ACTUATORS AND SENSORS. PART II

Lecture 13

Irob 2305 Introduction to Robotics

INTRODUCTION

- Robotic sensing is a branch of robotics science intended to give robots sensing capabilities, so that robots are more human-like.
- Robotic sensing mainly gives robots the ability to see, touch, hear and move and uses algorithms that require environmental feedback.
- The use of sensors in robots has taken them into the next level of creativity. Most importantly, the sensors have increased the performance of robots to a large extent. It also allows the robots to perform several functions like a human being.

PHYSICAL MEASUREMENTS AS INPUT

Physical Quantity	Name	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	S
Electric current	Ampere	A
Temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	candela	Cd

PHYSICAL MEASUREMENTS AS INPUT

Acceleration	Name	Symbol
Acceleration	m/s^2	m/s^2
Area	m^2	m^2
Capacitance	Farad	F=[s^4.A^2]/[m^2.kg]
Force	Newton	N=[kg.m^2/s^3]
Power	Watt	W=[kg.m^2/s^3]
Pressure	Pascal	Pa=[kg/m.s^2]
Speed	m/s	m/s
Voltage	Volt	V=[kg.m^2/A.s^3]
Energy	Joule	J=[kg.m^2/s^2]

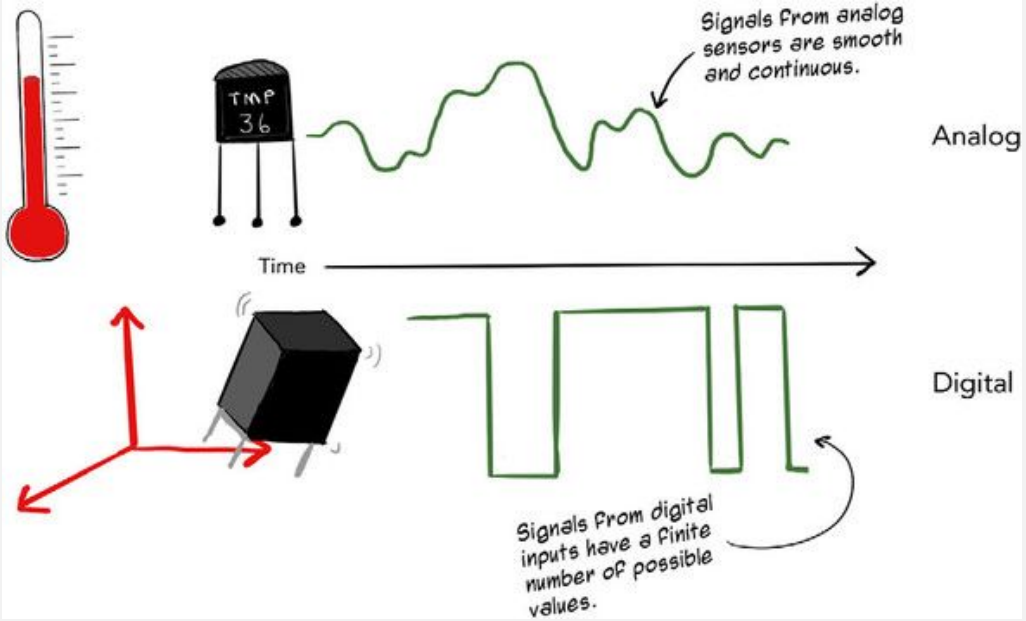
ACTIVE VS. PASSIVE SENSORS

- Active sensors: Active remote sensors create their own electromagnetic energy that is transmitted from the sensor towards the terrain, interacts with the terrain producing a backscatter of energy and is recorded by the remote sensor's receiver.

- Passive Sensors: Passive sensor detects the naturally emitted microwave energy within its field of view.

DIGITAL VS. ANALOG SENSORS

- 1) Digital sensors: The signal produced or reflected by the sensor is binary.
- 2) Analog sensors: The signal produces by the sensor is continuous and proportional to the measurand.



DIGITAL SENSORS

- Digital sensors are more straight forward than Analog
- No matter what the sensor there are only two settings: On and Off
- Signal is always either HIGH (on) or LOW (off)
- Voltage signal for HIGH will be a little less than 5V on your UNO
- Voltage signal for Low will be 0V on most systems

ANALOG SENSORS

Sensors	Variables
Mic	soundVolume
Photoresistor	lightLevel
Potentiometer	dialPosistion
Temp Sensor	temperature
Flex sensor	bend
Accelerometer	Tilt/acceleration

NULL AND DEFLECTION METHODS

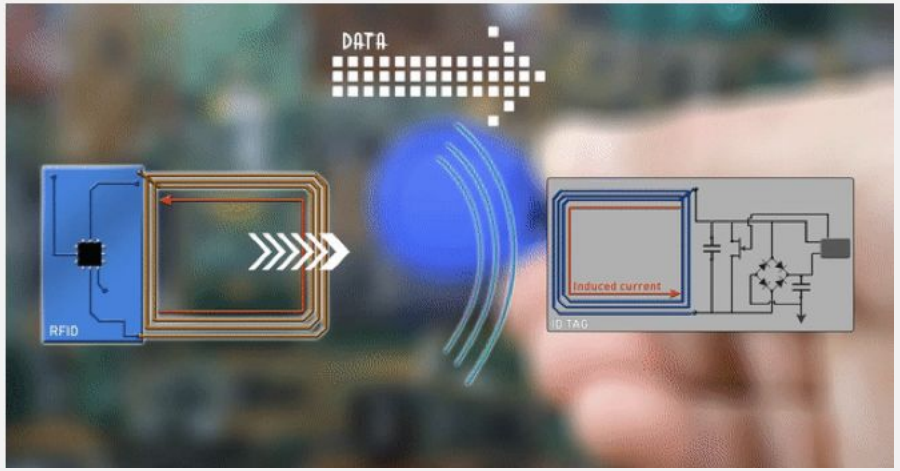
- 1) **Deflection**: The signal produces some physical (deflection) effect closely related to the measured quantity and transduced to be observable.
- 2) **Null**: The signal produced by the sensor is counteracted to minimize the deflection. That opposing effect necessary to maintain a zero deflection should be proportional to the signal of the measurand

INPUT-OUTPUT CONFIGURATION

- 1) Method of inherent insensitivity: Use whenever possible
- 2) Method of high gain feedback:
- 3) Method of calculated output corrections
- 4) Method of signal filtering
- 5) Method of opposing inputs

VISION

- **Method:** The visual sensing system can be based on anything from the traditional camera, sonar, and laser to the new technology radio frequency identification (RFID), which transmits radio signals to a tag on an object that emits back an identification code. All four methods aim for three procedures—sensation, estimation, and matching.
- **Image processing:** Image quality is important in applications that require excellent robotic vision. Robots can gather more accurate information from the resulting improved image.
- **Usage:** Visual sensors help robots to identify the surrounding and take appropriate action. Robots analyze the image of the immediate environment imported from the visual sensor. The result is compared to the ideal intermediate or end image, so that appropriate movement can be determined to reach the intermediate or final goal.

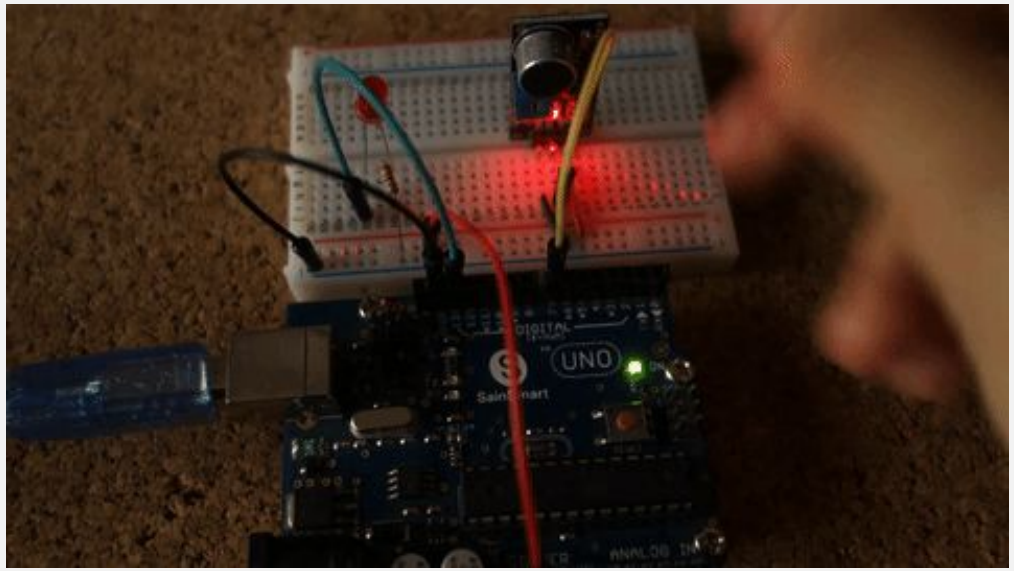


TOUCH

- Signal Processing: Touch sensory signals can be generated by the robot's own movements. It is important to identify only the external tactile signals for accurate operations. Recent solution applies an adaptive filter to the robot's logic. It enables the robot to predict the resulting sensor signals of its internal motions, screening these false signals out. The new method improves contact detection and reduces false interpretation.
- Usage: Touch patterns enable robots to interpret human emotions in interactive applications. Four measurable features—force, contact time, repetition, and contact area change—can effectively categorize touch patterns through the temporal decision tree classifier to account for the time delay and associate them to human emotions with up to 83% accuracy.

HEARING

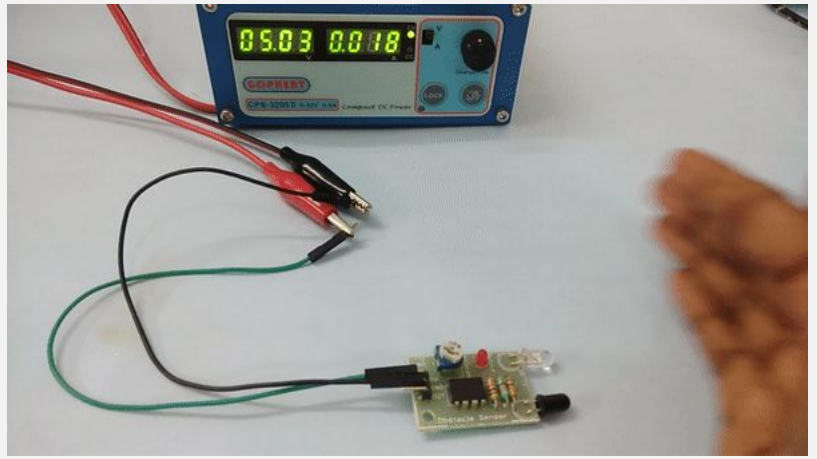
- Signal processing: Accurate audio sensor requires low internal noise contribution. Traditionally, audio sensors combine acoustical arrays and microphones to reduce internal noise level. Recent solutions combine also piezoelectric devices. These passive devices use the piezoelectric effect to transform force to voltage, so that the vibration that is causing the internal noise could be eliminated. On average, internal noise up to about 7dB can be reduced.
- Robots may interpret strayed noise as speech instructions. Current voice activity detection (VAD) system uses the complex spectrum circle centroid (CSCC) method and a maximum signal-to- noise ratio (SNR) beamformer.
- Usage Robots can perceive our emotion through the way we talk. Acoustic and linguistic features are generally used to characterize emotions.



SENSORS USED IN ROBOTICS

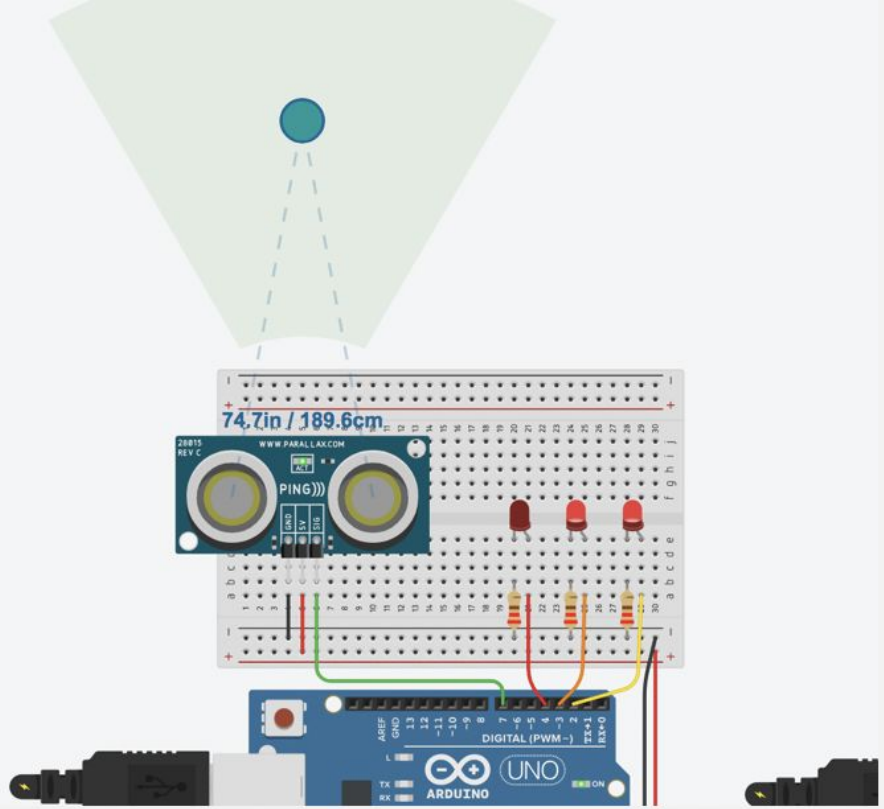
a) **Proximity Sensor:** This type of sensor is capable of pointing out the availability of a component. Generally, the proximity sensor will be placed in the robot moving part such as end effector.

- **Infrared (IR) Transceivers:** An IR LED transmits a beam of IR light and if it finds an obstacle, the light is simply reflected back which is captured by an IR receiver. Few IR transceivers can also be used for distance measurement.
- **Ultrasonic Sensor:** These sensors generate high frequency sound waves; the received echo suggests an object interruption. Ultrasonic Sensors can also be used for distance measurement.
- **Photoresistor:** Photoresistor is a light sensor; but, it can still be used as a proximity sensor. When an object comes in close proximity to the sensor, the amount of light changes which in turn changes the resistance of the Photoresistor. This change can be detected and processed.



b) Range Sensor

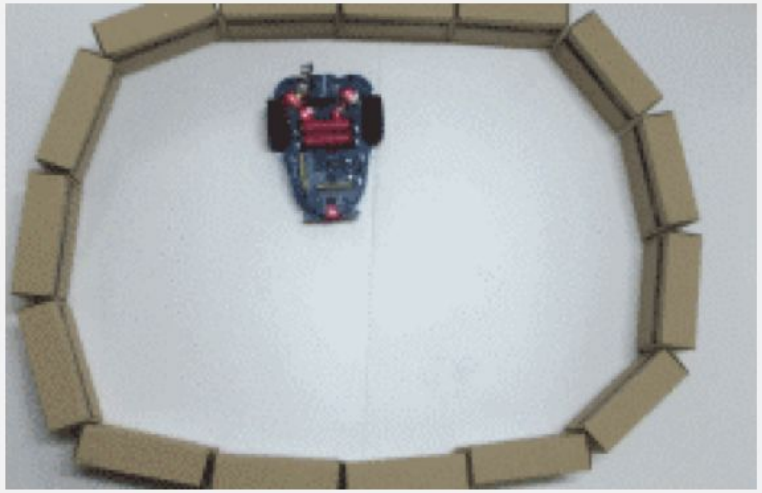
• Range Sensor is implemented in the end effector of a robot to calculate the distance between the sensor and a work part. The values for the distance can be given by the workers on visual data. It can evaluate the size of images and analysis of common objects. The range is measured using the Sonar receivers & transmitters or two TV cameras.



c) Tactile Sensors

• A sensing device that specifies the contact between an object, and sensor is considered as the Tactile Sensor. Tactile sensors are often in everyday objects such as elevator buttons and lamps which dim or brighten by touching the base. There are also innumerable applications for tactile sensors of which most people are never aware.

• This sensor can be sorted into two key types namely: a) Touch Sensor, and b) Force Sensor.



c)Touch Sensor

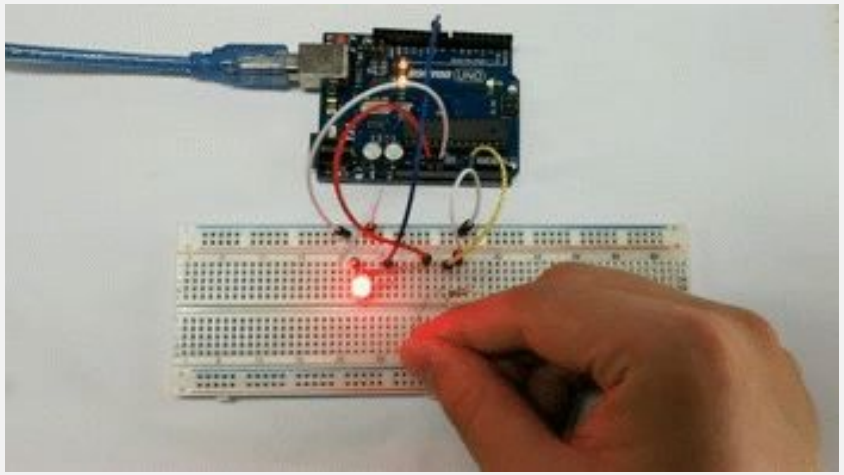
• The touch sensor has got the ability to sense and detect the touching of a sensor and object. Some of the commonly used simple devices as touch sensors are micro – switches, limit switches, etc.

d) Light Sensor

• A Light sensor is used to detect light and create a voltage difference. The two main light sensors generally used in robots are Photoresistor and Photovoltaic cells. Other kinds of light sensors like Phototubes, Phototransistors, CCD's etc. are rarely used.

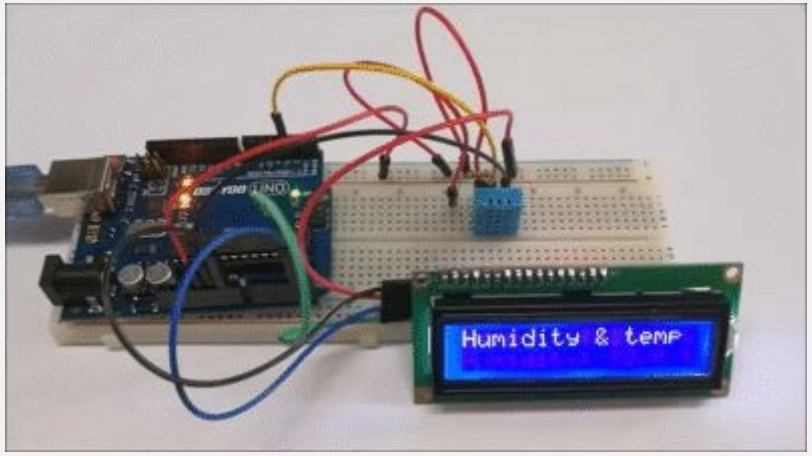
• Photoresistor is a type of resistor whose resistance varies with change in light intensity; more light leads to less resistance and less light leads to more resistance. These inexpensive sensors can be easily implemented in most light dependant robots.

• Photovoltaic cells convert solar radiation into electrical energy. This is especially helpful if you are planning to build a solar robot. Although photovoltaic cell is considered as an energy source, an intelligent implementation combined with transistors and capacitors can convert this into a sensor.



e) Sound Sensor

• As the name suggests, this sensor (generally a microphone) detects sound and returns a voltage proportional to the sound level. A simple robot can be designed to navigate based on the sound it receives. Imagine a robot which turns right for one clap and turns left for two claps. Complex robots can use the same microphone for speech and voice recognition. • Implementing sound sensors is not as easy as light sensors because Sound sensors generate a very small voltage difference which should be amplified to generate measurable voltage change.



f) Temperature Sensor

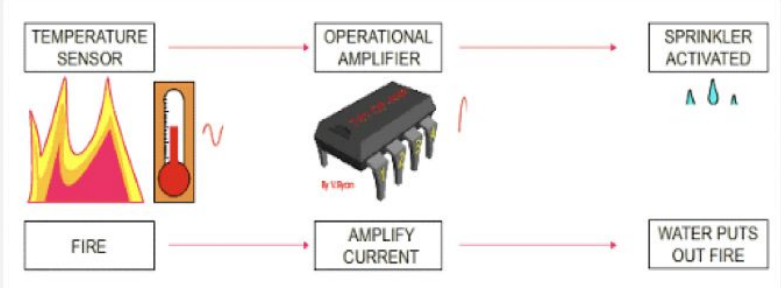
• Tiny temperature sensor ICs provide voltage difference for a change in temperature.

• NTC Thermistor can be assembled in housing in a variety of configurations for temperature sensing, measurement, detection, indicator, monitoring and control.

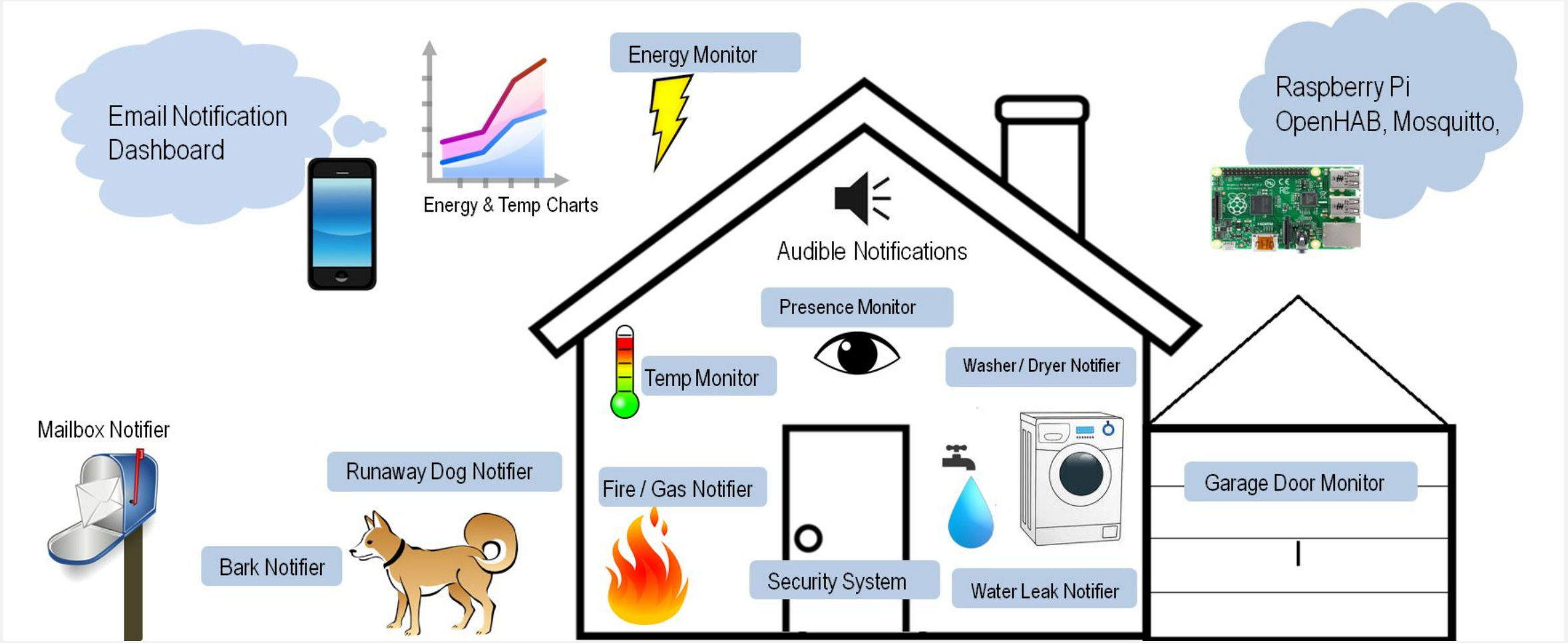
• Thermistor temperature sensor probe assemblies can conveniently attach to or be an integral part of any system to monitor or control temperature.

• The primary factors which determine the optimum configuration of a thermistor assembly are the operating environment; mounting & time.

• Applications for temperature sensing include air temperature sensors, surface temperature sensors and immersion temperature sensors. Housings for air temperature sensors are often simple, inexpensive devices such as molded plastic shells, deep- drawn brass or aluminum cylinders, or even stainless steel tubes.



SMART HOME



Smart home sensors