technology are assessed in this report and defined as follows:

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- Fitness and Wellness - Devices which pass the two tests of wearable technology and are used in the monitoring of activity and emotions.
- Healthcare and Medical - Devices which pass the two tests of wearable technology and require FDA or equivalent approval. They are used in monitoring of vital signs, as well as for augmenting senses.
- Industrial and Military – Devices that pass the two tests of wearable technology and receive/transmit real-time data in military and/or industrial environments.
- Infotainment - Devices that pass the two tests of wearable technology and are used to receive and transmit real-time information for entertainment or enhanced lifestyle purposes

Supported cognitive engines

Our prototype incorporates several cognitive engines based on available research and commercial software. These are summarized in Face Recognition: A most basic cognitive task is the recognition of human faces. Our face recognition engine runs on Windows. It uses a Haar Cascade of classifiers to perform detection, and then uses the Eigen faces method based on principal component analysis (PCA) to make an identification from a database of known faces. The implementation is based on Open CV image processing and computer vision routines. Object Recognition (MOPED): Our prototype supports two different object recognition engines.

- **Object Recognition (STF):** The other object recognition engine in our prototype is based on machine learning, using the semantic text on forest (STF) algorithm described by Shottonetal For our prototype, the MSRC21 image dataset mentioned in that work (with 21 classes of common objects) was used as the training dataset. Our Python-based implementation runs on Linux and is single-threaded.
- **OCR (Open Source**): A critical assistance need for users with visual impairments is a way to determine what is written on signs in the environment. Optical character recognition (OCR) on video\ frames captured by the Glass camera is one way to accomplish this. Our prototype supports two different OCR engines. One of them is the open source Tesseract-OCR package .
- **OCR (Commercial):** The second OCR engine supported by our prototype is a Windows-based commercial product: Very PDF to Text OCR Converter. It provides a command-line interface that allows it to be scripted and readily connected to the rest of our system. Neither OCR engine is ideal for our purposes. Since they were both intended to operate on scans of printed documents, they do not handle well the wide range of perspective, orientation, and lighting variations found in camera images. They are also not optimized for interactive performance. However, they are still useful as proofs of concept in our prototype.
- **Motion Classier:** To interpret motion in the surroundings (such as someone is waving to a user or running towards him), we have implemented a cognitive engine based on the Mo SIFT algorithm [33]. From pairs of consecutive frames of video, it extracts features that incorporate aspects of appearance and movement. These are clustered to produce histograms that characterize the scene. Classifying the results across a small window of frames, the engine detects if the video fragment contains one of a small number of previously-trained

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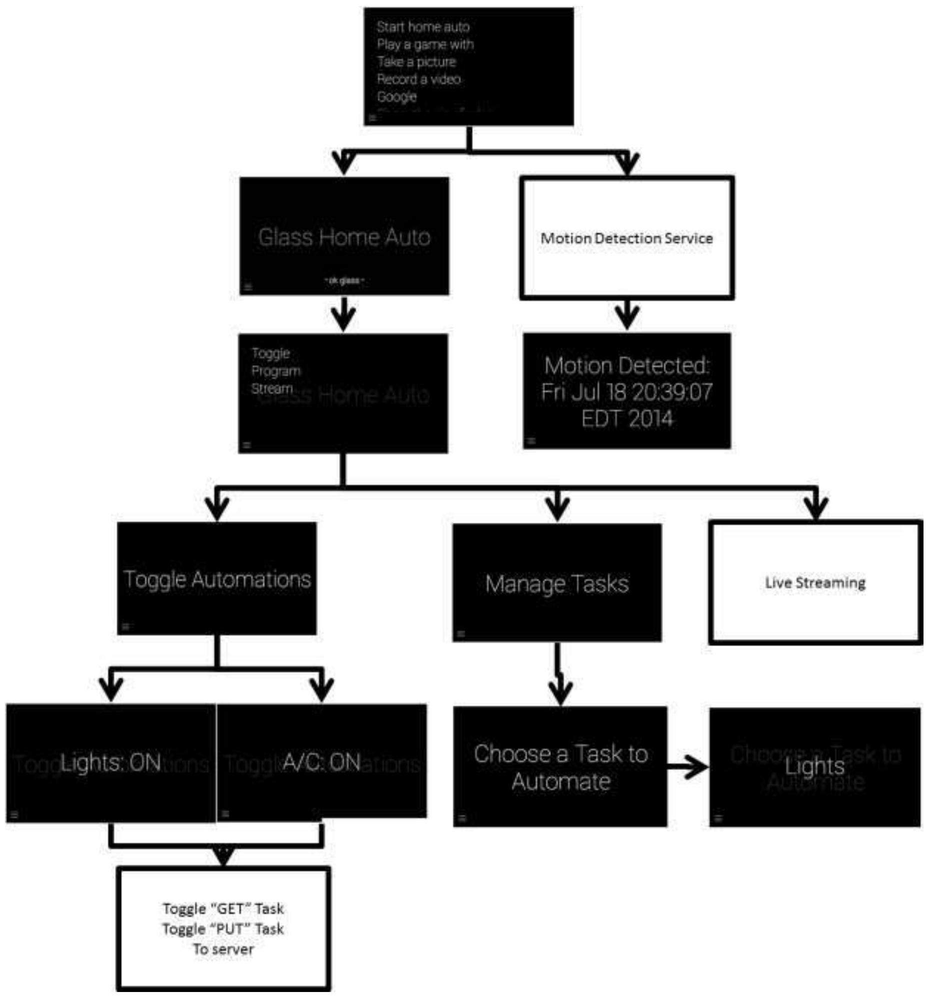
motions, including waving, clapping, squatting, and turning around.

- **Augmented Reality**: Our prototype supports a Windows-based augmented reality engine that identifies buildings and landmarks in images . It extracts a set of feature descriptors from the image, and matches them to a database that is populated from 1005 labeled images of 200 buildings.

The implementation is multi-threaded, and makes significant use of Open CV libraries and Intel Performance Primitives (IPP) libraries. Labeled images can be displayed on the Glass device, or their labels can be read to the user.



Evaluation

Gabriel is an extensible architecture that provides a plug-in interface for the easy addition of new cognitive engines. These cognitive engines are written by third parties, and are of varying quality. In some cases, these engines are closed source and we have no control except through a few external parameters. Our evaluation in this paper focuses on the intrinsic merits of the Gabriel architecture, rather than the speed, accuracy or other attributes of the cognitive engines or their synthesis into user assistance. Wherever possible, we use real cognitive engines in our evaluation so that the workloads they impose are realistic.

Future work and conclusion

The concept of home automation using wearable devices is easily expandable, and this project demonstrates just a fraction of its capabilities. "Start Home Auto" was created to be built upon a model for future applications. Its capabilities are minimal as a result of time constraints and limited access to home devices. Home automation systems should maximize

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user customization. “Start Home Auto” in some ways limits the extent to which the user may personalize the application for his specific needs. The application allows the user to toggle only two devices. Sustained progress in foundational technologies has brought the decade-long dream of mobile, real-time cognitive assistance via \magic glasses" much closer to reality. The convergence of mobile and cloud computing, the increasing sophistication and variety of cognitive engines, and the widespread availability of wearable hardware are all coming together at a fortuitous moment in time. The work presented here is an initial towards understanding this domain in depth and identifying areas where improvements are most critical.

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