Topic: 1.3.3 Input devices

An information system cannot do anything until you give it some information to process. Input devices transfer data into a computerized information system so that it can be processed. Remember that the computer does not process **information**; it processes **data**.

An input device transfers data from the outside world into a computer.

There are two different categories of input device. They are:

- Manual Input Devices: With a manual input device the user must enter data into the computer by hand. E.g. mouse, keyboard, scanner.
- Direct Data Entry (DDE) Devices: A direct data entry device can transfer information automatically from a source document such as a form or barcode into the computer. The user does not need to manually enter the information. E.g. optical mark recognition, smart cards.

There are many different input devices available. Each input device is suitable for a different purpose.

- Graphics Tablets
- Cameras
- Video Capture Hardware
- Trackballs
- Barcode reader
- Digital camera
- Gamepad
- Joystick
- Keyboard
- Microphone
- MIDI keyboard
- Mouse (pointing device)
- Scanner
- Webcam
- Touchpad
- Pen Input
- Microphone
- Electronic Whiteboard

Topic: 1.3.3 Input devices

Now you will see the working of some of the input devices:

SCANNERS

2D SCANNERS:

A scanner is a series of charge coupled devices (CCDs) (an array of photosensitive cells) mounted in a stationary row that registers the presence or absence of light reflected from a piece of flat art. This spot of light is then the "pixel" equivalent of the dot on the paper. The entire scanned image is built up row by row as the light scans the paper and is reflected onto the CCD.

The number of pixels horizontally is controlled by how closely the CCDs are placed next to each other along the single row. The number of pixels vertically is controlled by how slowly the light bar and mirror inch along the length of the flat art thus reflecting onto the CCDs. Therefore, the more CCDs and the smaller the steps of the advancing light bar the greater the resolution. Typically the resolution available is 600 dots per inch for full color (just 3 separate scans with filters).

- **Line Art** scanning is simply transferring pen and ink style drawings, clip art, and some pencil sketches into the computer system. Line Art has neither shading nor color other than black. Line Art scanning is considered 1-bit scanning, that is the computer sees the image as either black or white.

- **Grayscale Scanning** is most often used for original photographs, but can also be effective for maintaining the soft edge of some pencil sketches that use lots of shading. Most good flatbed desktop grayscale scanners are now capable of scanning 256 shades of grey.

- **Halftone Scanning** is essentially a grayscale scan with processing to reduce the threat of more patterns. (These are caused by the scan sampling interfering with the printing sampling due to the halftone printing process).

- **Color Scanning** is done on a continuous-tone device in a non-screened system that is capable of applying the entire range of its colors to the smallest picture element that it can reproduce. In effect, this means that the device is capable of making any spot on its output any color you wish.

Topic: 1.3.3 Input devices

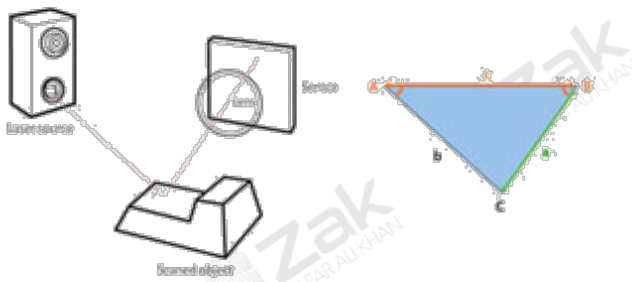
3D SCANNERS:

There are many different devices that can be called 3D scanners. Any device that measures the physical world using lasers, lights, or x-rays and generates dense point clouds or polygon meshes can be considered a 3D scanner. They go by many names including 3D digitizers, laser scanners, white light scanners, industrial CT, LIDAR, and others. The common uniting factor of all these devices is that they capture the geometry of physical objects with hundreds of thousands or millions of measurements.

There are many different approaches to 3D scanning, based on different principles of imaging. Some technologies are ideal for short-range scanning, while others are better for mid- or long-range scanning.

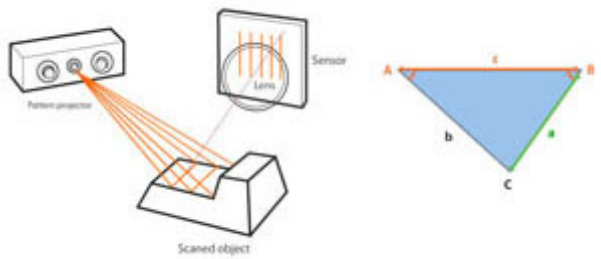
Short-Range (<1 meter focal distance)

Laser Triangulation 3D Scanners



Laser triangulation scanners use either a laser line or single laser point to scan across an object. A sensor picks up the laser light that is reflected off the object, and using trigonometric triangulation, the system calculates the distance from the object to the scanner.
The distance between the laser source and the sensor is known very precisely, as well as the angle between the laser and the sensor. As the laser light reflects off the scanned object, the system can discern what angle it is returning to the sensor at, and therefore the distance from the laser source to the object's surface.

Structured Light (White or Blue Light) 3D Scanners



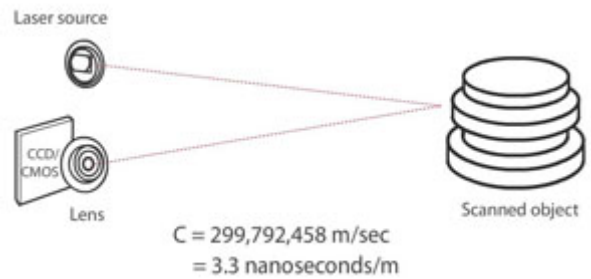
Topic: 1.3.3 Input devices

Structured light scanners also use trigonometric triangulation, but instead of looking at laser light, these systems project a series of linear patterns onto an object. Then, by examining the edges of each line in the pattern, they calculate the distance from the scanner to the object's surface. Essentially, instead of the camera seeing a laser line, it sees the edge of the projected pattern, and calculates the distance similarly.

Short-range 3D Scanner Types	Pros	Cons
Laser triangulation	Available in many forms Area scanner Handheld Portable arm Often more portable Less part prep needed Less sensitive to ambient light	Generally less accurate Generally lower resolution Higher noise
Pattern fringe triangulation	Usually more accurate Often higher resolution Lower noise	Limited to area scanner type Generally not as small/portable More sensitive to surface finish (requires prep) May require specific lighting

Mid- and Long Range (>2 meters focal distance)

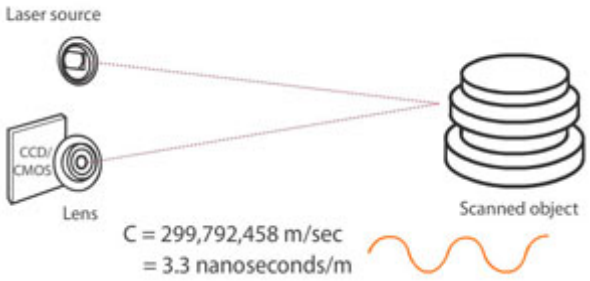
Laser Pulse-based 3D Scanners



Laser pulse-based scanners, also known as time-of-flight scanners, are based on a very simple concept: the speed of light is known very precisely, so if we know how long a laser takes to reach an object and reflect back to a sensor, we know how far away that object is. These systems use circuitry that is accurate to picoseconds to measure the time it takes for millions of pulses of the laser to return to the sensor, and calculates a distance. By rotating the laser and sensor (usually via a mirror), the scanner can scan up to a full 360 degrees around itself.

Topic: 1.3.3 Input devices

Laser Phase-shift 3D Scanners



Laser phase-shift systems are another type of time-of-flight 3D scanner technology, and conceptually work similarly to pulse-based systems. In addition to pulsing the laser, these systems also modulate the power of the laser beam, and the scanner compares the phase of the laser being sent out and then returned to the sensor. For reasons that are beyond this web page's scope, phase shift measurement is more precise.

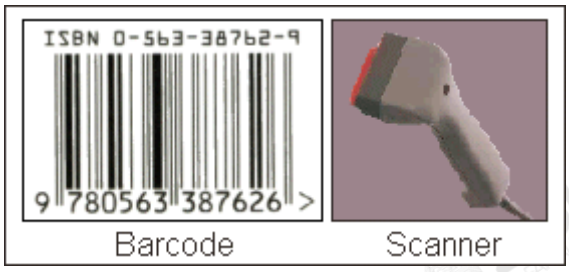
Mid- and Long-range 3D Scanner Types	Pros	Cons
Pulse-based	Medium and long range (2m – 1000m)	Less accurate Slower data acquisition Higher noise
Phase-shift	More accurate Faster data acquisition Lower noise	Medium range only

Topic: 1.3.3 Input devices

BARCODE READER

There are many types of barcode scanners such as Laser scanners, CCD barcode scanners, imager type scanners, and more. Our first focus will be on how a CCD barcode scanner works.

Bar codes are read into the computer using a wand or a fixed scanner. Bar codes are not easily damaged and can normally still be read if they are creased or not stuck onto a flat surface. They can be printed using a normal printer and ink and so are cheap to produce. The information normally included on a bar code for a product is country of origin, manufacturer and item code. *The price is not included in the bar code*.



The CCD barcode scanner is a scanner that has no moving parts. **CCD stands for Charged-Coupled Devise Scanner**. The scanner has a light source that when pointed to an object or barcode, it illuminates that image. The image is usually a barcode. Once the barcode is illuminated, a reflection is created and the barcode scanner reads that image.

How does the barcode scanner read the image? Well, there is a linear photodiode within the scanner head. This photodiode can read the reflected light off the lines on the barcode. This reflection is a digital image that is then scanned electronically within the device. When the image is scanned electronically, each bar on the barcode is converted to the corresponding number or letter.

The barcode scanner is connected to a PC or Mac and the CCD scanner then sends the sequence of numbers and/or letters to the PC or Mac to populate the field of entry. This connection can be made in a number of ways. One way is with a keyboard wedge. This is a Y connection where one end of the Y connects to the keyboard and the other end of the Y connects to the scanner with the bottom of the Y plugging into the PC where the keyboard would normally connect. This method is used many times when the PC does not have enough interfaces. Serial is another connection method and works with just a straight serial cable from the barcode scanner directly to the PC serial connection. USB is now about the most popular method, because most PC's and Mac's today have many USB ports. Just plug and play!

Now we can look at how a laser barcode scanner works. The laser scanner works by sending a low energy light beam or laser beam to read the spacing between patterns on the image one space at a time. The beam is moving back and forth by using a mobile mirror which causes a blinking effect. You can usually see the red line moving over the barcode. The reflection comes back and is then read by the fixed mirror in the scanner. The scanner then generates analog and digital signals that match the pattern. A barcode reader decoder then processes the information and sends it through the data communications interface.

Topic: 1.3.3 Input devices

DIGITAL CAMERAS:

A digital camera takes light and focuses it via the lens onto a sensor made out of silicon. It is made up of a grid of tiny *photosites* that are sensitive to light. Each photosite is usually called a *pixel*, a contraction of "picture element". There are millions of these individual pixels in the sensor of a DSLR camera.

Digital cameras sample light from the outside world, or outer space, spatially, tonally and by time. Spatial sampling means the angle of view that the camera sees is broken down into the rectangular grid of pixels. Tonal sampling means the continuously varying tones of brightness in nature are broken down into individual discrete steps of tone. If there are enough samples, both spatially and tonally, we perceive it as faithful representation of the original scene. Time sampling means we make an exposure of a given duration.

Our eyes also sample the world in a way that can be thought of as a "time exposure", usually on a relatively short basis of a few tenths of a second when the light levels are high as in the daytime. Under low light conditions, the eye's exposure, or ***integration time*** can increase to several seconds. This is why we can see more details through a telescope if we stare at a faint object for a period of time.

TOUCH SENSITIVE SCREENS:

These screens do a similar job to concept keyboards. Grids of light beams or fine wires crisscross the computer screen. When you touch the screen, the computer senses where you have pressed. Touch screens can be used to choose options which are displayed on the screen. Touch screens are not used very often as they are not very accurate, tiring to use for a long period and are more expensive than alternatives like a mouse. The main applications for which touch screens are used are the provision of public information systems. Touch screen operated computers can be found in places such as travel agents, airports, and ATM's.

MOUSE

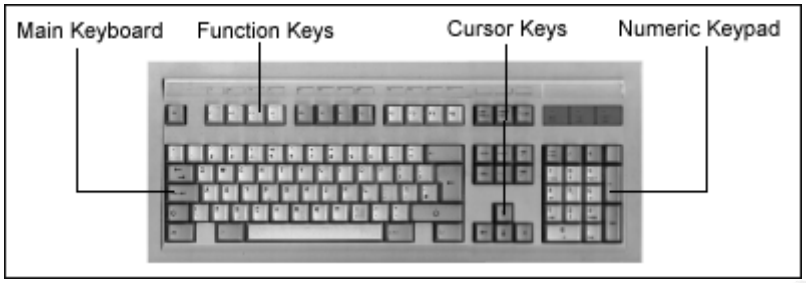
A mouse is the most common **pointing device**. You move the mouse around on a mat and a small cursor called a pointer follows your movements on the computer screen. By pressing a button on the mouse (most mice have 1, 2 or 3 buttons) you can select options using icons or menus on the screen. Mice can also be used to "draw" onto the screen. They are particularly useful if your computer has a graphical user interface.

Most mice use a small ball located underneath them to calculate the direction that you are moving the mouse in. As you move the mouse, this ball rotates. The mouse monitors how far the ball turns and in what direction and sends this information to the computer to move the pointer on the screen.

Topic: 1.3.3 Input devices

KEYBOARD

Almost all computers are supplied with a keyboard. A keyboard has over a hundred keys on it. When you press a key, a number (ASCII code) is sent to the computer to tell it which key you have pressed. The keys are arranged in four groups:



The keys on a keyboard are usually arranged in the same order as those on a typewriter. This layout of keys is called QWERTY because Q-W-E-R-T-Y is the order in which the letters occur on the top row of the keyboard. Some newer designs have the letters arranged in a different order such as the DVORAK keyboard. Most people find the QWERTY arrangement best as they have had some practice using it, but users trained on the new keyboards can type faster than the fastest typists can on QWERTY keyboards.

CONCEPT KEYBOARD

A concept keyboard is a flat board which contains a grid of switches. Each switch can be programmed to do whatever you want. An overlay image is placed on top of the grid so that the user can tell what pressing on different areas (switches) will do. Example uses of concept keyboards include:

- **Games for young children:** The overlay image could be a picture of a farmyard. Pressing on an animal would cause the computer to make the noise that the animal does.
- **Tills in restaurants/pubs:** The overlay contains a list of all the meals that can be sold. Instead of typing in prices the waiter simply presses the keyboard where the meals/drinks he is serving are listed.

Concept keyboards are particularly useful for people who would find using an ordinary keyboard difficult and in locations where an ordinary keyboard might be damaged, e.g. by spillage or dust.

Topic: 1.3.3 Input devices

TOUCH SCREENS ON MOBILE DEVICES:

There are three types of touch screens:

- Capacitive,
- Resistive,
- Infrared.



There are some basic differences in the way these three types of technology work. Resistive screens are made out of various layers. The commands for finger or stylus are made in the outer layer, which comes into contact with a flexible and protective membrane. The third layer is the first screen that touches the screen and closes the circuit. This type of screens doesn't support multi-touch, because the circuits can come in conflict.

Capacitive screens are made out of a protection layer, one with transparent electrodes and glass substrate. These electrodes are the ones that capture commands. The electrical induction of the fingers enables this layer to send signals to the running software.

The oldest and easiest to understand kind of screen is the infrared one. At the edges of the screen there are several infrared emitters and receivers. The transmitters are placed on one side of the screen and the receivers are placed on the other side. We have a matrix of vertical and horizontal infrared. If you press the screen with your finger, any infrared beam (vertical and horizontal) is interrupted. The system detects what rays have been interrupted, thus it knows what area of the screen is being pressed and acts accordingly.

Topic: 1.3.3 Input devices

Interactive whiteboards (SMART BOARDS)

While the traditional white board already has everyone's attention, the electronic device is a new technology that is slowly gaining popularity due to its interactive power.

The digital screen allows images from the computer to be displayed on a board. It can also be modified on the screen itself, using a pen or a highlighting tool. Its touch screen feature allows teachers to run programs directly from the screen simply by tapping the application with her finger and even makes scrolling easy.
Smart Boards are becoming an essential component of every classroom. Some reasons for this trend is that:

- It can accommodate different learning styles. Tactical learners can use the screen and learn by touching and marking at the board, audio learners can have a discussion and visual learners can observe the teaching on the board.
- It is neater and does not have the cleanliness hassle and is therefore easier to maintain.
- Most teachers understand the “why” but struggle with the “how”. Here are some ideas on how you can use Smart Boards.
- Use it as a tool for note-taking. Students can come and write important points on the board. Alternately, you can appoint a student to type out notes on the computer while you talk, so that the other students can view and take them down.
- Brainstorming in the classroom can be fun with a Smart Board. You can not only put together text/ ideas but also images, diagrams or videos.
- Classroom games can be played with ease on the board. Board games in particular can be played on the board itself.
- All forms of media– videos, photographs, graphs, maps, illustrations, games, etc. – can be used on the board, making it incredibly dynamic in nature. This expands the range of content that you can use for teaching or presenting new information.

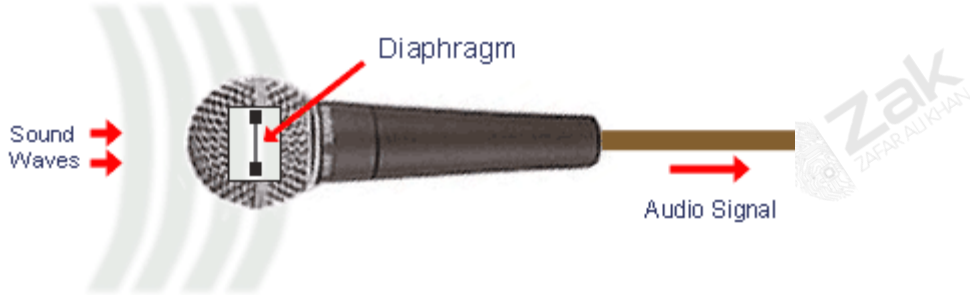
A lot of new software is available for free on the internet that can be easily integrated. There are many forums and websites that aim to help teachers by providing Smart Board ideas and activities. Explore these for more ideas.
The Smart Board is tomorrow's technology and is bound to change the look of classrooms forever. Using smart boards in your classroom can help you stay ahead with technology that could make the education process simpler and perhaps even more productive.

Topic: 1.3.3 Input devices

Microphones

Microphones are a type of transducer - a device which converts energy from one form to another. Microphones convert acoustical energy (sound waves) into electrical energy (the audio signal).

Different types of microphone have different ways of converting energy but they all share one thing in common: The diaphragm. This is a thin piece of material (such as paper, plastic or aluminium) which vibrates when it is struck by sound waves. In a typical hand-held mic like the one below, the diaphragm is located in the head of the microphone.



When the diaphragm vibrates, it causes other components in the microphone to vibrate. These vibrations are converted into an electrical current which becomes the audio signal.

Note: At the other end of the audio chain, the loudspeaker is also a transducer - it converts the electrical energy back into acoustical energy.

QR Code Scanner:

A barcode scanner is composed of three parts: the illuminator, the decoder, and the sensor/convertor. The barcode scanner illuminates the barcode with red light using the illuminator system. The sensor/convertor part of the scanner then detects the reflected light. Once the light is detected, an analog signal is generated. This signal contains varying voltage based on the intensities of the light reflection. The analog signal is converted by the sensor into a digital signal. The digital signal is then interpreted by the decoder. The decoder then sends the information to the computer attached to the scanner.

www.zakonweb.com **QR code**

Topic: 1.3.3 Input devices

In the case of QR code scanner, the decoder sends the information to your mobile phone instead of a computer. The app you download for your phone that is a QR code scanner contains the illuminator, which is the red light that runs across the screen when you open the app. The sensor and decoder then work to decode the QR code. Then the decoder sends the information to your phone, and you will be able to see where the QR code was supposed to take you.

The way the scanner reads the reflected light it actually a lot more complicated than the way that I simply described it, but I think it's fascinating that all you have to do is download a free app and all of a sudden your phone is a barcode scanner. The barcode was first patented in 1952, and now almost every person with a smart phone carries around their own barcode scanner with them every day. Since this scanning technology is so easily accessible with most phones, QR codes as a marketing tool seem like they will be around for a while.

Topic: 1.3.3 Input devices

INPUT DEVICES IN REAL LIFE SCENARIOS

PASSPORT SCANNING AT AIRPORTS:

At the airports during immigration check, the passport scanner captures ultraviolet and infrared images, as well the full page of a passport in color. In a simultaneous single action, the reader also decodes the machine readable zone (MRZ) and processes eData, including the holder's image, from the chip.

The scanner then automatically detects when a document with machine readable data has been presented. Additionally, it is able to compensate for out-of-position MRZ data, so that the advanced recognition engine reliably provides highly accurate and very fast document reading capability, allowing large volumes of documents and smart cards to be processed quickly and efficiently.

The unit features blue, amber, green and red LED lights to keep the user informed of statuses from ready to scan through to processing and successful scan, or that there is an issue with the document. A programmable audio beep provides additional user feedback to confirm successful scans.

Topic: 1.3.3 Input devices

BARCODE READERS IN SUPERMARKET CHECKOUTS:

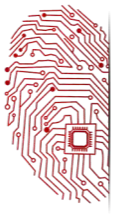
In case of a supermarket, a barcode can make the running of a supermarket easier. A customer walks into a supermarket, picks some items and shows it to the cashier. The cashier takes the items, shows the barcode on the item to a device (barcode scanner), the system calls up the product, item number, price and other information related to the item and notes it. The cashier shows the other items to the system and the system calls up the product in that manner. After the cashier has shown the last item to the scanner, the total cost is displayed on the screen, the cash drawer is opened and receipt is generated automatically, the system records the transaction against the account of the cashier that completed the transaction. The manager just connects to the database and reviews the transaction summary performed by his cashiers.

SENSORS:

Sensors are sophisticated devices that are frequently used to detect and respond to electrical or optical signals. A **sensor** converts the physical parameter (for example: temperature, blood pressure, humidity, speed, etc.) into a signal which can be measured electrically. Let's explain the example of temperature. The mercury in the glass thermometer expands and contracts the liquid to convert the measured temperature which can be read by a viewer on the calibrated glass tube.

TEMPERATURE SENSORS:

Temperature is the most common of all physical measurements. We have temperature measurement-and-control units, called thermostats, in our home heating systems, refrigerators, air conditioners, and ovens. Temperature sensors are used on circuit boards, as part of thermal tests, in industrial controls, and in room controls such as in calibration labs and data centers. Though there are many types of



Topic: 1.3.3 Input devices

temperature sensors, most are passive devices: Thermocouples, RTDs (resistance temperature detectors), and thermistors.

Thermocouples (T/Cs) are the most common type of sensor because they don't require an excitation signal. They consist of two wires made of different metals joined at the point of measurement. Based on the See beck effect, T/Cs operate on the premise that each metal develops a voltage differential across its length based on the type of metal and the difference in temperature between the ends of the wire. By using two metals, you get two different voltages V1 and V2. The difference (VT) represents temperature.

Resistance-temperature detectors (RTDs) have a smaller range, typically a few hundred degrees Centigrade, but they have better accuracy and resolution than thermocouples. RTDs use precision wire, usually made of platinum, as the sense element. The element needs a known excitation current, typically 1mA. RTDs come in two, three, and four-wire configurations. Four-wire configurations, are usually used as reference probes in calibration labs, have the best accuracy because two wires carry current and two are used for measuring the resistance across the element.

LIGHT SENSORS:

A light sensor, as its name suggests, is a device that is used to detect light. There are many different types of light sensors, each of which works in a slightly different way. A photocell or photo resistor, for example, is a small sensor that changes its resistance when light shines on it; they are used in many consumer products to determine the intensity of light. A charged coupled device (CCD) transports electrically charged signals, and is used as a light sensor in digital cameras and night-vision devices. Photomultipliers detect light and multiply it.

Devices that include these sensors have many uses in scientific applications, but are also found in items that people encounter each day. A simple light sensor may be part of a security or safety device, such as a burglar alarm or garage door opener. These types of devices often work by shining a beam of light from one sensor to another; if the light is interrupted, an alarm sounds or the garage door won't close.

Many modern electronics, such as computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen, especially in low-light or high-light situations. They can detect how much light is in a room and raise or lower the brightness to a more comfortable level for the user. Light sensors also may be used to automatically turn on lights inside or outside a home or business at dark.

Barcode scanners found in most retailer locations work using light sensor technology. The light emitted from the scanner illuminates the barcode, which is read and decoded by a sensor. Quick Response (QR) codes operate in much the same way, though they contain more information and typically can be read using a Smartphone if the user has downloaded a code reader.

Topic: 1.3.3 Input devices

MAGNETIC FIELD SENSORS:

Magnetic sensors detect changes and disturbances in a magnetic field like flux, strength and direction. Other types of detection sensors work with characteristics like temperature, pressure, light. From established knowledge about the existing magnetic field and the data collected from sensors regarding changes and alterations, many things can be known. Rotation, angles, direction, presence and electrical current can all be monitored. Magnetic sensors are divided into two groups, those that measure the complete magnetic field and those that measure vector components of the field. The vector components are the individual points of the magnetic field. The techniques used to create these sensors involve various combinations of physics and electronics.

Measuring a Magnetic Field

A magnetic field surrounds an electric current. The field is detectable by its force or interaction on electrical charges, magnets and magnetic products. The strength and direction of a magnetic field can be measured and documented. Fluctuations in that field are detected and adjustments or changes are made in a machines response, a doctor's decision, the direction the navigational instrument gives or the response of a detection system. The Earth's magnetic field is a great example. It is measured and tracked by magnetic sensors which are part of the navigational tools that Honeywell and other corporations design and manufacture. Most magnetic sensors are used for measurement in industrial processes, navigational tools, and scientific measuring.

Magnetic Sensing Technology

There are several types of technologies used to make a magnetic sensor work. Fluxgate, Hall Effect, magneto-resistive, magneto inductive, proton precession, optical pump, nuclear precession, and SQUID (superconducting quantum interference devices) each have a different approach to using magnetic sensors. Magneto resistive devices record electrical resistance of the magnetic field. Magneto-inductive are coils surrounding magnetic material whose ability to be permeated changes within the Earth's magnetic field. Fluxgate measures magnetic fields against a known internally created magnetic based response that runs through a continually fluxing set of parameters. Each type of technology focuses on a particular area for detection, a measurement to be detected and way of recording changes.

GAS SENSORS:

In current technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very crucial. **Gas sensors** are very important part of such systems. Small like a nose, gas sensors spontaneously react to the gas present, thus keeping the system updated about any alterations that occur in the concentration of molecules at gaseous state.

Gas sensors are available in wide specifications depending on the sensitivity levels, type of gas to be sensed, physical dimensions and numerous other factors. This Insight covers a **methane gas sensor** that can sense gases such as ammonia which might get produced from methane. When a gas interacts with this sensor, it is first ionized into its constituents and is then adsorbed by the sensing element. This

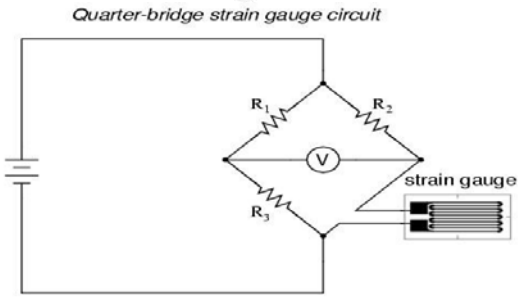
adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current.

The **gas sensor module** consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This current is known as heating current through it; the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it.

PRESSURE SENSORS:

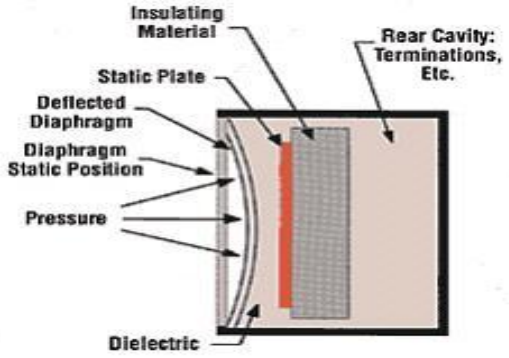
Based on the type of applications they are used in, pressure sensors can be categorized into many types. However, following are most common types of pressure sensors that have been widely used:

1. **Strain Gauge Type:** These sensors are similar to a wheat stone bridge in their working. In wheat stone bridge, the ratio of resistances of two adjacent arms connected to one end of the battery should be equal to that of other two arms connected to another end of battery. When the two ratios are equal, no output is generated from the wheat stone bridge. In the case of a strain gauge, one arm of the wheat stone bridge is connected to a diaphragm. The diaphragm compresses and expands due to the pressure applied. This variation in the diaphragm causes the output in the bridge to vary. A voltage would be generated proportional to every deviation from the normal balanced condition, so every single compression or expansion movement of the diaphragm will produce an output indicating a change in pressure conditions. Since resistance change is the main cause for potential difference, these sensors are also termed as piezo-resistive type of pressure sensors.

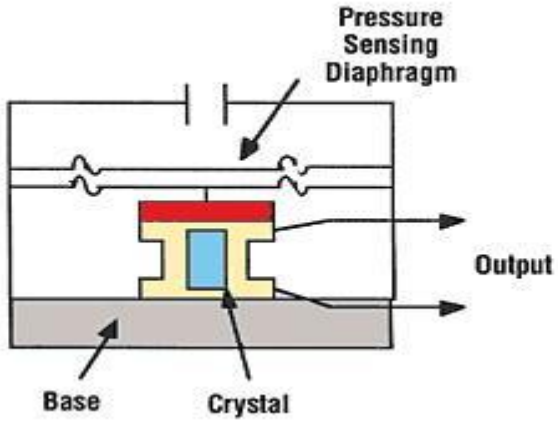


Topic: 1.3.3 Input devices

2. **Capacitive Pressure Sensor:** A capacitor has two metal plates and a dielectric sandwiched between them. In capacitive pressure sensor, one of these metal plates is permitted to move in and out so that the capacitance between them changes due to varying distance between the plates. The movable plate is connected to a diaphragm which senses the pressure and then expands or compresses accordingly. The movement of the diaphragm would affect the attached metal plate's position and capacitance would vary. These sensors, though much ineffective at high temperatures, are widely used at ambient temperature range due to their linear output.



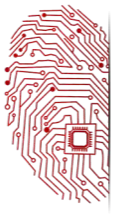
3. **Piezoelectric Pressure Sensor:** Piezoelectric crystals develop a potential difference (i.e. voltage is induced across the surfaces) whenever they are subjected to any mechanical pressure. These sensors have the crystal mounted on a dielectric base so that there is no current leakage. Attached to the crystal is a horizontal shaft to which a diaphragm is connected. Whenever the diaphragm senses pressure, it pushes the shaft down which pressurizes the crystal and voltage is produced.



MOISTURE SENSORS:

Operation of the sensor depends upon the adsorption of water vapor into a porous non-conducting "sandwich" between two conductive layers built on top of a base ceramic substrate.

The active sensor layer and the porous top conductor, that allows transmission of water vapor into the sensor, are engineered very thinly. Therefore the sensor responds very rapidly to changes in applied moisture, both when being dried (on process start-up) and when called into action if there is moisture ingress into a process. Despite this extreme sensitivity to changes in moisture content, the Impedance Moisture Sensor can be incredibly rugged due to the nature of its construction. To protect the sensor



Topic: 1.3.3 Input devices

further against contaminants and pipe sward it recommended that the sensor is housed in a protective sintered stainless steel guard.

HUMIDITY SENSORS:

Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapor also influences various physical, chemical, and biological processes. Humidity measurement in industries is critical because it may affect the business cost of the product and the health and safety of the personnel. Hence, **humidity sensing** is very important, especially in the control systems for industrial processes and human comfort.

Controlling or monitoring humidity is of paramount importance in many industrial & domestic applications. In semiconductor industry, humidity or moisture levels needs to be properly controlled & monitored during wafer processing. In medical applications, humidity control is required for respiratory equipment, sterilizers, incubators, pharmaceutical processing, and biological products. Humidity control is also necessary in chemical gas purification, dryers, ovens, film desiccation, paper and textile production, and food processing. In agriculture, measurement of humidity is important for plantation protection (dew prevention), soil moisture monitoring, etc. For domestic applications, humidity control is required for living environment in buildings, cooking control for microwave ovens, etc. In all such applications and many others, **humidity sensors** are employed to provide an indication of the moisture levels in the environment.

PH SENSORS:

In the process world, pH is an important parameter to be measured and controlled.

The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration- which ordinarily ranges between about 1 and 10 x -14 gram-equivalents per liter - into numbers between 0 and 14.

On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10 x 0, 10 x -1, or 10 x -2 gram-equivalents per liter) while a very basic solution has a high pH value, such as 12, 13, or 14 which corresponds to a small number of hydrogen ions (10 x -12, 10 x -13, or 10 x -14 gram-equivalents per liter). A neutral solution such as water has a pH of approximately 7.

A pH measurement loop is made up of three components, the pH sensor, which includes a measuring electrode, a reference electrode, and a temperature sensor; a preamplifier; and an analyzer or transmitter. A pH measurement loop is essentially a battery where the positive terminal is the measuring electrode and the negative terminal is the reference electrode. The measuring electrode, which is sensitive to the hydrogen ion, develops a potential (voltage) directly related to the hydrogen ion concentration of the solution. The reference electrode provides a stable potential against which the measuring electrode can be compared.

Topic: 1.3.3 Input devices

When immersed in the solution, the reference electrode potential does not change with the changing hydrogen ion concentration. A solution in the reference electrode also makes contact with the sample solution and the measuring electrode through a junction, completing the circuit. Output of the measuring electrode changes with temperature (even though the process remains at a constant pH), so a temperature sensor is necessary to correct for this change in output. This is done in the analyzer or transmitter software.

MOTION SENSORS:

The modern world is filled with gadgets that get excited when they sense *human* motion. Automatic doors in elevators and shopping malls, burglar alarms at houses and shops, automatic lighting systems, electronic amenities in washrooms are just a few examples where human presence or absence puts the device into active or passive state. Now, what if we tell you that behind this smart response to motion is a gizmo that does not even reach the 2cm mark in size. Known as Pyroelectric or Passive Infrared Sensor (PIR, in both cases), this small electronic device is the curious case for this Insight.

Every object that has a temperature above perfect zero emits thermal energy (heat) in form of radiation. We, Humans, radiate at wavelength of 9-10 micrometers all time of the day. The PIR sensors are tuned to detect this IR wavelength which only emanates when a human being arrives in their proximity. The term "pyroelectricity" means: heat that generates electricity (here, an electric signal of small amplitude). Since these sensors do not have an infrared source of their own, they are also termed as passive.

SENSORS IN REAL LIFE SCENARIOS:

STREET LIGHTS:

Some lights don't have any sort of detectors. For example, in a large city, the traffic lights may simply operate on timers -- no matter what time of day it is, there is going to be a lot of traffic. In the suburbs and on country roads, however, detectors are common. They may detect when a car arrives at an intersection, when too many cars are stacked up at an intersection (to control the length of the light), or when cars have entered a turn lane (in order to activate the arrow light).

There are all sorts of technologies for detecting cars -- everything from lasers to rubber hoses filled with air! By far the most common technique is the **inductive loop**. An inductive loop is simply a coil of wire embedded in the road's surface. To install the loop, they lay the asphalt and then come back and cut a groove in the asphalt with a saw. The wire is placed in the groove and sealed with a rubbery compound. You can often see these big rectangular loops cut in the pavement because the compound is obvious. Inductive loops work by detecting a change of inductance.

Topic: 1.3.3 Input devices

SECURITY DEVICES:

Door and window sensors come in two pieces. One fits onto the door or window itself, while its counterpart attaches to the frame. Adhesive usually keeps the sensors in place, though sensors can be screwed directly into the frame. Position the two pieces of the sensor right next to each other, because they interact. When the two pieces are separated, such as when the door or window is opened, they send a signal to the alarm panel.

Door and window sensors should not be your sole line-of-defense in your home security system. A shatter sensor detects the sound of a window breaking, alerting your alarm system in the process. Likewise, it detects strong vibrations that a regular window sensor might not pick up on. Motion sensors often rely on infrared energy detection. As someone moves through a room, the sensor detects the changes in infrared energy and activates an alarm. It works from a distance, whereas door and window sensors solely work for the door or window they're attached to.

POLLUTION CONTROL

Air pollution comes from many different sources: stationary sources such as factories, power plants, and smelters and smaller sources such as dry cleaners and degreasing operations; mobile sources such as cars, buses, planes, trucks, and trains; and naturally occurring sources such as windblown dust, and volcanic eruptions, all contribute to air pollution.

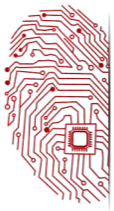
The amount of pollution also has an effect on total Air Quality. These pollution sources can also emit a wide variety of pollutants. These pollutants are monitored by national, state and local organizations.

Monitoring stations are set up in mobile or fixed facilities equipped with instrumentation to monitor pollutants down to very low levels. Part of this instrumentation invariably includes a wind sensor, as it is important to know the influence of wind on any modeling that is done on the results.

GAMES

The innovative technology behind Kinect is a combination of hardware and software contained within the Kinect sensor accessory that can be added to any existing Xbox 360. The Kinect sensor is a flat black box that sits on a small platform, placed on a table or shelf near the television you're using with your Xbox 360. For a video game to use the features of the hardware, it must also use the proprietary layer of Kinect software that enables body and voice recognition from the Kinect sensor

The motion-sensor controls allow users much more freedom when playing games. The advantages it has over a standard wireless control pad mostly revolve around response time and pointer accuracy. The controller and motion-sensor bar react very quickly. Using the controller lets the user quickly move from one side of the screen to the other with only a flick of the wrist. The motion-sensor bar is also very accurate and intuitive: The pointer moves precisely as would be expected. Moreover, games such as boxing or tennis are no longer a passive, couch-based entertainment. It can give the user actually enjoys a



Topic: 1.3.3 Input devices

cardiovascular workout. Experts have shown that playing an energetic game provides excellent exercise that burns calories and fat. A variety of games designed to simulate a workout routine or dance class is also available. Lastly, the motion-sensor remote is very easy to use. It allows non-gamers to pick up the remote and begin playing without having to learn complicated controls.

HOUSEHOLD APPLICATIONS

Sensors used in household appliances and consumer electronics comprise proximity sensors, temperature sensors, pressure sensors, flow and level sensors as well as acoustic sensors, image sensors and camera modules. Photodetectors, position sensors and rotary speed sensors are of importance, too.

The use of sensors in household appliances is mainly driven by higher energy and resource efficiency requirements, advanced performance and convenience standards as well as by smarter electronics to improve ease of operation. New consumer electronic devices must be capable to handle media and data simultaneously. The major sensors used are photosensors, image sensors, inertial sensors and acoustic sensors.

Large household appliances are expected to become smarter and even more efficient in their use of water and electric power. Smart electronic controls and sensors improve their user-friendliness and performance at the same time. Smart appliances of the future will be able to start their operation when electric power tariffs will be cheapest.

Coffee-making machines are becoming more automated, have enhanced functionalities and consume less energy than the previous generation. The sensor content of coffee machines as well as of other small appliances such as personal care and beauty appliances is constantly growing.

Topic: 1.3.3 Input devices

INDUSTRIAL APPLICATIONS:

Some examples of the industrial equipment sensors for include:

- **Transport and Case Refrigeration Systems**
  Temperature Sensors are used to measure the supply air to control compartments.
  Pressure Sensors measure refrigerant pressure to improve system efficiency.
- **Wind Farm**
  Inclinometers are used to level windmill during construction and operation.
  Vibration Sensors (Accelerometers) monitor the gearbox and provide early warning for maintenance.
- **Oil and Gas**
  Rugged, hermetically sealed Rotary Magnetic Encoders, which are coupled to the fuel flow meter of a gas pump, are used to convert rotational pulses into gallons or liters purchased.
  LVDT Sensors are used to provide positive feedback regarding valve position for flow controls.
- **Process Control**
  Fluid Property Analyzers installed in refrigeration and cooling systems monitor lubricant refrigerant ratios and fluid condition.
  LVDT Sensors provide positive feedback of pneumatic cylinder position.
- **Traffic/Smart Highway**
  Our specially designed Traffic Sensors are used to monitor traffic patterns and collect data on highways.