Geographic information systems (GIS)

Hardware components

The hardware of a GIS is composed of:

- Input devices.
- Processing and storage devices.
- Output devices.

Input devices:-

Digital data input depends on the type of data to be utilized.

Imagery input is possible from analogue images through the use of image scanners. Digital airborne and space-borne systems already use charge-coupled device CCD-sensors to supply the data in digital form.

Light falling onto a semi-conductor is transformed into an electric charge and into electric current. The light energy is proportional to the electric current, and thus brightness measurement becomes possible.

Area CCDs are capable of providing a full frame transfer of a shutter released image at full resolution. However, they suffer from long read-out times. Future CMOS technology may overcome the current size limitations of area CCDs. High-resolution systems therefore prefer the use of long linear arrays operated as push-broom scanners, which

integrate charges and read them out line by line, without the use of a shutter.

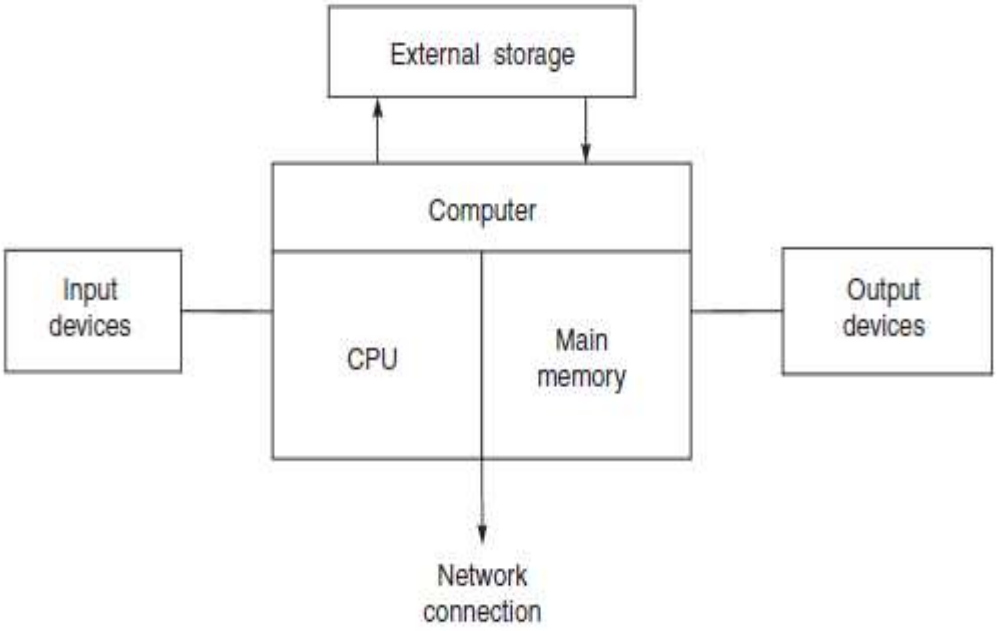


Figure illustrate the hardware components.

For analogue and for digital images a resolution of 50lp/mm can be reached.

Maps can be manually digitized by two-dimensional digitizers in vector form. This is possible in a single point mode or by dynamic measurement based on distance or time. The resolution of digitizing is about 0.2mm.

This is achieved by a fine wire grid inside the digitizing table. Digitizers are available for an A2 format or larger.

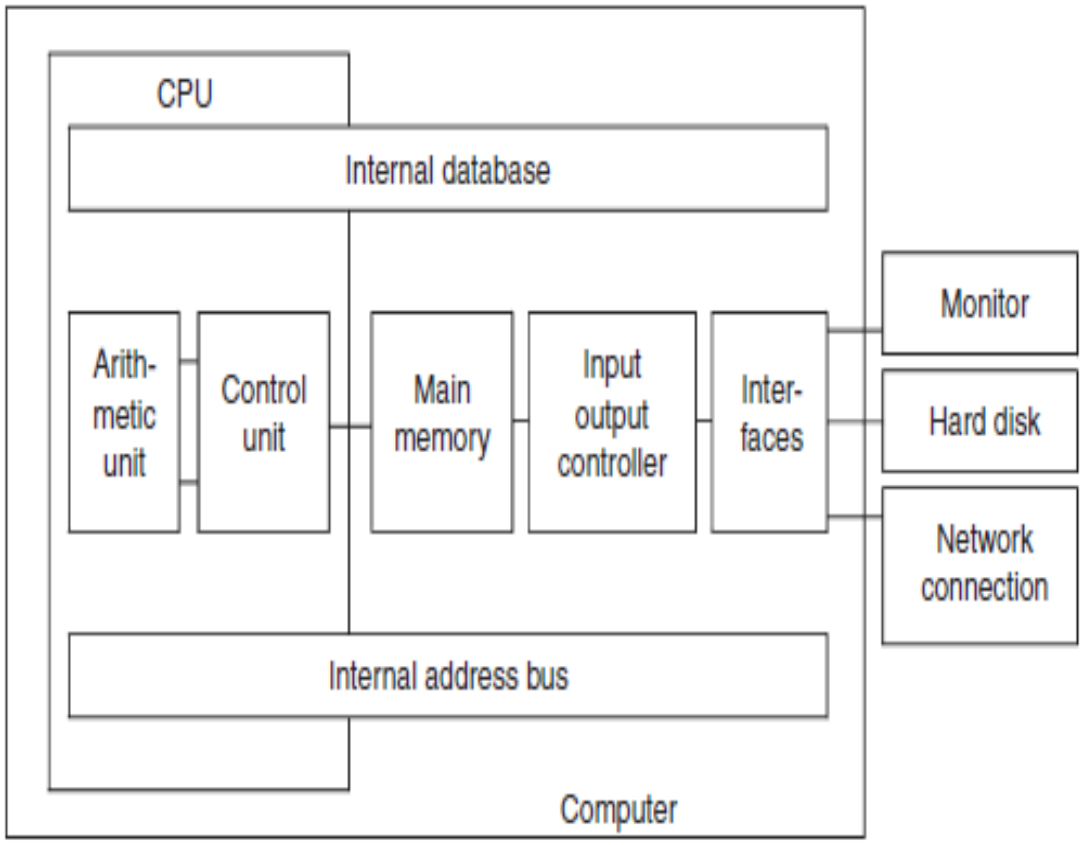
Maps may, however, also be raster scanned using scanners. These are available as drum scanners or as flat-bed scanners with a pixel size of 7mm and an accuracy of 2 to 4mm. They range from inexpensive desktop scanners limited in geometric and radiometric resolution to expensive but accurate cartographic scanners varying in geometric and radiometric resolution, their transparent or opaque use, and their suitability for black and white or for colour scanning. Scanned raster data may subsequently be converted into vector information with GIS software. 3D-vector data can be obtained directly by terrestrial survey equipment, such as:

- Theodolites.
- Electronic tacheometers.
- Levelling instruments.
- GPS receivers.
- Mobile mapping systems.

3D information from aerial photographs may be compiled by analogue or analytical plotters or by digital photogrammetric workstations.

Processing and storage devices:-

Processing and storage devices consist of the central processing unit (CPU) and the main memory, the external storage devices and the user interface (see Figure below).



The CPU executes the program commands. Its arithmetic unit performs algebraic and logical operations for the data. Its control unit regulates the data transfer between arithmetic unit and the main memory.

The *main memory* (random access memory, or RAM) contains the machine programs and accepts data in short access time with caching, if required. The *I/O controller* communicates with the periphery for hardware ports and for software drivers. The *bus system* establishes

the connections. To speed up the output process, additional graphic cards and memory are usually added as interfaces.

Criteria for the CPU's performance are:

• The processor speed (over 300MHz).

• The internal data format (32 or 64 bit).

• The external data format between the CPU and the main memory (64 bit).

• The physical memory (over 4 GB).

• The computing performance (over 2000 MIPS).

Output devices:-

Output devices include the ports to printers. Specific to GIS are the following graphic output facilities.

Vector devices are flat-bed plotters and drum plotters. Flat-bed plotters have an accuracy of 0.05 mm at a speed of 30m/min operated with a pen or a light beam. Drum plotters are less accurate but faster (300–900m/min). They are used for verification plots.

Raster devices permit the output of halftones in a pixel or a screened manner. They are able to print RGB in different saturations.