Project Based Technical Paper

WACIIH

(Pronounced as Whacky)

Wearable Assisted Computing for Increased Intelligence in Humans

Submitted at:

i-MAZE

(imagine your amazement to iips)

22nd and 23rd October, 2001

International Institute of Professional Studies

Submission by:
Gagan Bindra
MCA 6yrs Program, 9th Semester
International Institute of Professional Studies,
Devi Ahilya University, Indore.

ACKNOWLEDGEMENTS

The best I have gained while working in this project was to be efficient and clean in my work. Any work pays you good when planned and undertaken in an organized way. The best way to proceed is to have good ideas and a lot of ideas, always remembering that there exist many a ways to tackle a given problem. Also if it is important to have ideas it is more important to implement them, and the project that you are holding is a result of such an idea.

This work is the result of inspiration, support, guidance, cooperation and facilities that were extended to me at their best and at the most by persons at all labels and I am indebted to all of them.

During the entire project I have received endless guidance and help from my project guide Mr. S Mann, maker of the “Wearable Wireless Webcam”. I am fully thankful to **Dr. AK Ramani**, director IIPS for extending his support towards the project, and for that I keep a very deep sense of gratitude and again express my

humble thanks to him. Beyond him lie the blessings of all my **Teachers** who have in all their effort guided me towards the right direction. In this regard I specially thank **Dr. KN Saxena** who has always supported me at all levels of difficulties, **Dr. Biswaroop Sarkar** who has been the motivation and the driving force behind the thought and **Mr. Kapil Suri** who has been teaching us the formal methods of project planning and implementation and **Ms. Richa Tiwari** for her helping hand during various points of difficulties.

I am highly indebted also to **Mr. Gurveer Chabra**, **SIGMA PERIPHERALS**, for his support and sponsorship of the parts and equipments required during the project.

Lastly there are they, my most beloved **Parents** for who is my existence. Without their unending and faithful support and belief in me I could have done nothing.

And not to mention, all of **my friends, my classmates, especially thanking Anjali Kumari** who has held my hands so firmly during the entire course of designing and implementation of this project that I have no words to thank them all.

While in this project and many such others all of them have provided me with

great support every moment of it and I really appreciate their help and guidance. I am sure that this world of Computing will see a lot more coming out of me, if such a support remains with me forever.

Thanking again to all,

Gagan Bindra.

INDEX

INTRODUCTION

Miniaturization of electronics components has enabled systems that are wearable and nearly invisible, so that individuals can move about and interact freely, supported by their personal information domain.

WACIIH is a next generation *mobile computing platform* being designed at IIPS and “STORMLABS” – as a part of a Mobile Robotics project called ROBAGS-I under research at IIPS by our team. The design goal for WACIIH is a system that is light, ergonomic, reliable, flexible, and scalable wearable computing platform. WACIIH is a collection of low-aspect ratio, small, low-power computing components which connect with each other through the WACIIH body-bus and body network.

The WACIIH project is driven by the need for a truly functional, wearable, and flexible research platform for context-aware wearable computing research. My work of research is inspired by the work of many researchers, professors, colleagues and friends. My goal is not simply to build a platform, but to build a community of researchers, designers, and users. There is a great deal of technical depth and hard engineering behind WACIIH, but first and foremost WACIIH is about people and my desire to make people's lives better.

What's a Wearable?

To date, personal computers have not lived up to their name. Most machines sit on the desk and interact with their owners for only a small fraction of the day. Smaller and faster notebook computers have made mobility less of an issue, but the same staid user paradigm persists. Wearable computing hopes to shatter this myth of how a computer should be used. A person's computer should be worn, much as eyeglasses or clothing are worn, and interact with the user based on the context of the situation. With heads-up displays, unobtrusive input devices, personal wireless local area networks, and a host of other context sensing and communication tools, the wearable computer can act as an intelligent assistant, whether it is through a Remembrance Agent, augmented reality, or intellectual collectives.

Wearable Computer: Toward Humanistic Intelligence

Over the past 20 years, wearable computing has emerged as the perfect tool for embodying H*umanistic intelligenc*e. Humanistic Intelligence is intelligence that arises when a human is part of the feedback loop of a computational process in which the human and computer are in extreme close proximity.

It is common in the field of human–computer interaction to think of the human and computer as separate entities. How-ever, in HI theory, we prefer not to think of the wearer and the computer with its associated I/O apparatus as separate entities. Instead, we regard the computer as a second brain and its sensory modalities as additional senses, we must watch them merging with the wearer's senses. When a wearable computer functions in a successful embodiment of HI, the computer uses the human's mind and body as one of its peripherals, just as the human uses the computer as a peripheral. Thus, computing could be an interactive experience for manipulating words and pictures.

Assisting Human Intelligence

Human Intelligence also suggests a new goal for signal-processing hardware—that is, in a truly personal way, to directly assist, rather than replace or emulate, human intelligence. To facilitate this vision, we need a simple and

highly personal computational framework. The idea is to move the tools of augmented intelligence and communication directly onto the body. This will give rise not only to a new genre of truly personal computing but also to some new capabilities and *affordances* arising from direct physical proximity to the human body. Moreover, a new family of applications will arise, in which the body-worn apparatus augments

Why Wearable Computing?

An embodiment of wearable has three fundamental operational modes: *constanc*y, *augmentatio*n, and *mediatio*n.

Constancy. An embodiment of wearable is *operationally constan*t; that is, although it might have power-saving (sleep) modes, it is never completely shut down. So, for example, a pocket calculator kept in your pocket but left on all the time is still not interaction ally constant, because you cannot use it in this state (you still have to pull it out of your pocket to see the display or enter numbers). A wristwatch is a borderline case. Although it operates constantly to keep proper time and is conveniently worn on the body, you must make a conscious effort to orient it within your field of vision to interact with it. Wearable computers are unique in their ability to provide this always-ready condition, which might, for

example, include retroactive video capture for a face-recognizing reminder system. After-the-fact devices such as traditional cameras and palmtop organizers can-not provide such retroactive computing.

Mediation. Unlike handheld devices, laptop computers, and PDAs, good embodiments of wearable can *encapsulate* the user. Such an apparatus doesn't necessarily need to completely enclose us. However, the basic concept of mediation allows for whatever degree of encapsulation is desired (within the limits of the apparatus), because it affords us the possibility of a greater degree of encapsulation than traditional portable computers.

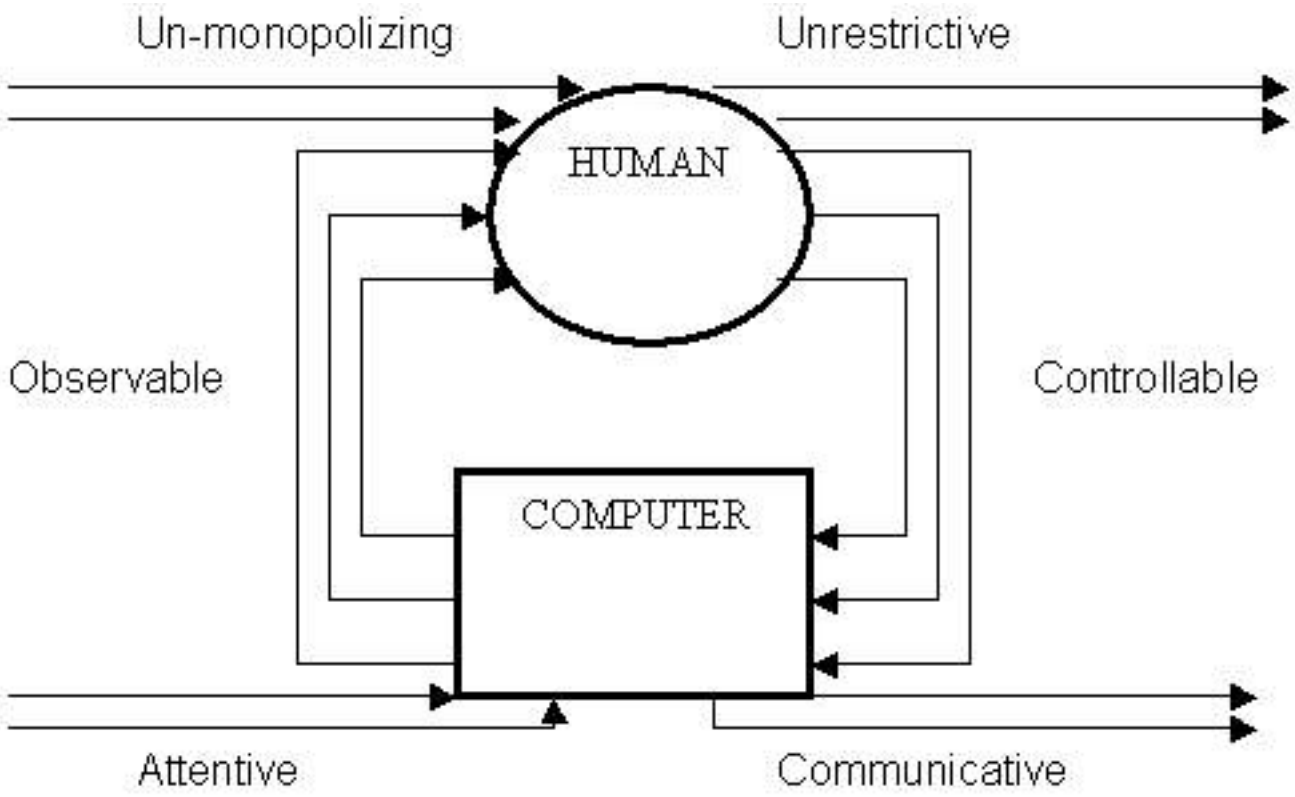
The encapsulation that mediation provides has two aspects, one or both of which can be implemented in varying degrees, as desired. These are:

Solitude: The first aspect is *solitud*e. The ability to mediate our perception lets an embodiment of wearable act as an information filter. For example, we can block out material we might not wish to experience (such as offensive advertising) or replace existing media with different media. This control over the input space con-tributes considerably to the most fundamental wearable issue: user empowerment.

Privacy: The second aspect is *privac*y. Mediation lets us block or modify

information leaving our encapsulated space. In the same way that ordinary clothing prevents others from seeing our naked bodies, an embodiment of wearable might, for example, serve as an intermediary for interacting with un-trusted systems, such as third-party implementations of digital anonymous cash. Other technologies such as desktop computers can, to a limited degree, help us protect our privacy with programs such as Pretty Good Privacy. However, the primary weak-ness of these systems is the space between them and their user. Compromising the link between the human and the computer (per-haps through a Trojan horse or other planted virus) is generally far easier when they are separate entities. A personal information system that the wearer owns, operates, and controls can pro-vide a much greater level of personal privacy. For example, if the user always wears it (except perhaps during showering), the hard-ware is less likely to fall prey to attacks. Moreover, the close synergy between the human and computer makes the system less vulnerable to direct attacks.

The following figure depicts the six basic signal flow paths for intelligent systems embodying wearable.



Each path defines a wearable attribute:

1. ***Un-monopolizing.*** The device does not necessarily cut you off from the outside world as a virtual reality game or the like does.
2. ***Unrestrictive.*** You can do other things while using the device—for example, you can input text while jogging or running down stairs.
3. ***Observable.*** The device can get your attention continuously if you want it to.

The output medium is constantly perceptible. It is sufficient that the device is almost always observable, within reason-able limitations—for example, as when a camera viewfinder or computer screen is not visible when you blink your eye.
4. Controllable. The device is responsive. You can take control of it at any time. Even in automated processes, you should be able to manually override the automation to break open the control loop and become part of the loop. Examples of this controllability might include a Halt but-ton you can invoke when an application mindlessly opens all 50 documents that were highlighted when you accidentally pressed Enter.
5. ***Attentive.*** The device is environmentally aware, multimodal, and multi-sensory. This ultimately gives you increased situational awareness.
6. ***Communicative.*** You can use the device as a communications medium when you wish. It lets you communicate directly to others or helps you produce expressive or communicative media.

Adapting to Human Intelligence

Because devices embodying HI often require that the user learn a new skill set, adapting to them is not necessarily easy. Just as a young child takes many years to become proficient at using his or her hands, some devices that implement HI have taken years of use before they begin to behave like natural

extensions of the mind and body. So, in terms of human–computer interaction,5 the goal is not just to construct a device that can model (and learn from) the user, but, more important, to construct a device from which the user also must learn. Therefore, to facilitate the latter, devices embodying HI should provide a constant user interface that is not so sophisticated and intelligent that it confuses the user. Over a long period of time, the user will become one with the machine, constantly adapting to the machine intelligence, even if he or she only occasionally deliberately uses the machine.

AIM

WACIIH is aimed at developing a synergistic, flexible and adaptable mobile and wearable computing platform for the use of common people to support them in

their daily lives.

OBJECTIVES

The Objectives behind the development of WACII-I are as follows:

- Build a light, economic, flexible and scalable wearable computing platform.
- Develop a computing technology that a person *lives with*.
- Build a system to support people in their daily lives.
- Build a community of researchers towards mobile computing.

In order to build wearable applications and systems which are useful, we must first understand how people interact with the real world and each other. By understanding, sensing, and modeling these interactions, we can build interfaces and applications which facilitate and support people, rather than getting in their way.

GOALS

The Goals with the design and development of WACIIH are:

- Work out concepts for development of a Wearable Computer.
- Justify the need of a Wearable Computer and its utility.
- Design the hardware interfacing of the various parts of the Wearable Computer.
- Design the Body Network and Body Bus for the Wearable Computer.
- Plan the wear ability of the intended computer.
- Perform hardware interfacing.
- Develop a Body Jacket to facilitate easy wear of the Computer.
- Integrate together the various parts of the computer to deliver the final product.

It is believed that context awareness is critical to a good wearable computer. Context, or non-explicit user input, is gathered through sensing and modeling the person's environment, state, and task. By knowing something about where the person is and what they are doing, we can create interactions which pro-activity support, anticipate, and facilitate the person's task.

WACIIH – AN INTRODUCTION

WACII-I is a project that is beyond my wildest thoughts. It is a research project being done by a Masters of Computer Applications student whose responsibility and essence of life lies in the fact that he should make computing not only easy but also fun for the users. That my moral responsibility and dreams lie on the fact that I should strive to bring computing closer to human beings and to innovate such things that will define the future of computing and human races.

Miniaturization of components has enabled systems that are wearable and nearly invisible, so that individuals can move about and interact freely, supported by their personal information domain.

Let's imagine a new approach to computing in which the apparatus is always ready for use because it is worn like clothing. The computer screen, which also

serves as a viewfinder, is visible at all times and performs multimodal computing (text and images).

With the screen moved off the lap and up to the eyes, you can simultaneously talk to someone and take notes without breaking eye contact. Miniaturized into an otherwise normal pair of eyeglasses, such an apparatus is unobtrusive and useful in business meetings and social situations.

Clothing is with us nearly all the time and thus seems like the natural way to carry our computing devices. Once personal imaging is incorporated into our wardrobe and used consistently, our computer system will share our first-person perspective and will begin to take on the role of an independent processor, much like a second brain--or a portable assistant that is no longer carted about in a box. As it "sees" the world from our perspective, the system will learn from us, even when we are not consciously using it.

Such computer assistance is not as far in the future as it might seem. Researchers were experimenting in related areas well before, when I first became interested in wearable computing devices. Much of our progress is due to the computer industry's huge strides in miniaturization. My current wearable prototype, equipped with head-mounted display, cameras, and communications, enables computer-assisted forms of interaction in ordinary situations--for example, while walking, shopping, or meeting people--and it is hardly noticeable.

My experiments in attaching a computer, radio equipment, and other devices to myself culminated in a system that lets me roam about the city. I can receive e-mail at any time through dial-up connections or LAN and enjoy various other capabilities exceeding those available on a desktop multimedia computer in my complete privacy.

This new approach to computing arose from my desire of freedom and interest in the visual arts--particularly still-life and landscape imaging in which multiple exposures of a static scene could be combined and illuminated by a variety of light sources.

To explore such new concepts, I designed and built the wearable personal imaging system. My invention differs from present-day laptops and personal digital assistants in that I could keep an eye on the screen while walking around and doing other things.

WACIIH is the next-generation wearable research platform currently in development at the IIPS Lab and STORMLABS. The design goal for WACIIH is a system that is light, ergonomic, reliable, flexible, and scalable. WACIIH is a collection of low-aspect ratio, small, low-power components which connect with each other through the WACIIH body-bus and body network

The WACIIH design naturally breaks down into four classes of components: computing cores, body networks, peripherals, and software (including OS, drivers, and application The WACIIH design is based on the use of one or more low-power computing cores, each of which is capable of running a full-blown operating system (Linux is currently our OS of choice for this research).

WACIIH employs two wired body networks: the WACIIH Body Network and the WACIIH Body Bus. The Body Network connects WACIIH low-power computing cores to each other, and the body bus connects peripherals and sensors (devices which do not require Ethernet networking) to a computing core. The WACIIH Body Network and WACIIH Body Bus simplify the physical on-body networking problem by providing a reliable single-cable power/data connection between each device on the body.

- WACIIH Body Network
  The WACIIH Body Network is the Ethernet/power network which connects the WACIIH cores, providing peer-to-peer TCP/IP networking and power. The current design employs standard 4-twisted pair Category 5 Ethernet cable for network connectivity.
- WACIIH Body Bus
  the WACIIH body bus is a branching single-cable power/data network design that provides regulated 5V and unregulated 12V power, USB and I^2C through a wire cable. The USB and I^2C protocols were selected to

provide maximal compatibility with current COTS (cheap, off-the-shelf) USB devices like cameras and microphones, and hack ability, since it is extremely easy to build simple microcontroller-based I^2C sensors and peripherals. The connectors and cables were chosen to be mechanically and electrically stable, robust, and locking. All components are flat and small, making it easy to integrate the WACIIH body bus with existing clothing or new designs.

WACIIH peripherals fall into two categories; "standard" WACIIH body bus peripherals and specialized devices which connect directly to a WACIIH core through some other interface, *e.g.* the head-mounted display which is described below.

- WACIIH body-bus peripherals
  one important goal of the WACIIH design is to make it as easy as possible to connect a wide range of sensor and IO devices to the system. The WACIIH body-bus supports both USB and I^2C protocols, making it easy to connect COTS (cheap, off-the-shelf) USB devices like cameras and microphones as well as custom microcontroller-based I^2C sensors and peripherals. The WACIIH body bus provides power as well as data connectivity, and makes it easy to place these devices anywhere on the body.

As of October 15, 2001 working WACIIH body bus peripherals include: USB cameras and Microphones and Headphones.

- WACIIH specialized peripherals
  As of October 15, 2001 functioning non-body-bus devices include:
  - An LCD driver, Digital to Analog and analog circuitry on a companion board.
  - A re-cabled keyboard and modified touchpad mouse, which are hot-swappable through an exterior plug.

THE WACIIH VISION

The WACIIH project is driven by the need for a truly functional, wearable, and flexible research platform for context-aware wearable computing research, and inspired by the work of many researchers, professors, colleagues and friends. Our goal is not simply to build a platform, but to build a community of researchers, designers, and users. There is a great deal of technical depth and hard engineering behind WACIIH, but first and foremost WACIIH is about people and our desire to make people's lives better.

The WACIIH vision includes the following thoughts:

People Vs Users

The design philosophy of WACIIH starts with people, not "users." One might *use* a hammer or PDA, but a person *wears* a watch or a shirt; the watch and shirt are always functioning and require a minimum of the wearer's attention.

Wearable computing is technology you live with; it must be synergistic, flexible, and adaptable to a wide range of circumstances. Our goal is to learn how to support people in their daily lives, which mean building technology that is reliable, comfortable, useful, and makes maximal use of the time and attention of the person wearing it.

Human Computer Interaction

Before we can make technology useful, we must understand the ways in which it can be used. In the case of wearable computing, no amount of sophistication in the hardware or computation will make up for a poor interface. Bad HCI on the

desktop is annoying, bad HCI in a wearable is life-threatening. In order to build wearable applications and systems which are useful, we must first understand how people interact with the real world and each other. By understanding, sensing, and modeling these interactions, we can build interfaces and applications which facilitate and support people, rather than getting in their way.

Context Awareness and Human Computer Interaction

We believe that context awareness is critical to good wearable HCI. Context, or non-explicit user input, is gathered through sensing and modeling the person's environment, state, and task. By knowing something about where the person is and what they are doing, we can create interactions which proactively support, anticipate, and facilitate the person's task.

Research Applications

As much as possible we hope to make WACIIH development a research application driven process; it is easy to loose sight of the overall goal (doing research to create technology that helps people) if we do not constantly tie the development process back to the research we want to do in the first place. For

this reason we are committed to deploying research applications as quickly as we can with the tools available.

WACIIH Community

By making our designs and research available on the web, we hope to foster a community of WACIIH researchers, developers, and (eventually) users. Over the coming months expect to see detailed plans (schematics, part lists, CAD files, *etc.*) for WACIIH components as well as source code and other technical documentation. Please be patient; we are still in the prototyping phase and must still hand-build (and blue-wire hack) our boards, connectors, and cables to make them work.

If you wish to be notified when new WACIIH information becomes available, please send email to gaganbindra@yahoo.com and ask to be subscribed to the WACIIH announcement list.

FEATURES

WACIIH boats the following features:

1) Fully Mobile Computing Platform
   WACIIH is a fully mobile platform which the users can wear on their body throughout the day and can conveniently put it to use to supplement their personal memory and processing capabilities.

2) Easy Wear
   WACIIH is built to be worn over the body. Its users can easily wear it like any other clothing material. There are no fuss, just plug in the devices – put in the power and compute.

3) Fast Processing Support
   WACIIH incorporates fast processing capabilities owing to its fast Intel Pentium II 350 MHz Processor and 128 MB of RAM, which is beyond the capacity of any other Personal Data Assistants.

4) Networking Support
   WACIIH has inbuilt network support for both 10Mbps Ethernet LAN's and 56 Kbps Dial Up connections through its Network Card and Modem.

5) Multimedia Included

WACIIH includes all the capabilities of Multimedia based computations. You can watch pictures; listen to songs and watch thrilling Movies while on move. You can even create your own multimedia to limited extends. You can record Voice and Video while on the fly at any moment and save them for future reference.

6) Video and Voice recording

WACIIH includes an on board Yamaha sound card, which enables users to record voice and sound in Stereo Channel through its microphones. It has an onboard Web Camera mounted with the Head Mounted Display Unit which can record video at up to 12 fps 320*240 pixel resolutions, or take snap shots for up to 640*480 pixel resolutions.

7) Voice Commands

WACIIH incorporates Voice Based Commands, so that users can talk to and voice command their personal WACIIH computers.

8) Integrated TV

WACIIH has an inbuilt Television which can allow VHF channels 2 to 12 and UHF channels 21 to 69 to be watched on the LCD display unit.

9) Dual Operating Systems

WACIIH runs on both Microsoft Windows and Linux Operating Systems giving its users a flexible choice of their liked Operating Systems.

10) Convenient Input Devices

WACIIH input devices include a conveniently palm mounted Touch Pad unit from Synaptics acting as mouse. An external keyboard may also be attached at any moment to its PS2 ports.

11) Large Secondary Storage

6.4 GB may seem a little for today's desktop PC's, but for a mobile environment it is large enough to meet all demands of its users.

12) Dual Video Out Support

WACIIH gives dual video out support so that you can take its video to a CRT Display Terminal or a LCD unit through its conventional VGA out port, or may have display directed to a Television set through its onboard VGA to Video converter.

METHODOLOGY

The whole project has been divided into phases to make planned development possible resulting into least wastage of valuable resources and proper documentation at each step. The following phases were a part of the whole development process to date:

- Phase-I: Conceptualization
- Phase-II: Design and Diagrams
- Phase-III: Construction

Phase-I: Conceptualization

Freedom has always been into the blood of mine. Freedom of thought and freedom of deeds always has put me on a path where I could make decisions wherever I am and in whatever situation I am in based upon my present knowledge of my environment. Computers are into my blood stream. I dream, think, eat, play and compute on computers. I always had wanted freedom to compute at any time, whatsoever I want and wherever I want.

Another area where my stimuli get excited is the field of Robotics and Human Computer Interaction. Working in these since last 10 months, in one of the research projects in the field of Robotics, I had realized the fact that I could

make my Robot completely independent if I could incorporate a mobile computing platform over its body. In that case the Robot would carry on itself a complete computer enabling it to make all sorts of necessary decisions it is supposed to make.

Both the above thoughts coming together wrapped up into another great idea of developing a wearable computer for myself and demonstrate how mobile computing technology can not only be useful for Robotic devices but also to Human beings.

Dreams were with me from time a long but the real thoughts came almost 8 months ago which marked the beginning of this project - which you have in front of you – my new invention – WACIIH – The Wearable Computer.

Phase-II: Design and Diagrams

WACIIH has a very interesting design. It consists basically of three core parts: the Body Mount, the Head Mounted Display and the Power unit. All these are connected through a Body Bus and a Body Network.

THE BODY MOUNT:

The Body mounts houses the Central Processing Unit mounted on a FIC VL-603 Main Board over the Intel LX Chipset. The main board has its specialty to support PII Processors (presently PII-300 MHz mounted) and consists of onboard Yamaha Sound Card, one Game Port, 2 * PS2 connectors, 2* Serial Ports, 2* USB Ports, one Parallel Port, support up to 512 MB RAM (128 MB presently mounted), 3* PCI slots and 2* ISA slots.

The main board has a 2*X Graphics AGP support and consists of Trident 4MB Video RAM 2*X AGP Card with Video Out support mounted on it. The main board has a D-Link 10 Mbps Ethernet LAN Network card mounted on one of its PCI slots and one internal modem on another of its PCI slots.

The main board has two IDE channels to support a maximum of 4 IDE devices. On one of these channels a 6.4 GB Seagate Hard Disk Drive is mounted as the Secondary Storage Unit as the Primary Master Drive. Optionally a CD-ROM can be mounted whenever required to any of the three remaining channels. An FDD channel is also provided by the board which can support up to 2 Floppy Disk Drives of 2.8MB maximum capacities.

This complete unit runs a body bus between devices not mounted directly on the main board. The main board itself is carried on a box made up of

hard board and Thermocol sheets to prevent leaking of electric shocks to the user and to act as a thermal sheath to the large amount of heat generated by the unit, so that it does not pass over to the user. The package is attached to Sleuths which can be easily worn by users over trousers, enabling them to actually wear their computer as any other clothing.

The Body Mount is powered by SMPS and a Body Network of electric wires carries electricity from the Power Unit to the Body Mount.

THE HEAD MOUNTED DISPLAY

The LCD, Web Cam, Head phones and Microphones are all mounted on a helmet which can again be conveniently worn by the user.

The LCD is taken out of a CASIO TV-880 hand held portable television unit. It is mounted on the helmet along with a Video input slot and its own Brightness/ Contrast controls. The Video Out of the AGP card is connected to the Video In of the LCD Display.

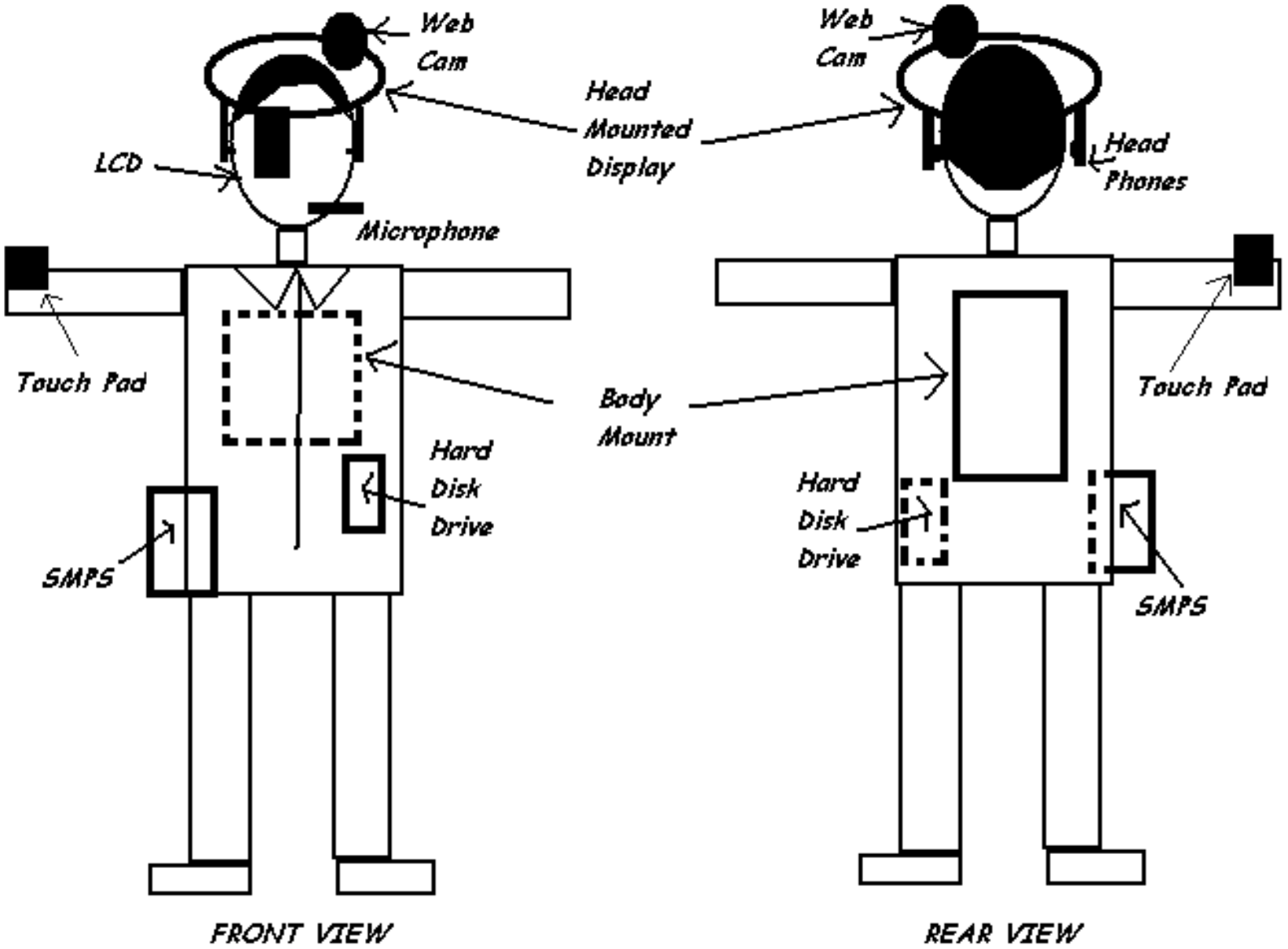
The Web Cam is connected directly to one of the USB Port of the main board. The AIWA microphones support Stereo recording and are connected to the

Audio in of the main board sound card. The Stereo headphones are again connected to the Sound Out connector of the Sound card on the main board.

THE POWER UNIT

The Power Unit is carried in another bag worn on the waist of the user for enhanced cooling and safety. It is a ATX SMPS, connected from one end to the 220 Volts standard electric supply of the house and on the other side its 5 Volt and 12 volt connectors are connected to the associated devices. The Power Unit carriage has Thermocol clothing to prevent electric shocks and heat to come in contact with its users.

The following diagram shows how WACIIH is worn



WEARING WACIIH

Phase-III: Construction

The steps of assembly of WACIIH are as follows:

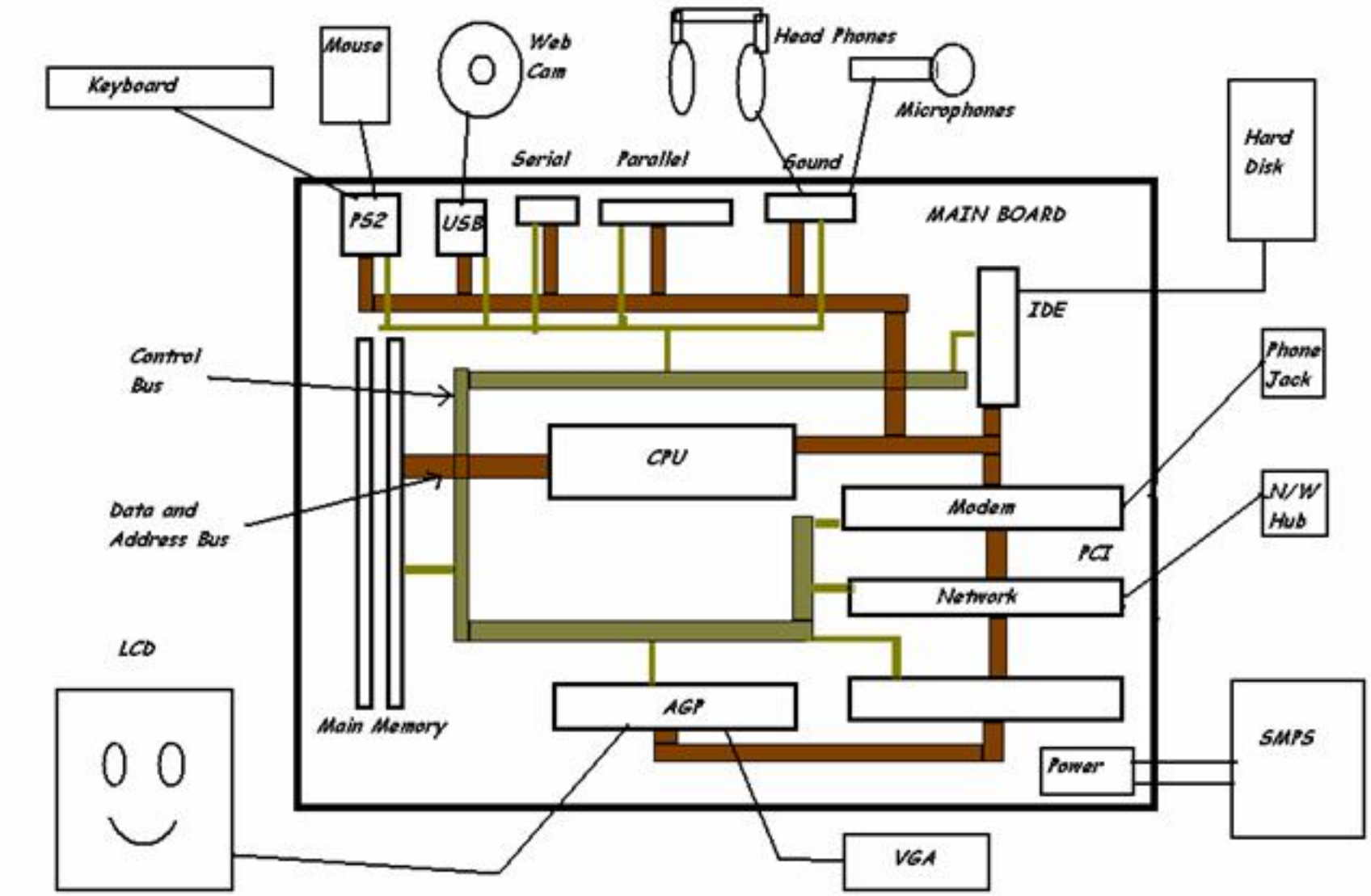
1) The CPU is mounted on the SLOT 1 type CPU slot of the Motherboard. The CPU fan is connected to its power slot.
2) Two 64 MB RAM modules are attached to the RAM mounts of the mother board.
3) The AGP card is mounted on the AGP slot of the main board.
4) Network card and Modem are mounted on the PCI slots.
5) IDE Channels are connected and on the Primary Master slot a Hard Drive is connected.
6) SMPS power cords are connected to the main board and to the various peripheral devices.
7) An external keyboard is connected to one of the PS2 slots.

8) The Touch Pad is interfaced with the other PS2 slot.
9) Video Out is connected to the Video Display In port of the Head Mounted Display.

10) Headphones and Microphones are connected to their respective connectors.
11) Power connectors are finally connected to a house hold power plug.

The main board is carried in a back pack type of arrangement which can be conveniently worn by the users on their body as a back pack.

The following diagram illustrates the functionality of the system



WACIIH Functionality Diagram

HARDWARE DESCRIPTION

Detailed specifications of the Hardware used in the construction of WACIIH are as follows:

1) FIC Motherboard

Processor Support: Intel Pentium II 350 MHz/ Celeron 300 MHz. max.
Processor Connector Type: SLOT 1
Chipsets: Intel North Bridge/ South Bridge.
Main Memory: 2 DIMM Sockets, 512 MB Max, PC-100 MHz.
Expansion Slots:
AGP: 2*X AGP Slot
IDE: Ultra DMA 66 Support.
PCI Slots: 3 Nos.
ISA Slots: 2 Nos.
Audio:
AC'97 V2.1 Audio Codec.
1 Game/ MIDI Connector.
1 Line In, 1 Line Out and 1 Microphone Connectors.
Infrared Support: Integrated.

Other Features:
Wake on LAN Connector.
Wake on Ring Connector.
Auto Modem Riser Connector.
ACPI Ready.
Concurrent PCI.
Smart BIOS – 2MB firmware.
Power: ATX
Form Factor: ATX

2) Intel PII-300Mhz CPU
SLOT 1 Type Connector
Speed: 300 MHz.
Family: Intel Pentium II
Core Voltage: 3 Volts.
Internal Bus Speed: 100 MHz.
Cache: 256 Kb.

3) RAM 128MB Hyundai
Make: Hyundai
ECC: Not Available
Internal Bus Speed: 100 MHz.

Type: SDRAM
Latency: 60ns.

4) Trident AGP 2X with Video Out
Make: Trident AGP
Video RAM: 4MB Not Shared.
Type: AGP 2*X
Video Out: 15 Pin D-Type
Analog Video: Supported.

5) D-Link Network Card 10MBPS
Make: D-Link
Connector: RJ-45
Speed: 10Mbps.
Protocols: IEEE 802.3

6) Hard Disk Drive Seagate 6.4GB
Make: Seagate ST36421A
Capacity: 6.4GB
CHS: 13300, 15, 63
Connector: IDE

7) CASIO LCD Monitor

Make: CASIO.
Type: LCD Color Display.
Display Element: High Resolution color liquid crystal display (T1-STN).
Drive System: Passive Matrix System.
Backlight: High Luminance fluroscent material.
Power Requirements: 6 Volts, 3.1 W.

8) FronTech SMPS

Make: FronTech.
Type: ATX.
Input: 115/ 230 Volts AC 50/60 Hz, 6/3 A.
Output: +12V, +5V, +3.3V.

9) Samsung Keyboard

Connector: PS2.
Keys: US English 104 Keys.

10) Synaptics Touch Pad Mouse

Connector: PS2
Type: Capacitive charging light Touch Pad

Buttons: 2

11) FIC Interface Cables
Type: 40 Pin IDE Connector Cables.

12) Logitech Web Cam
Type: Web Cam
Sensor: CCD 320*240 resolution.
Connector: USB
Frame Rate: max 30 fps.

SOFTWARE DESCRIPTION

Operating Systems Installed

Linux

To date, the operating system of choice for the WACCIH wearable computing program has been Linux due to the availability of drivers and applications, ease of programming, and the good community support

for the OS. I avoid Windows variants (especially Windows for Pens) due to the sloppy coding practices and lack of intelligent support I have experienced while working with this line of products. In addition, working drivers for new hardware tend to be written faster for Linux than for Windows (while commercial firms tend to write for Windows first, these drivers tend to interfere with other hardware on the machine). Time will tell if this has been a good choice.

Difficulties with Linux presently being faced include non-availability of Software Based Onscreen keyboard that can redirect input to other running programs from the commanding keyboard program. This makes it necessary to use an external keyboard which may be inconvenient for the users to carry along with them at all times.

Windows

Windows has been today the ‘THE Operating System’ for a large number of users around the world owing to its user friendly and straight forward nature. Indeed it is amongst the best Operating Systems ever produced. The undoubted winner of the OS race is included owing to its above mentioned features of Easy Look and Do computing nature and increasing number of Applications Software support.

I avoid Windows variants (especially Windows for Pens) due to the

sloppy coding practices and lack of intelligent support I have experienced while working with this line of products. Also Windows is a proprietary technology, closed to the confines of Microsoft and therefore it becomes very difficult to divulge deep into the corners and nitty-gritty of the Operating System itself.

Other Operating Systems
Other OS's of interest are Solaris (for its new mobility hooks and commercial support; by Sun), NetBSD (stability; by the net community), OS-9000 (real-time OS, small kernel, longevity, and rabid following; by Microware), and OS/2 (stability and commercial popularity; by IBM).

OPERATIONAL CONSTRAINS

The following operational constraints are involved while computing using WACIIH:

1) Needs a Power Source
   WACIIH needs a consistent power source of 220 volts from an external power supply unit like a power switch and plug, to power the SMPS unit

attached to the wearable.

2) Size of Head Mounted Display

The Head Mounted display is of very low resolution, specifically 352*248 pixels display, which by any standards today is a low resolution to display graphical images. Moreover the head mounted display is bulky, little heavy (about 150gms) and can not only cause inconvenience on long usage but also obstruct the normal view of the person wearing it.

3) Generation of Heat

The body generates a lot of heat which need to be dissipated through various means like fans, heat sinks etc. If accumulated, it can cause serious damage to the equipment and to the wearer.

4) No Integrated Keyboard

There is no integrated keyboard present with the system, so it needs an external keyboard to be inconveniently carried together for fast data and instructions feeding. Mostly the software based keyboard is being used in inputting the data and instructions through the use of a pointing device, which is slow.

5) Risk of getting hurt

There is always a risk of getting hurt from the equipment by entangling wires and high voltages. The user needs to take constant care while operating the Wearable Computer.

6) Exposure to extreme environments

The equipment may get damaged easily if exposed to extreme environments like direct harsh sunlight for long hours, or can get damaged by dropping it or subjecting to strong impacts.

PROBLEMS FACED

I faced genuinely the following problems while developing WACIIH:

1) Conceptualization of the system

The first step during any project development is the conceptualization of the system. It was very difficult task for me since there was absolutely no help, technical know-how, or book and documentation available for this kind of project. The whole project was done on self designing and experimentation.

2) Design of the Body Mount

Difficulty was faced during the design of the body mount of the system since the project presently is being done by me alone. The Body Bus and the Body Network was developed with great difficulty due to this since no external help for measurements etc. was available and had to be done by self.

3) The Head Mounted Display

The biggest challenge in the development of the project was the design of the Head Mounted Display. It was completely kept to personal knowledge and experience with electronics that I could successfully integrate my computing system with a Head Mounted Display type output system. No help was available in this regard of interfacing a VGA signal and PAL based video signal.

4) Finance

There was a large amount of financial constraints with this project. All the finances put in was generated by self by working in different other projects and through taking tuitions. No help was taken from anybody regarding financial matters, which may have resulted into increased time of implementation and lack of quality of production owing to purchase of cheap quality products. A lot of finances also got wasted in performing

experimentation into unknown areas of interfacing hardware devices before sufficient knowledge was gained to perform the task with confidence.

EXPENSES INCURRED TO DATE

The following table illustrates the expenses incurred in procuring parts and performing experiments for WACIIH

EXPENSE ITEM	AMOUNT
Computer Related:	
1) FIC Motherboard	Rs. 2700/-
2) Intel PII-300Mhz CPU	Rs. 3100/-
3) RAM 128MB Hyundai	Rs. 1100/-
4) Trident AGP 2X with Video Out	Rs. 1700/-
5) D-Link Network Card 10MBPS	Rs. 700/-
6) Hard Disk Drive Seagate 6.4GB	Rs. 3500/-
7) CASIO LCD Monitor	Rs. 3500/-
8) Frontech SMPS	Rs. 450/-

9) Samsung Keyboard	Rs. 450/-
10) Synaptics Touch Pad Mouse	Rs. 700/-
11) FIC Interface Cables	Rs. 300/-
12) Web Cam	Rs. 2900/-
Total:	Rs.21100/-

Other Miscellaneous

1) Stripes	Rs. 100/-
2) Thermocol	Rs. 30/-
3) Wires and Switches	Rs. 50/-
4) Fevicol	Rs. 50/-
5) Connectors	Rs. 40/-
6) Helmet Assembly	Rs. 300/-
6) Packaging and Postage Charges	Rs. 400/-
7) Customs Duty Charges	Rs. 350/-
Total:	Rs. 1320/-
GRAND TOTAL:	Rs.22420/-

APPLICATIONS

ELECTRONIC EYES:

A LCD on the helmet presented both text and images. I can use my camera to take snapshots and video of the environment round me and then zoom into or manipulate them to my convenience.

I can carry an electronic flash lamp that let me capture images in total darkness. An array of push-button switches controls the computer, camera, and so forth.

FINDING MY WAY OUT

I can use my computer to connect to internet and search for any information that I need at any time.

COMPUTING ON THE FLY

I use my computer to compute and keep my information at any moment of time. Thus saving me a lot of hardships in maintaining my required information at various places.

MULTIMEDIA

My invention enables me to see pictures, listen to songs or watch video whenever I am free.

AND LOT’s MORE…

SOCIAL ASPECTS

The early prototypes of wearable were quite obtrusive and often made people ill at ease, but more recently the apparatus has been gaining social acceptance. I attribute this partly to miniaturization, which has allowed me to build much smaller units, and partly to dramatic changes in people's attitudes toward personal electronics. With the advent of cellular phones, pagers, and so forth, such devices may even be considered fashionable.

When equipped with truly portable computing, including a wireless Internet connection and an input device, I find that people I talk with aren't even distracted by my looking at the screen. In fact, they cannot discern whether I am looking at my screen or at them, because the two are aligned on exactly the same axis. The problem of focal length can generally be managed by setting it so that the screen and anyone I'm talking with are in the same depth plane.

With enough light present, images can be incorporated into the note-taking process in a natural manner, without distracting the other person. Even in low light--for example, while talking with someone outdoors after dark--a small flash can be used during a conversation without breaking eye contact. The only distraction is the light from the flash itself, which may startle people at first (An infrared flash would be less obtrusive).

I hope that very near in the future, of course, we will not need keyboards and mice at all. A goal of personal imaging is to use the camera as the input device. A rough prototype of a "finger mouse" has already been developed, and it isn't hard to envision a system for inputting data using hand gestures.

FUTURE WORK

The project is not at all complete although it in its present form practically demonstrates to a very large extend the concept and utility of such a system. I would be working on the following grounds to improve on my Wearable Computer, as and whenever I would be able to support the finances needed for the same:

SOCIAL ASPECTS

Suppose that instead of just two people we have a networked community of individuals wearing computer clothing. This could be either a homogeneous community, all wearing the same form of the apparatus, or a heterogeneous community wearing several variations. People would most likely focus primarily on their own surroundings, but they could occasionally receive an image from someone sending an important signal. For example, someone anticipating danger might trigger a distress signal to others nearby over the Internet. Alternatively, the clothing itself could trigger the signal.

It may also be possible for people to incorporate wireless networks so that they may exchange information as soon as the computers come along to each other, like you would come to know the names and addresses of people you are standing along with, without any need to asking them.

HARDWARE ASPECTS

I would like the following hardware improvements to be made to my Wearable in order to make working with it fun and easy:

1) Procurement of better Head Mounted Display Unit
   A higher resolution Head Mounted Display unit is highly recommended for as application as this since the user can be given an enhanced and clearer view of the operating environment. So I would try to procure a better LCD display panel so that images in better resolutions can be displayed.

2) Development of Portable Power Supply Unit
   A portable power supply unit is required in order to provide complete independence of movement for the user. Presently the system requires an external power supply arrangement which seriously restricts the movements of the user in his environment. He can use his system only if he is present near to a power supply plug. The need of independence not only will provide more flexibility to the system but will make it surely more useful.

3) Implementation of Wireless Network
   A network allows computing systems to talk to each other and exchange

information. My present Wearable Computer does support networking features, but is restricted due to the used of a wired network. The user presently cannot move around freely while being connected to a Network continuously. In future a wireless network option will be introduced so that the users are not concerned about the frills of network wires and re connected to a network as soon as they enter the boundary of an operational wireless network.

4) Interfacing a Small Hand Mounted Keyboard

A serious limitation with the operational environment of the present system is the lack of an integrated physical keyboard. The user is either forced to carry an external keyboard or he must use a software based onscreen keyboard, which limits his data and instruction entry speed. I would also work on this regard and would provide a small hand mounted keyboard unit through which the user can conveniently and speedily enter his required information.

5) Use of PC-104 Main Board.

The system in its present form is built upon a relatively bulky Intel LX Chipset based Main Board. The job could have easily be done using a much smaller form factor based Main Board, like PC-104 series of Main Boards. These boards are not presently available in India, but can be

procured from foreign countries easily. So in order to reduce the size and weight of the system, such a Main Board can be well taken into consideration.

6) Better Hardware

Lastly the hardware may be upgraded to better configurations in order to make processing efficient and faster. Hardware may be chosen carefully in order to look for inter parts synchronization for enhanced efficiency. More hardware, like RAM, Audio/ Video Devices, storage units may also be added as the need arises.

FUTURE BUDGET ESTIMATES

If WACIIH is to incorporate above up gradations then we would incur the following expenses:

1) Procurement of better Head Mounted Display Unit

Rs. 30,000/- for a 800*600 Pixel Resolution Eye Mounted Unit.

2) Development of Portable Power Supply Unit

Rs. 15,000/- for circuit and Backup batteries to last 2 hours.

3) Implementation of Wireless Network
   Rs. 6000/- each Network Card installed.

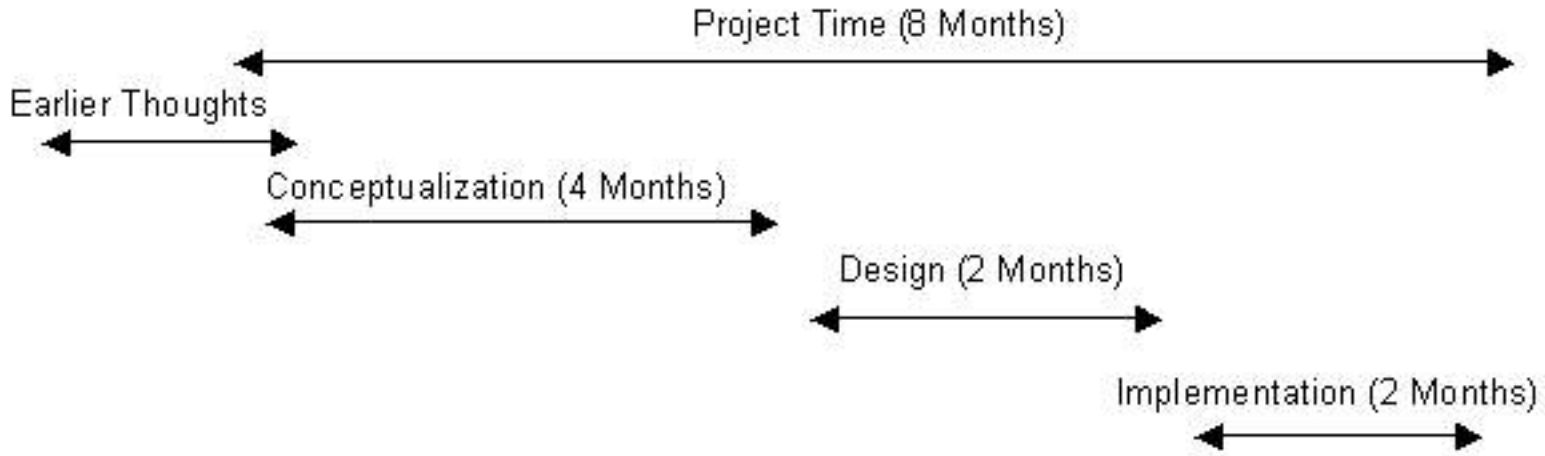
4) Interfacing a Small Hand Mounted Keyboard
   Rs. 3500/- for each Portable Keyboard.

5) Use of PC-104 Main Board
   Rs. 4000/- for PC-104 Chipset based Main Board.

6) Better Hardware
   Depend upon the hardware purchased.

GANTT CHART

The work on this project was being done for a long time. The following Gantt chart illustrates the time when various tasks were performed:



REFERENCES

The following reference material was consulted in developing the project:

BOOKS:

The following is the list of books that were consulted during the development of the project:

- Inside the Windows Operating System, Microsoft Press.
- Windows Kernel Internals, Microsoft Press.
- Interfacing Embedded Systems, Orielly Publications.
- The CGA/VGA Handbook.

- Digital Computers Fundamentals, Bartee.
- Microprocessors and interfacing, Programming and Hardware.
- Analysis and Design of Informational Systems, Senn.
- Data and Computer Communications, Stallings.

WEB SITES:

The following is the list of the Web Sites visited and consulted during the development of the project:

- www.wearables.stanford.edu
- www.mit.edu
- www.supercircuits.com
- www.ramseyelectronics.com
- www.cosource.com
- www.freedevelopers.com
- www.radioshack.com
- www.motioncontrol.com
- www.eio.com
- www.wirz.com

- www.technologyindex.com
- www.anandtech.com
- www.pricewatch.com

JOURNALS & MAGAZINES:

The following Journals and Magazines were consulted during the development of the project:

- Electronics for You.
- Digit.
- CHIP.
- PC Quest.

PLACES

The following places are deeply involved in the development of wearable computing:

- IBM’s TJ Watson Laboratory.

- Carnegie Melon University, Software Engineering Institute.
- Wearable Lab, University of Berkeley.
- The MIT Wearable Lab.
- IIPS, DAVV, Indore.

PARTICIPANTS

The following participants are involved in the development of WACIIH,

Gagan Bindra
9th Semester, MCA 6yrs. program,
IIPS, DAVV, Indore.

E-Mail:gaganbindra@yahoo.com
mailtostorm@yahoo.com
stormlabs@rediff.com

I, Gagan Bindra am a student at International Institute of Professional Studies, perusing 6yrs Master of Computer Applications Course and am currently studying in the 9th semester. My areas of interest include Robotics and

Human Computer Interfaces and Interactivity. My present projects in these fields include ROBAGS-I, which is a self navigating Robotic vehicle with capability to detect presence of simple objects coming in its path. I can be contacted at the above mentioned addresses. Please feel free to put forward any questions, doubts or clariferances. I would feel really happy to interact with anybody interested and willing to work with me in the above mentioned fields.

SPONSORSHIPS

The project was impossible to be done without any sponsorship owing to the great experimental, equipment and development costs. I sincerely thank **Mr. Gurveer Chabra, SIGMA PERIPHERALS**, for extending me the material support through sponsorships towards this project. His generosity and helping attitude has made this project practically possible. His is a computer peripherals business which is amongst the best that one can have in the city of Indore. He provides latest parts in best competitive prices as compared to any other vendor

in the city. He has showed excellent after sales service to all is customers and is very inclined towards helping the student generations in their endeavor towards gaining knowledge.I hereby mention his contact information for anybody to contact him for any sort of such help.

SIGMA PERIPHERALS
Mr. Gurveer Chabra
Ground Floor, Silver Mall
RNT Marg, Indore.
Ph: 98260-40036 (Mobile), 240036.

KEYWORDS

Wearable, Wearable Computing, Body Computing.