EMERGING TECHNOLOGIES

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FAITH • INTEGRITY • EXCELLENCE

OBJECTIVES

1. Understand the impact that emerging technologies will have in the future.
2. Define the use of emerging technologies –
   a) Cloud Computing,
   b) Big data concept and analytics,
   c) Data Centre and virtualization,
   d) internet of things,
   e) 4G/5g Mobile technologies,
   f) optical computing,
   g) quantum computing and quantum cryptography,
   h) virtual reality and wearable computing.
4. Define the ways in which certain technologies will impact homes of the future.
5. Describe some emerging technologies and their uses that are extreme.

OPTICAL COMPUTING

What is optical computing?

- An optical computer (also called a photonic computer) is a device
  that uses the **PHOTONS** in visible light or infrared (IR) beams, rather than electric current, to perform digital computations.
- An optical computer, besides being much faster than an electronic one, might also be smaller.
- Bright flashes of laser light can be sent hundreds of miles along fine strands of specially made glass or plastic called **OPTICAL FIBERS.**
- Instead of transistors, such a computer will have **TRANSPHASORS**
- These are switches that are activated by beams of light rather than by pulses of electricity
- And unlike transistors, transphasors can be built to handle several incoming signals at once

FEATURES OF OPTICAL COMPUTING

- Optical interconnections and optical integrated circuits have several advantageous over their electronic counterparts.
- They are free from electrical short circuits.
- Optical data processing can perform several operations in parallel much faster and easier than electrons.
- They are compact, lightweight, and inexpensive to manufacture
- Computing is that optical data processing can be done much easier and less expensive
- Optics has a higher bandwidth capacity over electronics, which enables more information to be carried

WHY DO WE NEED OPTICAL COMPUTERS?

- Rapid growth of the Internet
- Network speeds currently limited by electronic circuits
- Terabit speeds are required
- Traditional silicon circuits have a physical limit

SOME KEY OPTICAL COMPONENTS FOR COMPUTING

1. VCSEL (VERTICAL CAVITY SURFACE EMITTING LASER)

- *VCSEL (pronounced 'vixel') is a semiconductor vertical cavity surface emitting laser diode that emits light in a cylindrical beam vertically from the surface of a fabricated wafer*

- *There are two special semiconductor materials sandwiching an active*
  layer where all the action takes place.

- *But rather than reflective ends, in a VCSEL there are several layers of partially reflective mirrors above and below the active layer. Layers of semiconductors with differing compositions create these mirrors, and each mirror reflects a narrow range of wavelengths back in to the cavity in order to cause light emission at just one wavelength.*

2. SMART PIXEL TECHNOLOGY

• Smart pixel technology is a relatively new approach to integrating electronic circuitry and optoelectronic devices in a common framework.

• Here, the electronic circuitry provides complex functionality and programmability.

• While the optoelectronic devices provide high-speed switching and compatibility with existing optical media.

• Arrays of these smart pixels leverage the parallelism of optics for interconnections as well as computation. A smart pixel device, a light emitting diode under the control of a field effect transistor can now be
made entirely out of organic materials on the same substrate for the first time. In general, the benefit of organic over conventional semiconductor electronics is that they should lead to cheaper, lighter, circuitry that can be printed rather than etched.

3. WDM (WAVELENGTH DIVISION MULTIPLEXING)

- Wavelength division multiplexing is a method of sending many different wavelengths down the same optical fiber. Using this technology, modern networks in which individual lasers can transmit at 10 gigabits
  per second through the same fiber at the same time.
- WDM can transmit up to 32 wavelengths through a single fiber, but cannot meet the bandwidth requirements of the present day communication systems. So nowadays DWDM (Dense wavelength division multiplexing) is used. This can transmit up to 1000 wavelengths through a single fiber. That is by using this we can improve the bandwidth efficiency.

4. ADVANCES IN PHOTONIC SWITCHES

Logic gates are the building blocks of any digital system. An optical logic gate is a switch that controls one light beam by another; it is ON when the device transmits light and it is OFF when it blocks the light.

TYPES OF OPTICAL COMPUTERS

- **Optical Analog**
  - *These include 2-D Fourier transform or optical correlators, and optical matrix-vector processors*
- **Optoelectronics**
  - *This types of computing device would be to shorten the pulse delay in chips and logic elements by using optical interconnections*
- **Optical parallel digital computers**
  - *These would use the inherent parallelism of optical devices along with digital electronics for flexibility.*
- **Optical neural computer**
  - *Neural computers compute in the sense that they have streams of input and output bits.*

DEVICES USED FOR OPTICAL COMPUTING

- **Logic gates :**
  - *Logic gates implemented optically by controlling the population inversion that occurs to produce lasing. A controlling laser is used to control the population inversion thus switching to occur.*
- **Holographic truth table:**
  - *Destructive interference with light to be emitted or not is based on phase relationship.*
- **Logic based on gratings:**
  - *1 is represented by vertical grating causing light*
  - *0 is represented by horizontal grating causing darkness.*

DEVICES USED FOR OPTICAL COMPUTING

- **Holographic storage**: holographic data storage has 4 components:
  - ***Holographic material****: thin film on which data is to be stored*
  - ***Spatial light Modulator (SLM):*** *2D array of pixels, each of which is a simple switch to either block or pass light.*
  - ***Detector array****: 2D array of detector pixels, either as Charge-coupled device (CCD) camera or to detect existence of light.*
  - ***Reference arm****: arm carrying the laser source to produce the reference beam*

APPLICATION OF OPTICAL COMPUTING

- **Optical Computing In Communication**
  - *Wavelength division multiplexing*
  - *Optical Amplifiers*
  - *Storage area network*
  - *Fiber Channel Topologies*
    - **Fiber Channel Arbitration Loop (F C-AL)**
      - *Cost effective, low performance solution*
    - **Switched:**
      - *Better performance, more expensive*
    - **Hybrid topologies**
      - *Uses loops and switches as building blocks*

APPLICATION OF OPTICAL COMPUTING

- **Optical Computing In VLSI Technology**
  - *Many researchers have been investigating suitable optical logic devices, interconnection schemes, and architectures*
- **Optical computing as expanders**
  - *The optical expander described utilizes high-speed and high-space-bandwidth product connections that are provided by optical beams in the three dimensions.*

ADVANTAGES

- Small size
- High density
- High speed
- Low heating of junctions
- Dynamically reconfigurable and scalable into larger or smaller topologies and network
- Massively parallel computing capability
- Applications in artificial intelligence applications

QUANTUM COMPUTING

- Quantum Computer
  - *A computer that uses quantum mechanical phenomena to perform operations on data through devices such as superposition and entanglement.*
  - *Harnesses the power of atoms and molecules to perform memory and processing tasks*
  - *Parallel Processing – millions of operations at a time*
    - 30-qubit quantum computer equals the processing power
      of conventional computer that running at 10 teraflops (trillions of floating-point operations per second).

WHAT SPECIAL ABOUT QUANTUM COMPUTER.

APPLICATIONS OF QUANTUM COMPUTING

- Cryptography
- Artificial Intelligence
- Teleportation
- Quantum communication

VIRTUAL REALITY

What is Virtual reality?

- A three-dimensional computer simulation in which you actively participate
- Special input and output devices needed
  - *Glove*
  - *Headset*
  - *Walker*

Figure 1

What is Virtual reality?

- Virtual Reality means feeling the imaginary(virtual) world, rather than the real one. The imaginary world is a simulation running in a computer.

- Virtual reality is the term used for computer generated 3D environments that allow the user to enter and interact with alternate realities.
- The definition of ‘virtual’ is near and ‘reality’ is what we experience as human beings.

TYPES OF VIRTUAL REALITY

- Immersive Virtual Reality
- Non-Immersive Virtual Reality
- Window on world Virtual Reality

IMMERSIVE VIRTUAL REALITY

- Immersion into virtual reality is a perception of being physically present in a non-physical world.
- Elements of virtual environments that increase the immersiveness of the experience:

- *Continuity of surroundings*
- *Conformance to human vision*
- *Freedom of movement*
- *Physical interaction*
- *Physical feedback*

NON-IMMERSIVE VIRTUAL REALITY

- Non-immersive VR is a type of the virtual reality technology that provides users with a computer-generated environment without a feeling of being immersed in the virtual world.
- Large display, but doesn’t surround the user.

WINDOW ON WORLD VIRTUAL REALITY

- Desktop- based Virtual Reality involves displaying a 3-dimensional virtual on regular desktop display without use of any specialized movement tracking environment

APPLICATIONS OF VIRTUAL REALITY

- Will change the way we live our lives
- Will change how we interact with technology
- Generally thought of in terms of games and fun events
  - *Can help people cope with everyday life*
  - *Can help people with disabilities like autism*

ADVANTAGES AND DISADVANTAGES

Advantages

- Virtual reality creates a realistic world experience
- It enables user to explore places.
- Through Virtual Reality user can experiment with an artificial environment.
- Virtual Reality make the education more easily and comfort.

Disadvantages

- The equipment used in virtual reality are very expensive.
- It consists of complex technology.
- In virtual reality environment we can’t move by our own like in the real world.

Microsoft's Concept of Virtual reality

WEARABLE COMPUTERS

- A small portable computer that is designed to be worn on the body during use.
- Wearable computers are usually either integrated into the user's clothing or can be attached to the body through some other means, like a wristband.
- They may also be integrated into everyday objects that are constantly worn on the body, like a wrist watch or a hands-free cell phone.
- wearable computers differ from PDAs (personal digital assistant), which are designed for hand-held use.

HOW IT WORKS

- Some wearable computers use **“keyers”** (key switches mounted to a grip, rather than to a board, as with a keyboard) and trackballs as input device.
- Many try to use more intangible means of input like gesture, speech recognition or context awareness.
- The output may be presented through displays, lights, sound or even haptic interfaces(touch screen).

WEARABLE COMPUTING IMPLEMENTATION

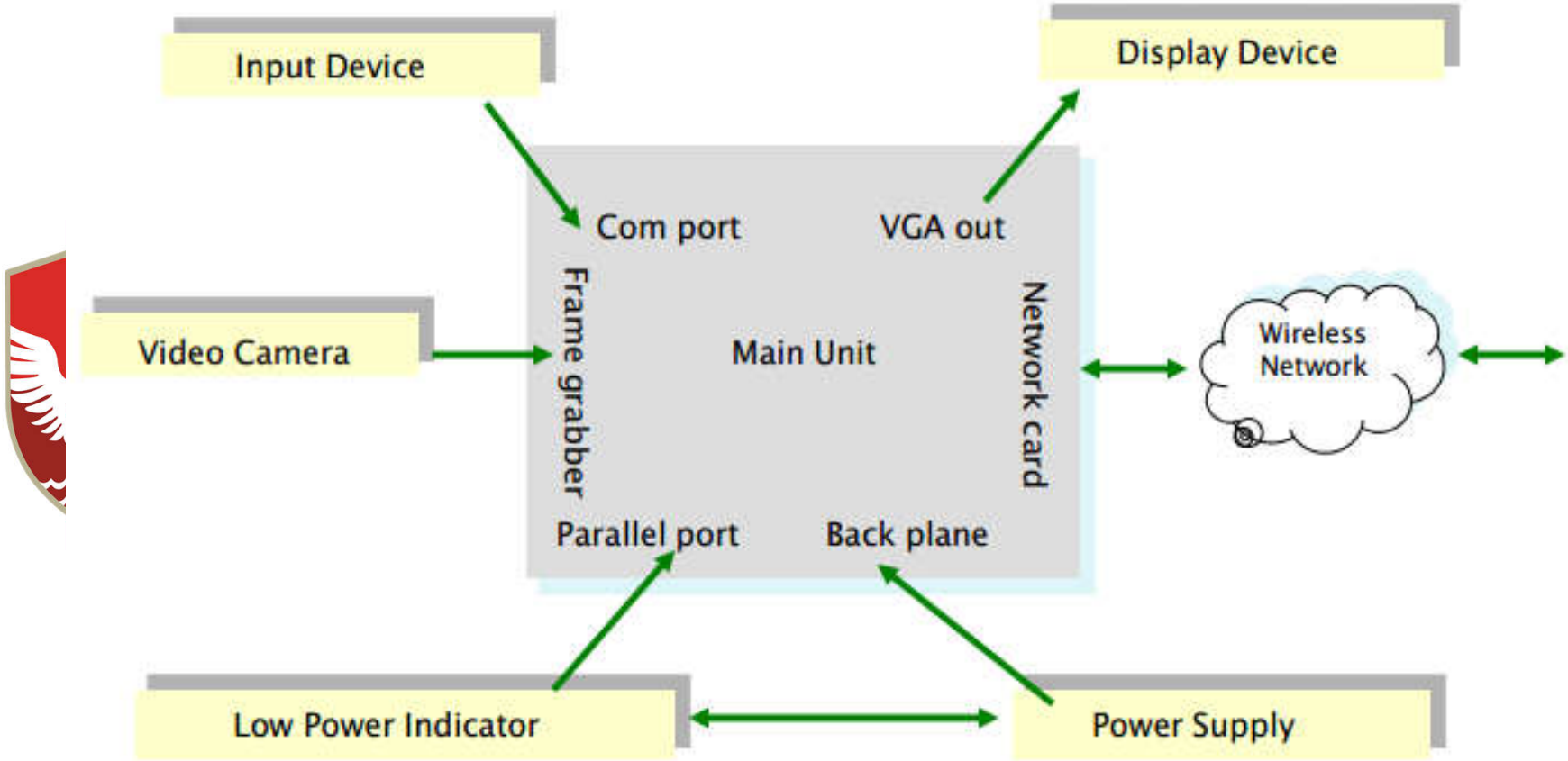

Figure 5 – Overall system block diagram

ADVANTAGES AND DISADVANTAGES

Advantages

- Enhanced Communication
- Able to use wearable computers to complete daily tasks such as a computer which tracks the movements and habits of a person.
- Flexibility
- Freedom
- Work from anywhere

Disadvantages

- Equipment can be heavy, Expensive
- Some Wearable Computers can consist of a lot of wiring
- Can be used to gain an unfair advantage over others
- It may become easier to get data on an individual if the item is lost/stolen

Continue with your research to know more

Thank you

God Bless You all