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Unit 131 - Multimedia and Virtual Reality

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Unit 131 - Multimedia and Virtual Reality

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Advanced Organizer

Unit Topics and Learning Outcomes

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Metadata and Revision History

Multimedia and Virtual Reality

1. Introduction to Multimedia and Virtual Reality

Multimedia (MM) - Computer systems allowing for integrated access to a range of data through the means of stiimulating human senses using digital technologies

Virtual Reality (VR) - Computer systems able to combine a mixture of real world experiences and computer generated material to allow for simulated real world representation

- Closely related technologies sharing some similar hardware and data usage

- From a Geographical Information System (GIS) perspective MM and VR are the means to an end - handling (integrating, storing, accessing and viewing) a multitude of spatial data using a variety of tools. Can be considered under the general heading of visualisation: methods therefore vary depending on whether usage is for private investigation or for public demonstration; whether data is accessed interactively or in a pre-determined manner; and whether there is data investigation and interrogation or whether mere presentation suffices.

- Multimedia data
  - multimedia covers the integration of:
    - images, video and graphics (both still and animated); including raster and vector data, maps, photographs
    - text; in a variety of forms including alphanumeric databases
    - sound
    - (potentially) smell and taste

- Multimedia tools
  - under computer control, allowing interaction with real world digital data in the form mentioned above (including spatial digital data) with 'hyper-card' tools, visualisation software, audio and video players

- Virtual Reality data
  - VR addresses the construction of artificial worlds, with clear spatial dimensions databases for VR can structure and store data using methods beyond the conventional abstractions of GIS

- Virtual Reality tools
  - under computer control allowing access to the artificial worlds with internet viewers, VR navigators and dedicated stand-alone hardware stations

- Among the important concepts in MM and VR are database construction and integration, and user navigation and interaction
  - the former can be achieved
    - using existing datasets or 'on-the-fly'
  - the latter can be done
    - real-time or can be pre-determined
    - can be in a fixed sequence or can be interactively led

- geographical data has a role in the enabling of such implementations, although there are implications for geographical data when included in MM and VR systems
  - data structuring; difficulty in altering or enhancing data; lessening the importance of a reference system for the data; user interaction with the data and the importance of representation, particularly in three and four dimensions

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2. Technological Issues

The hardware components of a multimedia and/or a Virtual Reality PC or workstation

- Multimedia requires perception and interaction with use of visual and auditory participation, i.e. the production of vision and sound, Virtual Reality additionally requires tactile and vestibular participation

- A typical multimedia PC must comprise of the following:-
    - A powerful PC with one of the most up-to-date processors
        - large amounts of on board memory
        - large capacity hard disk
        - e.g. in 1996, an Intel Pentium or Pentium Pro, 32MB RAM, high speed bus and SCSI 2.0GB hard drive
    - A high performance high resolution graphics processing capability
        - dedicated memory
        - specialist graphics microchips
        - high speed bus
        - e.g. in 1996 1024 x 768 resolution with 64k colour, PCI local bus, 2MB graphics memory
    - Very fast, multi-session, Kodak Photo-CD compatiable CD ROM drive
        - full screen, 25 frames per second Video-CD and MPEG playback
        - e.g. in 1996 Multimedia PC3 (MPC3) standard
    - High quality stereo sound and high quality wavetable sampling
        - Sound Blaster compatable card with 16-bit stereo sound
        - headphones
        - mains powered speakers
    - High resolution colour printer/plotter device
        - laser, ink jet, bubble jet
        - A mouse and keyboard

    Figure 1.

- A Virtual Reality system may be considered to be an expansion of a multimedia system into a multi-sensory system

- The additional components of a Virtual Reality PC or workstation may include any of the following
    - Tactile interaction
        - Head Mounted Display (HMD) - wide field of view, anamoriphically projected stereo
        - Tactile feedback devices, vibrotactile displays - teletactile feedback glove, virtual joystick
    - Force feedback
        - Teleoperation systems - force feedback joystick, remote manipulator arm, joystring
    - Vestibular
        - Motion platforms - flight simulators, motion simulators
    - Other interactive devices
        - 2 degrees of freedom (DOF) - mouse, joystick, 2-d tablet with gesture

recognition, touch screen
        - 6 degrees of freedom - wand, 6 DOF mouse, dataglove, force ball
        - Wired clothing - datasuit
        - Biological input (biosensor) - voice recogniser, skin temperature probe, myoelectric (muscle) sensor, cerebroelectric (brain) sensor

- For the processing of geographical data, e.g. a multimedia GIS, graphical output in both digital and hard copy form are of the utmost importance

- Graphics
    - Visual Display Unit (VDU)
        - cathode ray tube (CRT), traditional TV/monitor device
        - liquid crystal display (LCD), flat screen
    - Three dimensional (3D) display, this requires perspective and stereoscopic vision.
        - A single display unit presenting two images alternatively, arranged so that one eye sees each. This requires a rate of change greater than 50 times a second and the use of special spectacles with liquid crystal shutters, synchronised with the display, or polarised glasses and an alternating polarising of the display
        - Immersive graphical display devices such as head mounted display consisting of two miniature VDUs
        - Direct Volume Display Device (DVDD) generate images directly in a volume, users of DVDD see a solid volume that they can walk around
        - High Definition Television (HDTV)

- Interactive interface tools for access and manipulation
    - Keyboard
    - Mouse, trackball and joystick
    - A digitising tablet
    - Light pen - contains a photodetector at it's tip that enables the screen position to be calculated from refresh rate information
    - 3D pen position sensor
    - Data glove, transmits positional data from the wearer's hand movements

- Data storage
    - Hard Disk, usually internal, with capacities of up to tens of Gigabytes (GB)
    - Floppy magnetic disk, with capacities of up to tens of Megabytes (MB)
    - Magnetic tape, used for large capacity backup/archive storage, with capacities of up to units of GB
    - Optical storage, compact disk (CD), with a typical capacity of 650MB would hold over 1000 large scale (1:1250) 500km x 500km digital map sheets
    - Digital Video Disks, with a capacity of 4.5GB

- Multimedia on networks
    - Hypermedia systems are multimedia systems with link-based navigation
    - Distributed databases on Local Area Networks (LANs) and Wide Area Networks (WANs) and the international network, Internet
    - A World Wide Web (WWW) page or series of pages form a route through a

hierarchical or network model using Uniform Resource Locations (URLs) to both graphical (spatial) and textual (aspatial) data. Additionally to other media such as sound and video data
    - Access to the Internet using a Web browser such as Nescape Navigator or Microsoft Internet Explorer

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3. Computer Science Aspects

- Multimedia object modelling in GIS
    - Geographical access, coordinate based, place name, map region, arbitrary point
    - Hypermap concept - similar to hypertext document where texts are organised bysemantic units called nodes and associated with links
    - Icons, windows etc. represent multimedia entities in a database, linked by graphics means on the screen, e.g. a line, area, point or several of these
    - Many current 'relational' database management systems (RDMS) will store pointers to graphical, sound and video files using appropriate executable programs to process them
    - Simple relational model for multimedia data

        PICTURE1 (Image_ID, Format, Resolution, Capture_date, Filename)
        VIDEO1 (Film_ID, Time, Format, Filename)
        SOUND1 (Song_ID, Time, Format, Filename)

  Diagram of a more complex object model for multimedia data

- The data would be processed for retrieval by table name and format attribute value

  Diagram of a hypermap with multimedia data linked to an area

- Queries for retrieving Hypermap nodes would use conventional GIS spatial query (select graphical node, define area, buffer zone etc.) and SQL, textual, semantic matching

- Advanced Hypermap systems will match images, video and sound sequences, with data of the appropriate media, held in the database

- Standards exist for multimedia data
    - Image formats - TIFF, BMP, GIF, JPG, PCX, WPG, etc.
    - Video Data - NTSC (National Television Standards Committee), PAL (PhaseAlternate Line), SECAM (Sequential Colour and Memory)
    - CD-ROM - CD-RX (CD ROM Read-Only Data Exchange), DXS (Data Exchange Standard) for CD-ROM file systems. Colour Book Standards (Philips and SonyCorps)

- Compression of graphical data
    - Uncompressed Image
        - true colour 800 x 600 pixel image requires 1.44MB of disk space

        - a 10 second video clip played at 30 frames per a second, with a resolution of 320 x 200 pixels, and in true colour requires 57.6MB of storage
    - Compressed bitmap formats
        - Still image
            - JPEG (Joint Photographic Experts Group) can compress images from 2:1to 160:1 using a symmetrical compression algorithm. This is a 'lossy' scheme as reconstructing an exact replica of the original is not possible
            - LZW (developed by Lempel, Ziv and Welch) is a 'lossless' scheme which substitutes more efficient codes for the data
            - Fractal image compression (used by Microsoft in the Encarta multimedia encyclopedia) uses Fractal segments and three-dimensionalaffine transformations
            - Compression and decompression for JPEG and LZW take about thesame time. However Fractal compression takes much longer; eight minutes compared to 41 seconds (JPEG) while decompression is faster, seven seconds compared to 41 seconds (JPEG)
            - Compressed images are resolution dependent
        - Video, moving images
            - MPEG (Motion Picture Experts Group) is the standard, it uses intraframe coding, which removes redundancies within individual frames,50:1 compression rates are possible
            - Px64 is the video conferencing standard compression algorithm of CCITT Consultative Committee International Telegraph and Telephone)

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4. User Interface

- Multimedia relies on "hyper-links" which ensure integration of "documents" or "pages"

- Hyper-links can be initiated through "hot-spots" defined by:
    - text
    - coordinated position
    - area of image
    - embedded objects

- VR can incorporate similar linkages and also requires sophisticated graphic displays, possibly including stereo viewers, moving chambers, audio, etc (See Section 2), along with'cursor' positioning, possibly in four dimensions
    - Types of interaction
        - passive or active
        - natural (language, spoken word) or artificial ("fly-bys")

- "Free-form" active navigation of data is user-controlled and needs
    - navigation tools

joysticks, mouse, pointer
  - browsing and searching tools
  - querying and reporting capability
  - visual "trails" to monitor navigation
    - preview of any 'pre-set' routes
    - overview showing complete 'map' or virtual world being used
    - "you are here" indicating relative position
  - recording the thread
    - producing a route plan of locations accessed or journey undertaken

- Cognitive aspects of interfacing with MM and VR have been researched
  - 'free-form' navigation possibilities may lead to a lack of focus and inefficient interaction
  - real world problem solving may be difficult in these environments
  - multi-sensory access to spatial data may lead to information overload
  - improvements in realism and more naturalistic interaction with data may improve decision making

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5. Interaction with Geographic Information

- New search languages are being developed such as OO-SQL and MM-SQL both part of SQL3 to aid in searching MM data

- 3D and MM data can either be attached to the GIS as attributes of 'standard' datasets or be used as data sources directly to which further information is then added

- MM data allows for
  - opening of GIS to more people
    - change in the application of spatial information
    - aid in enticing a younger audience to be involved
  - creation of 3D models from still and video imagery

- VR can be used in a GIS in two ways
  - a tool for purely viewing three dimensional models of data
    - this can be purely in an office situation or in the field overlaying three dimensional data on top of real world data
    - applications of the latter in underground pipe work, user can 'see' network under their feet
  - the whole user interface to the GIS dataset, allowing for the display of VR, MM and standard data in three dimensions
    - this would envolve the creation of a virtual interface
    - possibility of viewing any data easily from any angle

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6. Applications

- Anywhere the "limited sensory bandwidth of current GIS representations of the world" (Shepherd, 1991) needs to be extended
    - to overcome the stylised and conventionalised picture of the real world which GISoften gives, by constructing VR interfaces to spatial databases and by using MM integration of disparate data sources

- Education
    - self-led interaction with the real world, especially for children
    - introducing geographical concepts, displaying distant 'realities'
        - possibilities, using MM and VR, of the 'virtual fieldtrip'
    - use of MM for local studies and global geography knowledge building, whilst integrating with other National Curriculum subjects such as history, economics, biology, geologyand information technology

- Scientific research
    - creating three and four dimensional views of spatial data
    - preliminary views of integrated data sets prior to verification of data linkages and casualtiess
        - MM integration and overlay of datasets, for example; vector data with attribute information on raster satellite imagery
    - exploratory data analysis in "virtual worlds"
    - physical geography data, e.g. meteorological, geological, oceanographic data ideallysuited to its four dimensional nature
        - VR applications include environmental monitoring, hazard and risk assessment, atmospheric modelling, planning and forecasting, pollution analysis, terrain visualisation, multi-variate analysis

- Military
    - for training purposes and scenario building, particularly VR representations of terrain

- Entertainment
    - improving realism of interaction with spatial data

- Built environment
    - VR applications in architectural simulation, urban planning, resource modelling

- Archival of geographic information
    - MM storage of the disparate range of data which can convey geographical information

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7. Potential

- The future for both MM and VR is developing rapidly, input is coming from both the entertainment industry and military as well as major software houses

- Increased usage of all five senses

  - in 1996, only have sight, sound, touch
  - experimental ideas in smell
  - little approach to the idea of taste

- Advancement to the masses requires more computer power at lower price range giving
  - photorealistic shading of VR models in realtime
  - immediate response and display update
  - high resolution images

- VR and MM across the web
  - Already have basic MM and VR across the internet using Web browsers
    - Developments need to be made in the searching and indexing of multimedia data sources
  - HTML, VRML, Java are 'on-going' developments to aid in distributed data
  - The Superscape product is currently, in 1996, the closest so far to true VR across the WWW
  - Development of the WWW into a better, more organised, system than in 1996

- Open system technology
  - creation of distributed computing for GIS in general
  - seemless remote data object access
  - use of remote application objects
  - driving force is the Open GIS Consortium

- Data availability
  - still only really use and collect static 2D
  - move to full 4D data sets
  - data collection with MM and VR applications in mind
  - removal or lowering of cost and copyright restrictions

- More public applications
  - Currently just visualisation in main
  - More analysis of MM and VR data

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Metadata and Revision History

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2. Details about the file

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3. Key words

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6. Subsequent units

7. Other contributors to this unit

8. Revision history

- August 1996 - created
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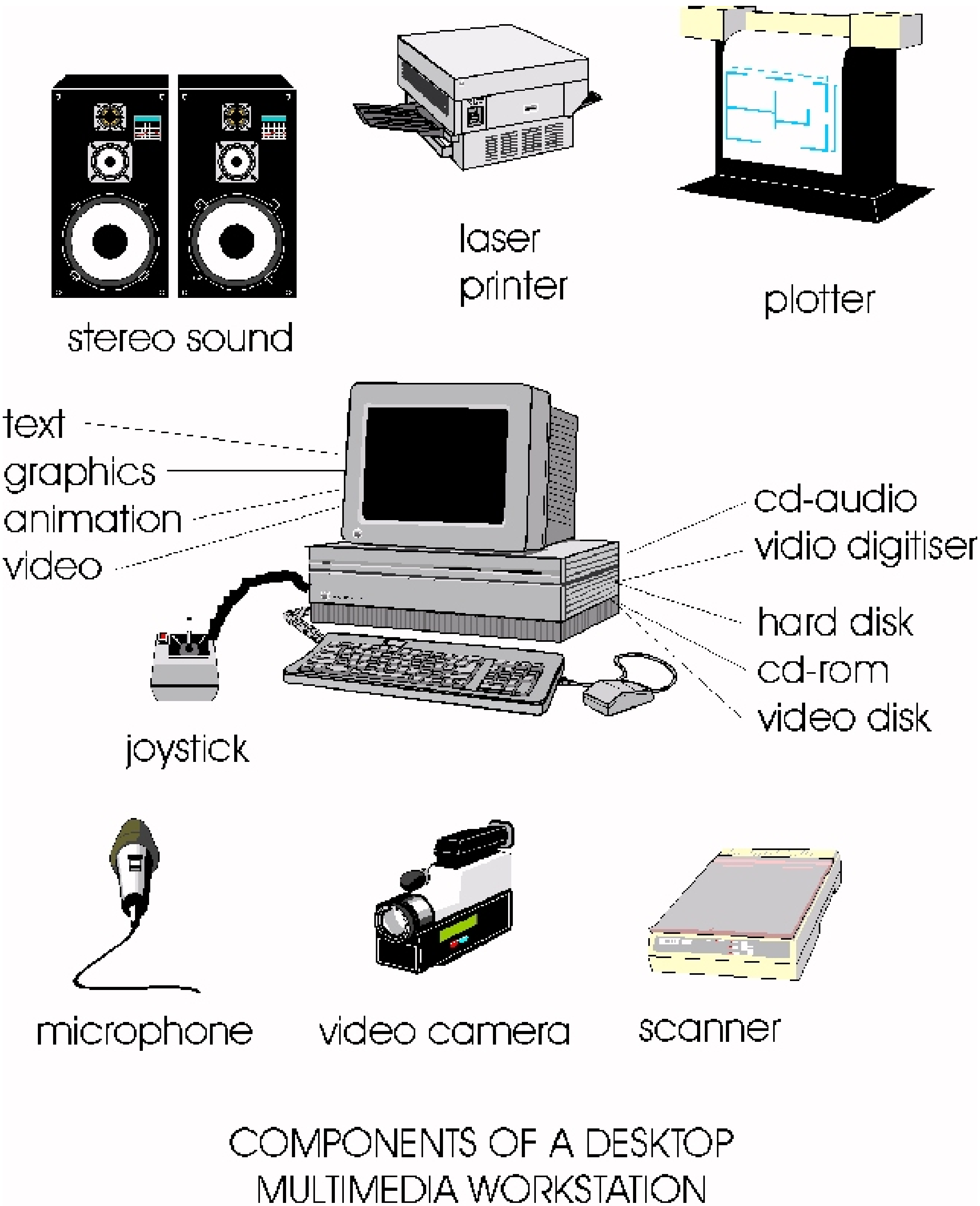
Back to the Unit.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laser
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text
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video
cd-audio
vidio digitiser
hard disk
cd-rom
video disk
joystick
microphone
video camera
scanner
COMPONENTS OF A DESKTOP
MULTIMEDIA WORKSTATION

Figure 1.