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18/ENG02/0644
Computer Engineering

1 Describe briefly (with examples) Sensors and Actuators for Biomedical Applications.

Answer

A Sensor is a device that changes a physical parameter to an electrical output.

Example;

- EMG Sensor ÷ known as Electromyography, it is a method to evaluate motor units action potential activity in a muscle region. As electrical signals travel through nerves to neuromuscular junctions, the change in electrical potentials (voltage) can be measured. Some current examples of the EMG Sensors being used today are in VR and Prosthetic arms.

- GSR Sensor ÷ known as galvanic skin response, it refers to changes in sweat gland activity that are reflective of the intensity our emotional state, otherwise known as emotional arousal. Skin conductance offers direct insights into autonomous emotional regulation as it is not under conscious control. For example, if you are scared, happy, agitated or any emotional related response, we will experience an increase in eccrine sweat gland activity which the sensor can pick up through the electrodes and transmit to the master device.

- Heart Rate Sensors ÷ known as a heart rate monitor, it is a personal monitoring device that allows a user to track and display his/her heart rate in real time or for studies purposes.
There are two ways (Optical and electrical) that this sensor monitors your heart rate which are:
  - Electrical - Consists of 2 elements which are the monitor and the receiver when a heartbeat is detected a radio signal or coded signal is transmitted which the receiver uses to display/ determine the current heart rate.
  - Optical - Uses a light that shines through a human skin which will then measure the amount of light that reflects back. The light reflections will vary as blood pulse under the skin will go past the light which are then interpreted as heartbeats.

An actuator is a mechanical or electro-mechanical device that provide controlled and sometimes limited movements or positioning which are operated electrically, manually, or by various fluids such as air, hydralic etc.
It takes an electical signal and combines it with an energy source to create physical motion.

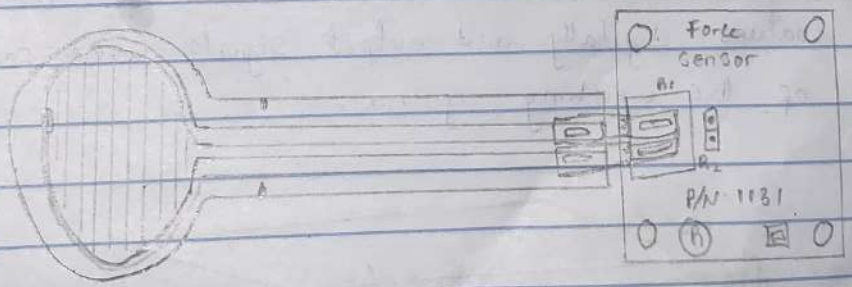
- Example :-
- Linear actuators :- This helps control the accuracy and positioning of a beam in the laser positioning equipment.

- Scanners; MRI and PI scanning instruments are used in hospitals and clinics for examination and diagnosis purposes. These scanners are powered with linear actuators which allow easy movement and direct

2 Describe, with sketches and examples, of the components of a basic measuring instrument.

- ~~Force sensors~~
  ~~Used in bath~~
- Force sensors :-

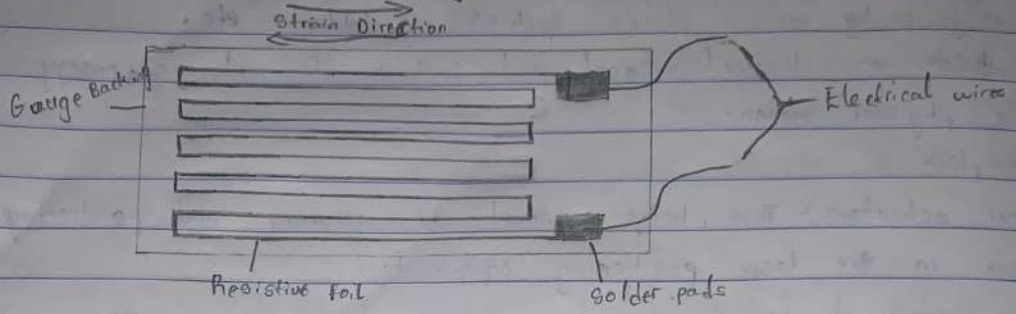
  Used in bath scales, various other types of scales, game consoles, home appliances, load sensors, etc. These sensors are sensors for mass production that use strain.



- Strain guage :

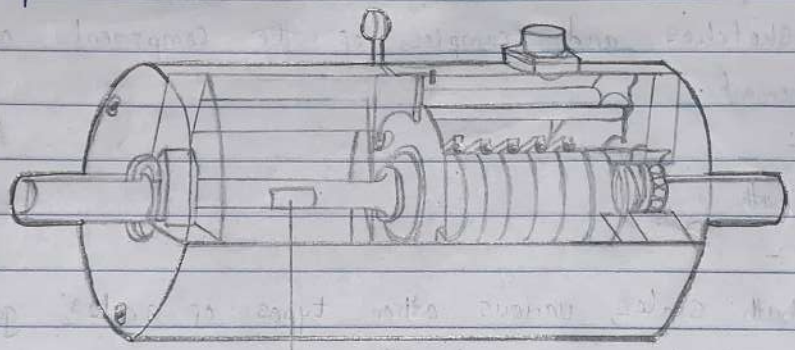
  A strain guage is a sensor whose resistance varries with applied force. it converts force, pressure, tension, weight into a change in electrical

resistance which can then be measured. An example of a strain gauge is the type used for measuring force in industrial environment.



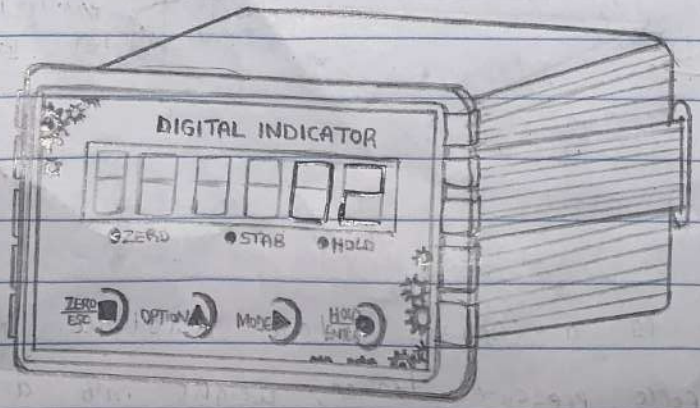
- Torque transducer :

The sensor for torque measurement in various driving parts like the engine and the transmission. This sensors measures the twist with a strain gauge, and transmits the output signal by using a transformer, or by using an optical sensor.



- Digital Indicators :

These devices, connected to various sensors and transducers, display measured values digitally and output signals, used for control and monitoring of the weighing systems.



3 Describe briefly case studies of two medical measurement instrument.

- Sphygmomanometer :

This is a device that measures blood pressure. It composes of an inflatable rubber cuff, which is wrapped around the arm.

~~Abstract~~

Introduction;

Arterial Blood pressure is a significant indicator of the current health condition of an individual. The correct detection of hypertension is essential, where this health problem is considered as one of the greatest health risk factors that appect the heart and circulatory system. This paper presents the importance of the application of metrological criteria for the diagnosis of hypertension using a Sphygmomanometer aneroid.

Method;

72 ~~methods~~ mechanical aneroid sphygmanometers were calibrated using a standard manometer and the indication error, hysteresis, air leakage and rapid exhaust were determined; readings of these Sphygmonometers were compared to a properly calibrated and adjusted aneroid Sphygmomanometer to carry out pressure measurements as those made during the hypertesion diagnosis; the uncertainty of measurement associated with the sphygmomanometers calibration, and pressure values was assessed according to the recommendations of the Guide to the Expression of Uncertainty in measurement, defined by the Joint Committee for Guides in metrology.

Results;

The results obtained have shown that about 61% of the evaluated aneroid Sphygmomanometers did not meet the specifications. The variable that most contributed to the final calibration uncertainty was the hysteresis of the standard manometer, with 33% of contribution, followed by the Sphygmomanometer resolution with 27%.

- Thermometer :-

It's an instrument for measuring and indicating temperature, typically one consisting of a narrow, hermetically sealed glass tube marked with graduations and having at one end a bulb containing mercury or alcohol which extends along the tube as it expands.

Objective;

Implement a temperature monitoring solution to inform the hosital pharmacy whether unused IV bags, returned from nurse stations throughout the hospital, have lost their efficacy due to length exposure in non refrigerated environment.

Strategy;

With the effectiveness of Logic 360™ loggers proven for the external cold chain, the same solution was chosen to record the temperature of IV bags travelling throughout the hospital, giving the pharmacist a full time /temperature history.

Implementation;

The multi-use Log-ic 360™ logger is attached to IV bags with high-value medications. Pharmacists easily see if the medications have been exposed to adverse temperatures and then reuse the loggers on other medications.

Result;

As a result of the Log-ic 360™ implementation, the hospital has saved costs by preventing unnecessary waste of good medications, while providing a safer environment for their patients.