INDOOR POSITION TRACKING AND DETECTION SYSTEM

Submitted in partial fulfillment of the requirements
of the degree of

Bachelor of Engineering

By

MUHAMMAD MUFAZZAL HUSSEIN SYED	13ET63
SHAIKH ZAINUL ABEIDN	13ET71
FARID JIBRAN	13ET70
WAJA AARAF	13ET68

Supervisor:

Asst. Prof. Zarrar Khan

Department of Electronics and Telecommunication Engineering
Anjuman-I-Islam'sKalsekar Technical Campus,
New Panvel

MUMBAI UNIVERSITY

2015-2016

Project Report Approval for B.E

This project report entitled ***INDOOR POSITION TRACKING AND DETECTION SYSTEM*** by ***MUHAMMAD MUFAZZAL, SHAIKH ZAINUL, FARID JIBRAN*** *and* ***WAJA AARAF***is approved for the degree of ***Bachelor of Engineering***.

Examiners:

1.________________________________

2.________________________________

Supervisor:

____

Asst. Prof. ZARRAR KHAN

H.O.D(EXTC):

____

Asst. Prof.

MUJIB A. TAMBOLI

Date:

Place:

I

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

1.____________________________
MUHAMMAD MUFAZZAL
13ET63

2.____________________________
SHAIKH ZAINUL ABEDIN
13ET71

3.____________________________
FARID JIBRAN
13ET70

4.____________________________
WAJA AARAF
13ET68

Date:

Place:

ACKNOWLEDGEMENT

We appreciate the beauty of a rainbow, but never do we think that we need both the sun and the rain to make its colors appear. Similarly, this project work is the fruit of many such unseen hands. It’s those small inputs from different people that have lent a helping to our project.

I take this opportunity to express my profound gratitude and deep regards to my guide **Asst.Prof. ZARRAR KHAN** for his exemplary guidance, monitoring and constant encouragement throughout the course of this project work.

I also take this opportunity to express a deep sense of gratitude to **Asst.Prof. MUJIB A.TAMBOLI**, HOD of E.X.T.C. Dept. for his cordial support, valuable information and guidance, which helped me in completing this task through various stages.

I am obliged to staff members of **AIKTC**, for the valuable information provided by them in their respective fields. I am grateful for their cooperation during the period of my project work.

TABLE OF CONTENT

Project approval for B.E____I

Declaration ____II

Acknowledgement ____III

1. Abstract ____7
2. Motivation ____8
3. Introduction ____9

   3.1 Why not Global Positioning System??? ___________________10

4. Project Methodology _____________________________________11

   4.1 Circuit Diagram ____12

5. Related Theory ____14

   5.1 Accelerometer Sensor ____________________________________14

      5.1.1 Physical Principle ______________________________15

      5.1.2 Structure _____________________________________17

   5.2 Types of Accelerometer Sensors _______________________19

      5.2.1 Capacitive Sensing _____________________________19

      5.2.2 Piezoelectric Sensing ___________________________21

   5.3 Accelerometer Sensor ADXL 335 _______________________23

   5.4 Color Sensor ____26

      5.4.1 Color Sensor TCS3200 ___________________________29

   5.5 Bluetooth Module HC-05 ___________________________32

   5.6 Arduino Microcontroller ___________________________34

6. Software Specifications ________________________________38

6.1 Arduino IDE ____38

7. Applications ____39

8. Future Scope ____40

9. Conclusions ____41

10. References ____42

11. Appendix ____43

1. ABSTRACT

This project serves the need to automatically identify and track the location of objects and people in usually within a building or other contained area.

The development and implementation of the Accelerometer Sensors are playing the key role in this indoor tracking system, and the results obtained will be displayed on the monitor using a suitable Graphical User Interface.

This project is an alternative to GPS and is able to measure the position of the person inside a building. With this scheme, the accuracy of positioning can be dramatically improved, especially in offices and closed areas. Preliminary results show that this idea is feasible.

System designs must take into account that at least three independent measurements are needed to unambiguously find a location. For smoothing to compensate for stochastic (unpredictable) errors there must be a sound method for reducing the error budget significantly.

2. MOTIVATION

This project serves the need to automatically identify and track the location of objects or people in usually within a building or other contained area. The system also enables facility operators to automatically send location-based information to mobile device users and to monitor their position inside the facility.

An indoor positioning system (IPS) is a system to locate objects or people inside a building using radio waves, magnetic fields, acoustic signals, or other sensory information collected by mobile devices. There are several commercial systems on the market, but there is no standard for an IPS system.

IPS systems use different technologies, including distance measurement to nearby anchor nodes (nodes with known positions, e.g., WiFi access points), magnetic positioning,dead reckoning. They either actively locate mobile devices and tags or provide ambient location or environmental context for devices to get sensed. The localized nature of an IPS has resulted in design fragmentation, with systems making use of various optical, radio, or even acoustic technologies.

The system might include information from other systems to cope for physical ambiguity and to enable error compensation.

These systems are useless in closed spaces because apermanent communication with satellites is needed for pinpointing the location and measuring the travelled distance.

Distance measurement is necessary in various areas andapplications. This project is an alternative to GPS and is able to measure the position of the person inside a building.

3. INTRODUCTION

Indoor navigation have many potential applications which remain underexploited: indoor navigation systems can be used to assist a visually challenged person by differentiating the free space and blocked space, they can provide navigation inside huge structures such as airports and industries or even help a user to locate his favorite products in a shopping mall.

Over the last decades there have been lots of devices that measure traveled distance. The best results have been obtained with GPS, but these systems are useless in closed spaces because a permanent communication with satellites is needed for pinpointing the location and measuring the traveled distance. The main sensors used for determining the distance are: GPS, ultrasonic, infrared, optical, inertial and electromagnetic sensors.

Due to the signal attenuation caused by construction materials, the satellite based Global Positioning System (GPS) loses significant power indoors affecting the required coverage for receivers by at least four satellites. In addition, the multiple reflections at surfaces cause multi-path propagation serving for uncontrollable errors.

Systems based on radio frequency signals (RF) require fewer infrastructuresthan other technologies but have less accuracy. This accuracy is of tens of centimeters for UWB (Ultra Wide-Band) systems based on measurements of TOA (Time-of-Arrival), of several meters usingWiFi, ZigBeeand RFID (Radio Frequency Identification) or tens of meters for mobile networks. Such precision is unacceptable for applications with centimeter accuracy requirements.

Thus, unlike these technologies the accelerometer sensors will help us to determine the co-ordinates of the location and provide approximate results depending upon the position of the device.

3.1 Why not Global Positioning System (GPS)???

Global navigation satellite systems (GPS or GNSS) are generally not suitable to establish indoor locations, since microwaves will be attenuated and scattered by roofs, walls and other objects. However, in order to make positioning signals ubiquitous, integration between GPS and indoor positioning can be made

Currently, GNSS receivers are becoming more and more sensitive due to ceaseless progress in chip technology and processing power. High Sensitivity GNSS receivers are able to receive satellite signals in most indoor environments and attempts to determine the 3D position indoors have been successful.[16] Besides increasing the sensitivity of the receivers, the technique of A-GPS is used, where the almanac and other information are transferred through a mobile phone.

However, proper coverage for the required four satellites to locate a receiver is not achieved with all current designs (2008–11) for indoor operations. Beyond, the average error budget for GNSS systems normally is much larger than the confinements, in which the locating shall be performed

4. PROJECT METHODOLOGY

The schematic consisting of the floor plan and a tag inside a room is shown below:

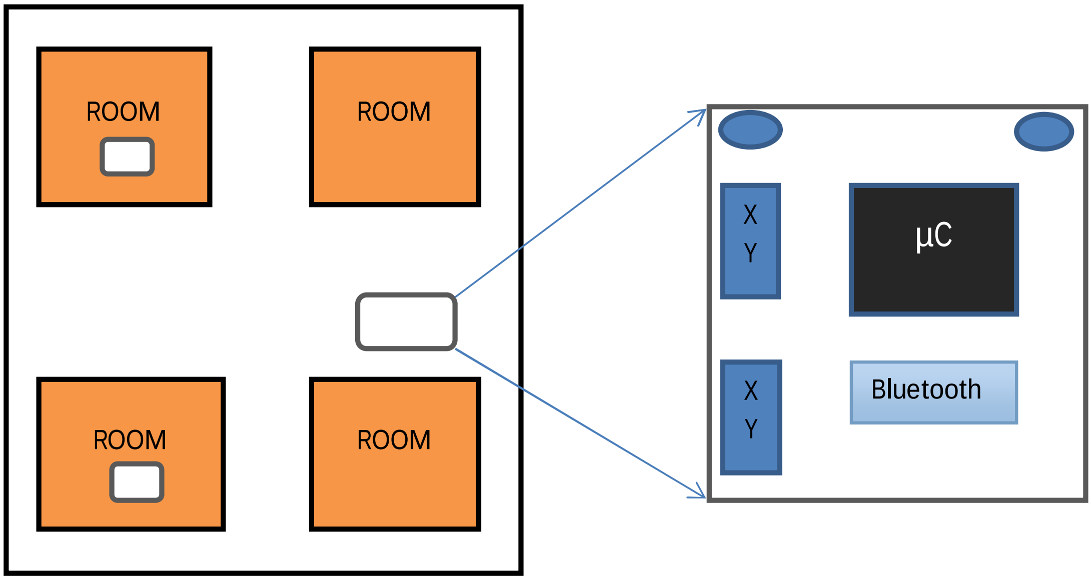


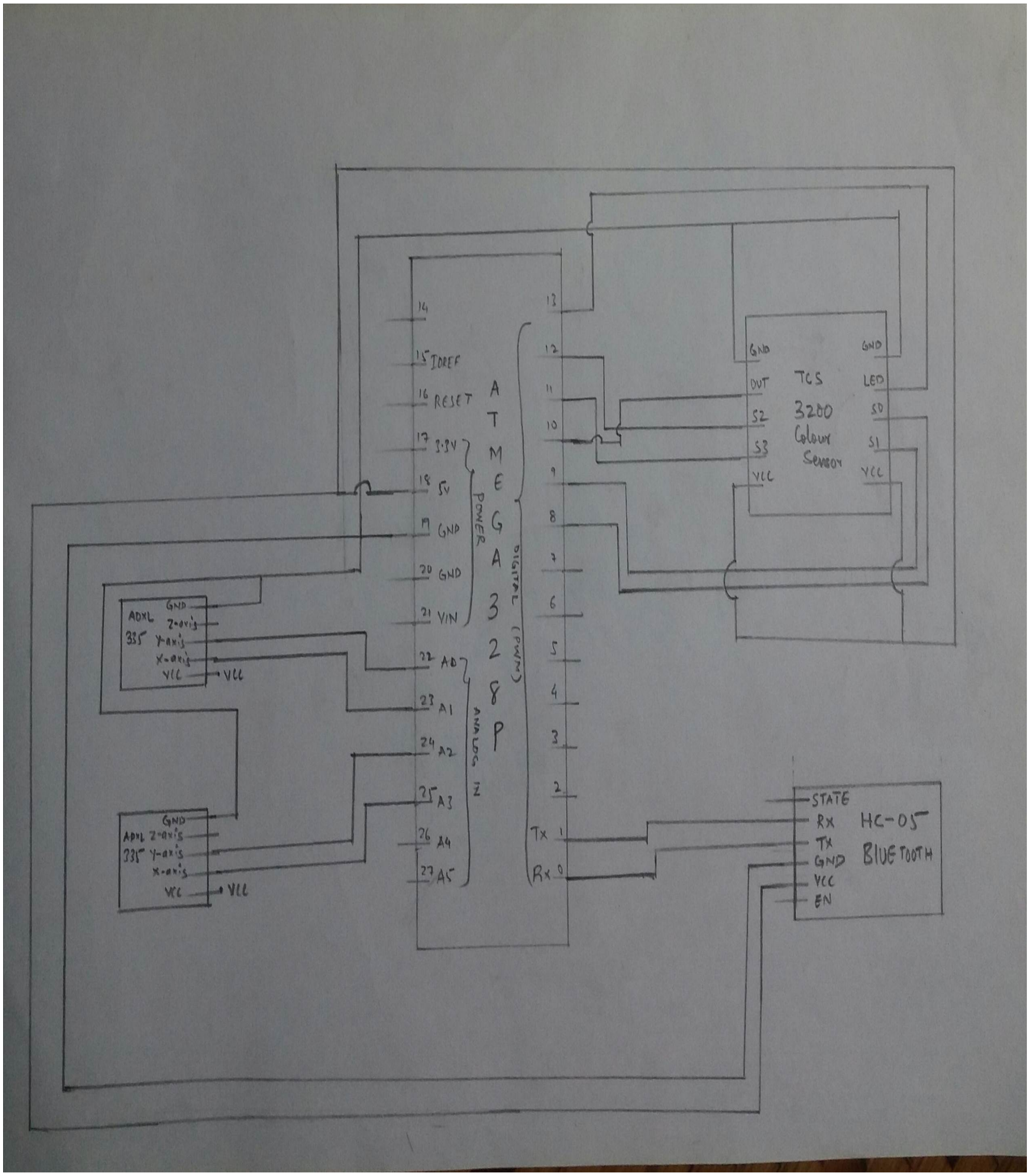
Fig1: Floor Plan

The typical floor plan of building is as shown above, the white figures represent the tracking device and these tags then comprises of the following modules:

1. Accelerometer Sensors (ADXL335)
2. Arduino Uno
3. Bluetooth Module (HC-06)
4. Color Sensor (TCS3200)

The data from this devices is then transmitted wirelessly using the bluetooth device to the reciever to the display device which will provide the data corresponding to the position of the object.

4.1CIRCUIT DIAGRAM:



In this project a module is constructed consisting of two different sensors which is used for pin pointing the x-y coordinates and the other sensor is used for determining the different locations on the floors.

The rooms and the floors are divided into x and y co-ordinates. Accelerometer sensors calculates the ‘x’ and the ‘y’ dimensions of the given area.Out of these two sensors corresponds to the ‘x’ or the horizontal direction.The other two corresponds to the ‘y’ or the vertical direction.

The purpose of using the two sensors is to provide more accurate results so as to obtain exact position of the person or an object inside a closed area.

The color sensor which is being used will let the microcontroller to know whether the tracking device is on a floor corridor or inside a room.

The dimensions of the room is already calculated and fed into the microcontroller.

Depending upon the output co-ordinates of the accelerometer sensors the microcontroller will perform arithmetic operations and provide the accurate position of the mobile device.

5. RELATED THEORY:

This topic includes all the details of the hardwares and softwares used to build the project.

5.1 ACCELEROMETER

An **accelerometer** is a device that measures proper acceleration ("g-force"). Proper acceleration is not the same as coordinate acceleration (rate of change of velocity). For example, an accelerometer at rest on the surface of the Earth will measure an acceleration $g = 9.81\ m/s^2$ straight upwards. By contrast, accelerometers in free fall (falling toward the center of the Earth at a rate of about $9.81\ m/s^2$) will measure zero.

Accelerometers have multiple applications in industry and science. Highly sensitive accelerometers are components of inertial navigation systems for aircraft and missiles.

Accelerometers are used to detect and monitor vibration in rotating machinery. Accelerometers are used in tablet computers and digital cameras so that images on screens are always displayed upright. Accelerometers are used in drones for flight stabilisation. Pairs of accelerometers extended over a region of space can be used to detect differences (gradients) in the proper accelerations of frame of reference point. These devices are called gravity gradiometers, as they measure gradients in the gravitational field. Such pairs of accelerometers in theory may also be able to detect gravitational waves.

Single- and multi-axis models of accelerometer are available to detect magnitude and direction of the proper acceleration (or g-force), as a vector quantity, and can be used to sense orientation (because direction of weight changes), coordinate acceleration (so long as it produces g-force or a change in g-force), vibration, shock, and falling in a resistive medium (a case where the proper acceleration changes, since it starts at zero, then increases).

5.1.1 PHYSICAL PRINCIPLE

An accelerometer measures proper acceleration, which is the acceleration it experiences relative to freefall and is the acceleration felt by people and objects. Put another way, at any point in spacetime the equivalence principle guarantees the existence of a local inertial frame, and an accelerometer measures the acceleration relative to that frame. Such accelerations are popularly measured in terms of g-force.

An accelerometer at rest relative to the Earth's surface will indicate approximately 1 g *upwards*, because any point on the Earth's surface is accelerating upwards relative to the local inertial frame (the frame of a freely falling object near the surface). To obtain the acceleration due to motion with respect to the Earth, this "gravity offset" must be subtracted and corrections made for effects caused by the Earth's rotation relative to the inertial frame.

The reason for the appearance of a gravitational offset is Einstein's equivalence principle, which states that the effects of gravity on an object are indistinguishable from acceleration. When held fixed in a gravitational field by, for example, applying a ground reaction force or an equivalent upward thrust, the reference frame for an accelerometer (its own casing) accelerates upwards with respect to a free-falling reference frame. The effects of this acceleration are indistinguishable from any other acceleration experienced by the instrument, so that an accelerometer cannot detect the difference between sitting in a rocket on the launch pad, and being in the same rocket in deep space while it uses its engines to accelerate at 1 g. For similar reasons, an accelerometer will read *zero* during any type of free fall. This includes use in a coasting spaceship in deep space far from any mass, a spaceship orbiting the Earth, an airplane in a parabolic "zero-g" arc, or any free-fall in vacuum. Another example is free-fall at a sufficiently high altitude that atmospheric effects can be neglected.

However this does not include a (non-free) fall in which air resistance produces drag forces that reduce the acceleration, until constant terminal velocity is reached. At terminal velocity the accelerometer will indicate 1 g acceleration upwards.

For the same reason a skydiver, upon reaching terminal velocity, does not feel as though he or she were in "free-fall", but rather experiences a feeling similar to being supported (at 1 g) on a "bed" of uprushing air.

Acceleration is quantified in the SI unit meters per second per second (m/s^2), in the cgs unit gal (Gal), or popularly in terms of g-force (*g*).

For the practical purpose of finding the acceleration of objects with respect to the Earth, such as for use in an inertial navigation system, a knowledge of local gravity is required. This can be obtained either by calibrating the device at rest, or from a known model of gravity at the approximate current position.

5.1.2 STRUCTURE

Conceptually, an accelerometer behaves as a damped mass on a spring. When the accelerometer experiences an acceleration, the mass is displaced to the point that the spring is able to accelerate the mass at the same rate as the casing. The displacement is then measured to give the acceleration.

In commercial devices, piezoelectric, piezoresistive and capacitive components are commonly used to convert the mechanical motion into an electrical signal. Piezoelectric accelerometers rely on piezoceramics (e.g. lead zirconatetitanate) or single crystals (e.g. quartz, tourmaline). They are unmatched in terms of their upper frequency range, low packaged weight and high temperature range. Piezoresistive accelerometers are preferred in high shock applications. Capacitive accelerometers typically use a silicon micro-machined sensing element. Their performance is superior in the low frequency range and they can be operated in servo mode to achieve high stability and linearity.

Modern accelerometers are often small *micro electro-mechanical systems* (MEMS), and are indeed the simplest MEMS devices possible, consisting of little more than a cantilever beam with a proof mass (also known as *seismic mass*). Damping results from the residual gas sealed in the device. As long as the Q-factor is not too low, damping does not result in a lower sensitivity.

Under the influence of external accelerations the proof mass deflects from its neutral position. This deflection is measured in an analog or digital manner. Most commonly, the capacitance between a set of fixed beams and a set of beams attached to the proof mass is measured. This method is simple, reliable, and inexpensive. Integratingpiezoresistors in the springs to detect spring deformation, and thus deflection, is a good alternative, although a few more process steps are needed during the fabrication sequence. For very high sensitivities quantum tunneling is also used; this requires a dedicated process making it very expensive.

Another, far less common, type of MEMS-based accelerometer contains a small heater at the bottom of a very small dome, which heats the air inside the dome to cause it to rise. A thermocouple on the dome determines where the heated air reaches the dome and the deflection off the center is a measure of the acceleration applied to the sensor.

Most micromechanical accelerometers operate *in-plane*, that is, they are designed to be sensitive only to a direction in the plane of the die.

By integrating two devices perpendicularly on a single die a two-axis accelerometer can be made. By adding another *out-of-plane* device three axes can be measured. Such a combination may have much lower misalignment error than three discrete models combined after packaging.

Micromechanical accelerometers are available in a wide variety of measuring ranges, reaching up to thousands of *g*'s. The designer must make a compromise between sensitivity and the maximum acceleration that can be measured.

5.2 TYPES OF ACCELEROMETER SENSORS

5.2.1 CAPACITIVE SENSING:

This article is about the sensing technology used in human interfaces. For the device used in distance measurements, see capacitive displacement sensor.

In electrical engineering, is a technology, based on capacitive coupling, that can detect and measure anything that is conductive or has a dielectric different from air.

Many types of sensors use capacitive sensing, including sensors to detect and measure proximity, position or displacement, humidity, fluid level, and acceleration. Human interface devices based on capacitive sensing, such as trackpads, can replace the computer mouse. Digital audio players, mobile phones, and tablet computers use capacitive sensing touchscreens as input devices. Capacitive sensors can also replace mechanical buttons.

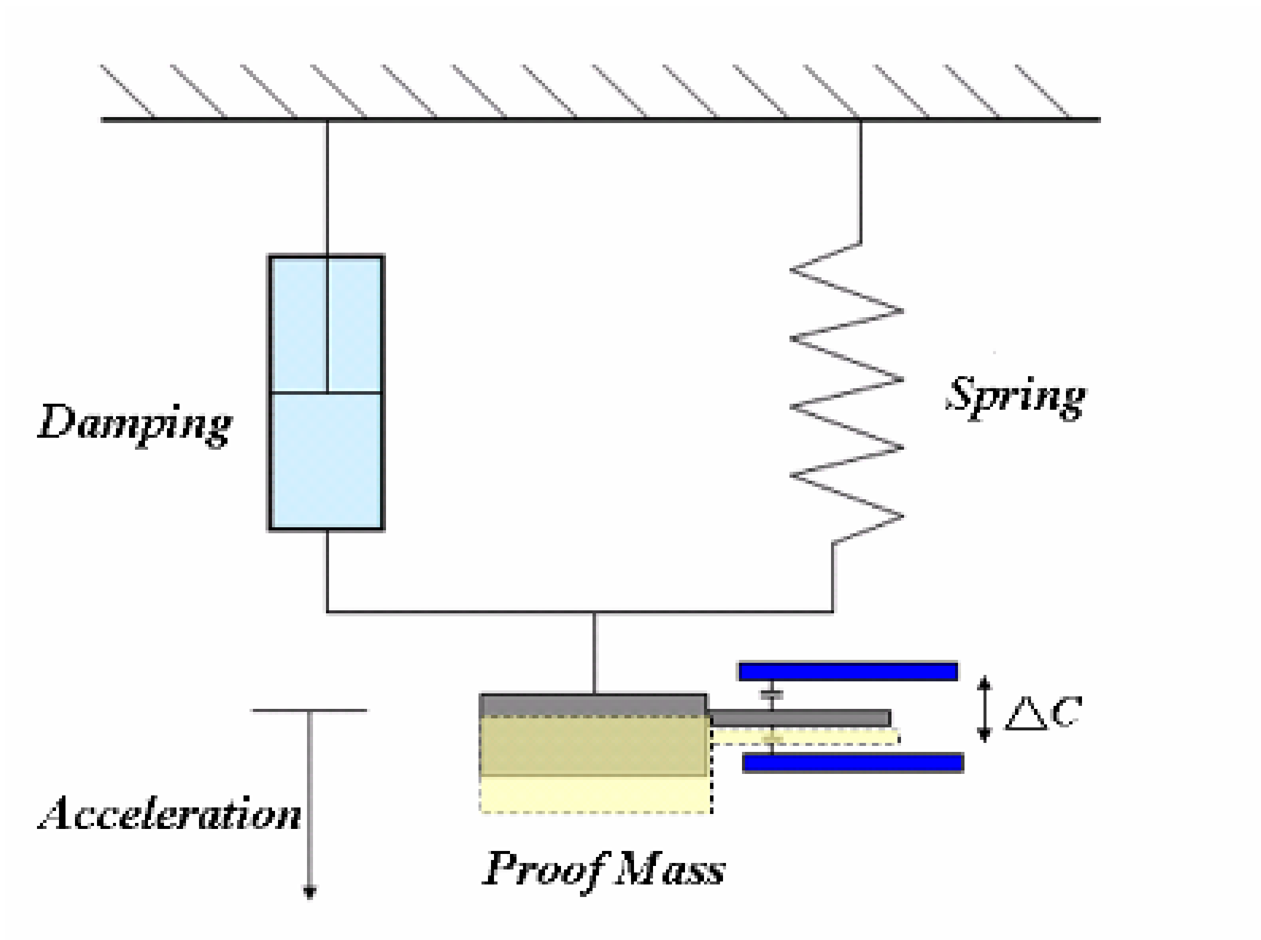
Capacitive sensors are constructed from many different media, such as copper, Indium tin oxide (ITO) and printed ink. Copper capacitive sensors can be implemented on standard FR4 PCBs as well as on flexible material. ITO allows the capacitive sensor to be up to 90% transparent (for one layer solutions, such as touch phone screens). Size and spacing of the capacitive sensor are both very important to the sensor's performance. In addition to the size of the sensor, and its spacing relative to the ground plane, the type of ground plane used is very important. Since the parasitic capacitance of the sensor is related to the electric field's (e-field) path to ground, it is important to choose a ground plane that limits the concentration of e-field lines with no conductive object present.

Designing a capacitance sensing system requires first picking the type of sensing material (FR4, Flex, ITO, etc.). One also needs to understand the environment the device will operate in, such as the full operating temperature range, what radio frequencies are present and how the user will interact with the interface.

There are two types of capacitive sensing system: mutual capacitance, where the object (finger, conductive stylus) alters the mutual coupling between row and column electrodes, which are scanned sequentially and self- or absolute capacitance where the object (such as a finger) loads the sensor or increases the parasitic capacitance to ground.

In both cases, the difference of a preceding absolute position from the present absolute position yields the relative motion of the object or finger during that time. The technologies are elaborated in the following section.

Accelerometers that implement capacitive sensing output a voltage dependent on the distance between two planar surfaces. One or both of these “plates” are charged with an electrical current.



5.2.2 PIEZOELECTRIC SENSING:

A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge. The prefix *piezo* is Greek for 'press' or 'squeeze'.

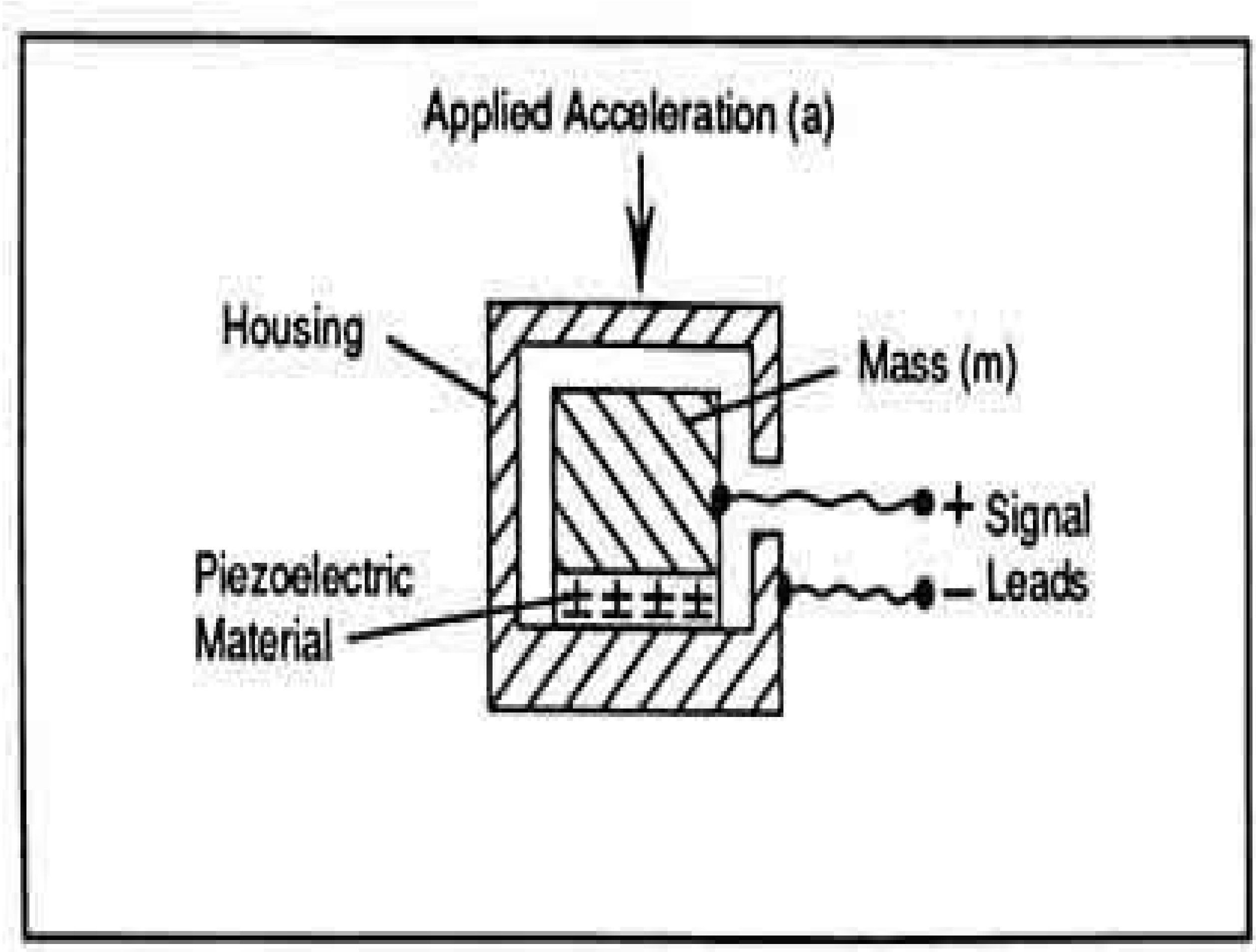
Piezoelectric sensors are versatile tools for the measurement of various processes. They are used for quality assurance, process control, and for research and development in many industries. Pierre Curie discovered the piezoelectric effect in 1880, but only in the 1950s did manufacturers begin to use the piezoelectric effect in industrial sensing applications. Since then, this measuring principle has been increasingly used, and has become a mature technology with excellent inherent reliability.

They have been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a tilt sensor in consumer electronics or a pressure sensor in the touch pads of mobile phones. In the automotive industry, piezoelectric elements are used to monitor combustion when developing internal combustion engines. The sensors are either directly mounted into additional holes into the cylinder head or the spark/glow plug is equipped with a built-in miniature piezoelectric sensor.

The rise of piezoelectric technology is directly related to a set of inherent advantages. The high modulus of elasticity of many piezoelectric materials is comparable to that of many metals and goes up to 10^6 N/m^2. Even though piezoelectric sensors are electromechanical systems that react to compression, the sensing elements show almost zero deflection. This gives piezoelectric sensors ruggedness, an extremely high natural frequency and an excellent linearity over a wide amplitude range. Additionally, piezoelectric technology is insensitive to electromagnetic fields and radiation, enabling measurements under harsh conditions. Some materials used (especially gallium phosphateor tourmaline) are extremely stable at high temperatures, enabling sensors to have a working range of up to 1000 °C. Tourmaline shows pyroelectricity in addition to the piezoelectric effect; this is the ability to generate an electrical signal when the temperature of the crystal changes. This effect is also common to piezoceramic materials. Gautschi in *Piezoelectric Sensorics* (2002) offers this comparison table of characteristics of piezo sensor materials vs other types.

However, it is not true that piezoelectric sensors can only be used for very fast processes or at ambient conditions. In fact, numerous piezoelectric applications produce quasi-static measurements, and other applications work in temperatures higher than 500 °C.

Piezoelectric sensing of acceleration is natural, as acceleration is directly proportional to force. When certain types of crystal are compressed, charges of opposite polarity accumulate on opposite sides of the crystal.



5.3ACCELEROMETER SENSOR ADXL335:

GENERAL DESCRIPTION

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for axis.

The outputs are analog voltage or digital signals whose duty cycles (ratio of pulsewidth to period) are proportional to acceleration. The duty cycle outputs can be directly measured by a microprocessor counter, without an A/D converter or glue logic. The duty cycle period is adjustable from 0.5 ms to 10 ms via a single resistor (RSET).

FUNCTIONAL BLOCK DIAGRAM

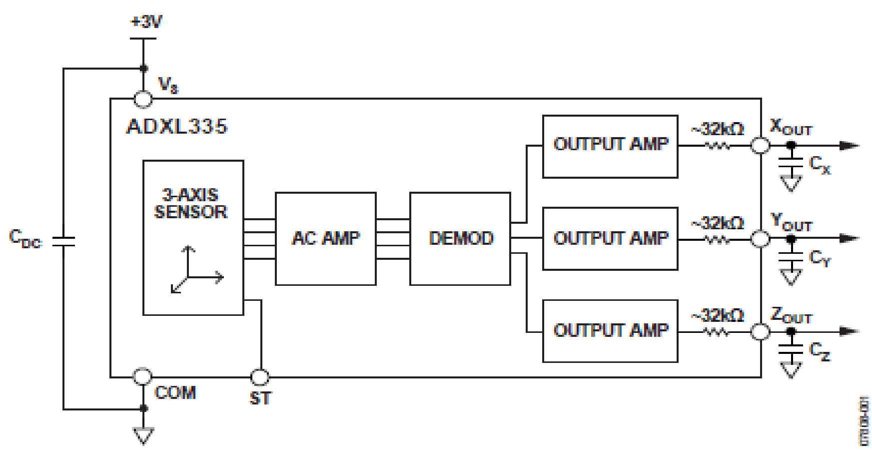


Figure 1.

PIN DESCRIPTION:

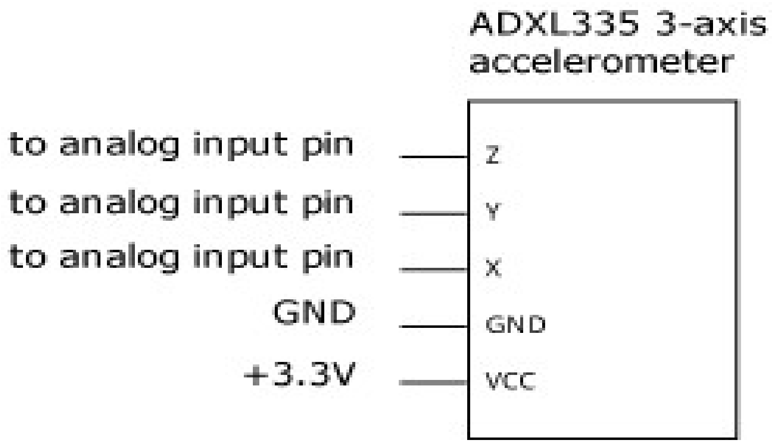


Fig: 3

THEORY OF OPERATION:

The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 *g* mini-mum. It contains a polysilicon surface-micromachined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration.

The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

MECHANICAL SENSOR

The ADXL335 uses a single structure for sensing the X, Y, and Z axes. As a result, the three axes' sense directions are highly orthogonal and have little cross-axis sensitivity. Mechanical misalignment of the sensor die to the package is the chief source of cross-axis sensitivity. Mechanical misalignment can, of course, be calibrated out at the system level.

PERFORMANCE

Rather than using additional temperature compensation circui-try, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or nonmonotonic behavior, and temperature hysteresis is very low (typically less than 3 m*g* over the −25°C to +70°C temperature range.

5.4 COLOR SENSOR

Although the human eye is very strong ability to distinguish colors, but different people describe the same color will be different, which means that demand accurate color detection and management of applications, the verbal description is not enough. Despite the better the ability of the human eye distinguish colors is very strong, but different people will describe the same color are different, which means that demand accurate color detection and management of applications, the verbal description is not enough.

A better solution is to use fully calibrated color sensing equipment to digitally describe the color. These devices include expensive laboratory grade spectrophotometer to the economy, RGB color sensors (such as the production of Avago color sensor). Avago has a variety of color sensors, many of the actual color of the current sensing and measurement applications provide a practical solution. The objective of this paper is to examine color perception, measurement and specification, and how to apply color sensor-generated data. Finally, the article discusses the Avago's RGB color sensor products and how for a variety of color sensing applications. The perception of color into the electronic devices in the theory of how the color sensor, it is necessary to understand how humans perceive color.

Color is light, the interaction between object and observer results. In reflected light, the light falling on an object will be reflected or absorbed, depending on the surface characteristics, such as the reflection coefficient and transmission conditions. For example, the red paper will absorb most of the spectrum with the green part and the part with the blue, while reflecting part of the spectrum with the red, so the viewer will show in red. Luminous objects in their own, its the same principle: light will reach the human eye, and then processed by the receiver eye, from the nervous system and brain for interpretation. Human visual system can detect from about 400nm (violet) to about 700nm (red) of the electromagnetic spectrum, can adapt to a wide range of illumination changes and a lot of color saturation (pure white color in proportion.)

Although the rod-shaped cells are able to work on a wide range of illumination, and provide rapid response to changes in light sensor element, but these rods can not detect color. Called cone cells, light sensors to provide high-resolution color image components. There are three cone cells, at different wavelengths to achieve peak sensitivity, the respective red (580nm), green (540nm) and blue (450nm). Visible spectrum of light at any wavelength will be in varying degrees, all three types of cone cells in the stimulation of one or more units, we feel that the color is our nerve and brain processes visual information. Obviously, people with normal color vision see the wavelengths in the same light, basically feel the same color. Scientific tests showed that humans can distinguish very subtle color differences, it is estimated the maximum could reach 1,000 million, the problem is that we do not have enough words to describe all of these have a slightly different color.

Color measurement principle shows the use of color measurement instruments or sensors than the human eye detect the basic principles of color. The sensor device is high-end equipment, such as spectrophotometer or the British International Commission on Illumination (CIE) calibration of the camera, it can be low-end devices, such as RGB color sensors. Figure 1a measuring instruments are usually divided into two categories: color analysis and metering method. Analysis of the use of color, the device uses sensor with three filters light from the object.

Under normal circumstances, the sensor profile is optimized, and is therefore very similar to the human eye response. Then, microcomputer equipment requirements through the integration of data obtained to calculate the value of the triple stimulation.

The working principle of the color sensor is divided into three different types of color sensors: light to photocurrent conversion, light-to-analog voltage converter, light-to-digital conversion. The former usually represent the actual color of the sensor input part, because the original current amplitude is very low light, always require amplification to the optical flow into the available levels. Therefore, the most practical analog output color sensor at least one transimpedance amplifier, and provides the voltage output.

Fall of light on each photodiode current is converted into light, the amplitude depends on the brightness and wavelength of incident light (due to color filters).

Properly designed filter will mimic the human eye photodiode array after filtering to provide spectral response. Each of the three photodiode photodiode photocurrent will use current to voltage converter, convert VRout, VGout and VBout. There are two color sensing modes: reflection and transmission sensor sensing. Reflection in the reflective sensing sensors, color sensors detect a surface or object from the reflected light, light and color sensors are placed near the target surface.

From the light source (such as incandescent or fluorescent lamps, white LED or calibrated RGB LED module) to leave the light bouncing surface, measured by the color sensor. Leave the surface reflection color and the color on the surface. For example, the white light incident on the red surface, will be reflected in red. Reflecting the impact of red light color sensor, producing R, G and B output voltage. By interpreting the three-voltage, can determine the color.

Since the three output voltage linearly increased the density of the reflected light, so the color sensor also can measure the reflection coefficient of a surface or object. The color of light reflected depends on surface reflection and absorption of the color of the color sensor in the transmission mode of transmission, the sensor toward the light. Filter color sensor with photodiode array converts the incident light R, G and B light current, and then amplified and converted to analog voltages. Since all three output will increase linearly with the optical density increased, so the sensor can measure the color of the light and the total density. Transmission sensor can be used to determine the color of transparent materials such as glass and transparent plastics, liquids and gases.

5.4.1 COLOR SENSOR TCS3200

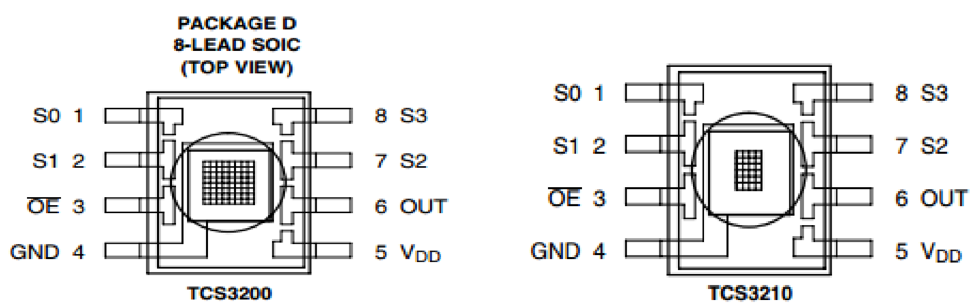
DESCRIPTION:

The TCS3200 and TCS3210 programmable color light-to-frequency converters that combine configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance).

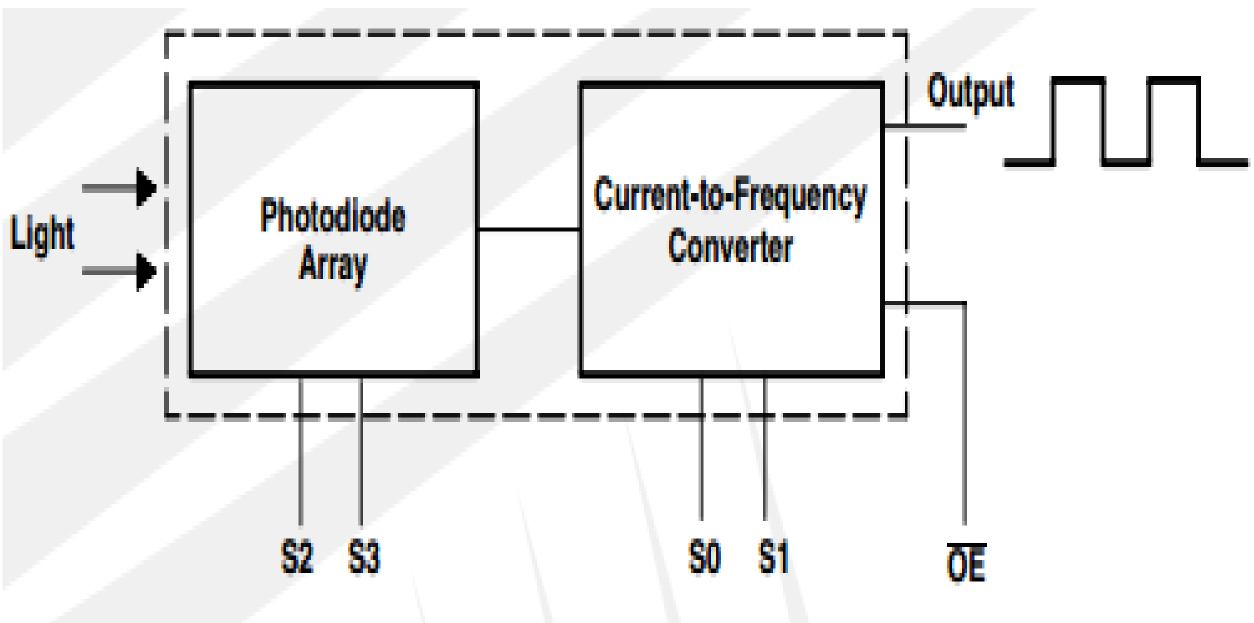
The full-scale output frequency can be scaled by one of three preset values via two control input pins. Digital inputs and digital output allow direct interface to a microcontroller or other logic circuitry. Output enable (OE) places the output in the high-impedance state for multiple-unit sharing of a microcontroller input line.

In the TCS3200, the light-to-frequency converter reads an 8 x 8 array of photodiodes. Sixteen photodiodes have blue filters, 16 photodiodes have green filters, 16 photodiodes have red filters, and 16 photodiodes are clear with no filters.

In the TCS3210, the light-to-frequency converter reads a 4 x 6 array of photodiodes. Six photodiodes have blue filters, 6 photodiodes have green filters, 6 photodiodes have red filters, and 6 photodiodes are clear with no filters.



FUNCTIONAL BLOCK DIAGRAM:



TERMINAL FUNCTIONS:

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
GND	4		Power supply ground. All voltages are referenced to GND.
$\overline{OE}$	3	I	Enable for f_o (active low).
OUT	6	O	Output frequency (f_o).
S0, S1	1, 2	I	Output frequency scaling selection inputs.
S2, S3	7, 8	I	Photodiode type selection inputs.
V_{DD}	5		Supply voltage

SELECTABLE OPTIONS:

S0	S1	OUTPUT FREQUENCY SCALING (f_o)
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

S2	S3	PHOTODIODE TYPE
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

5.5 BLUETOOTH MODULE HC-05

OVERVIEW:

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

PIN CONFIGURATION:

HARDWARE FEATURES:

- Typical -80dBm sensitivity.
- Up to +4dBm RF transmit power.
- Low Power 1.8V Operation, 3.3 to 5 V I/O.
- PIO control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

5.6 ARDUINO MICROCONTROLLER:

HISTORY

Colombian student Hernando Barragán created the development platform *Wiring* as his Master's thesis project in 2004 at the Interaction Design Institute Ivrea in Ivrea, Italy. Massimo Banzi and Casey Reas (known for his work on Processing) were supervisors for his thesis. The goal was to create low cost, simple tools for non-engineers to create digital projects. The Wiring platform consisted of a hardware PCB with an ATmega128 microcontroller, an integrated development environment (IDE) based on Processing and library functions to easily program the microcontroller.

In 2005, Massimo Banzi, with David Mellis (then an IDII student) and David Cuartielles, added support for the cheaper ATmega8 microcontroller to Wiring. But instead of continuing the work on Wiring, they forked (or copied) the Wiring source code and started running it as a separate project, called Arduino.

The Arduino's initial core team consisted of Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, and David Mellis.

The name *Arduino* comes from a bar in Ivrea, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of theMarch of Ivrea and King of Italy from 1002 to 1014.

Following the completion of the Wiring platform, its lighter, lower cost versions were created and made available to the open-source community. Associated researchers, including David Cuartielles, promoted the idea. Arduino's initial core team consisted of Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, and David Mellis.

HARDWARE:

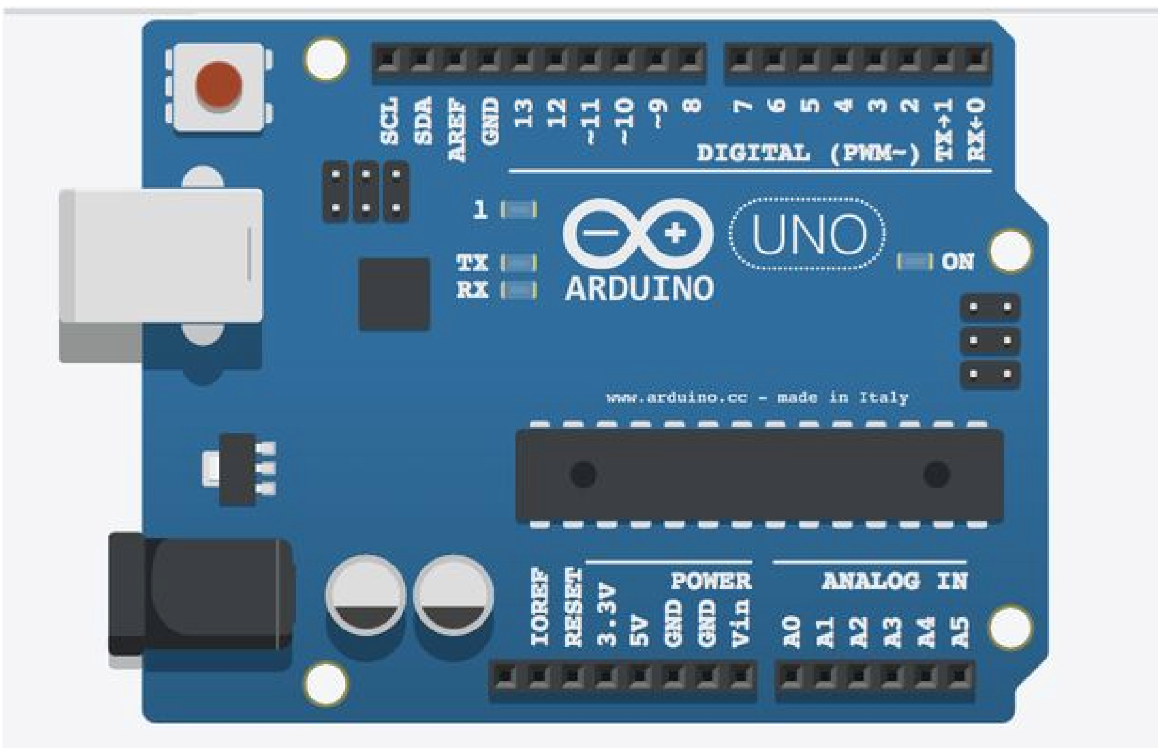
An Arduino board historically consists of an Atmel 8, 16 or 32-bit AVR microcontroller (although since 2015 other makers' microcontrollers have been used) with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which let users connect the CPU board to a variety of interchangeable add-on modules termed *shields*. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus—so many shields can be stacked and used in parallel.

Before 2015, Official Arduinos had used the Atmel megaAVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560. In 2015, units by other producers were added. A handful of other processors have also been used by Arduino compatible devices. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator (or ceramic resonator in some variants), although some designs such as the LilyPad run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, optibootbootloader is the default bootloader installed on Arduino UNO.

At a conceptual level, when using the Arduino integrated development environment, all boards are programmed over a serial connection. Its implementation varies with the hardware version. Some serial Arduino boards contain a level shifter circuit to convert between RS-232logic levels and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the

FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header.

Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable,Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR in-system programming (ISP) programming is used.



The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits.

The Diecimila, Duemilanove, and current Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1-inch (2.54 mm) headers. Several plug-in application shields are also commercially available.

The Arduino Nano, and Arduino-compatible Bare Bones Board and Boarduino boards may provide male header pins on the underside of the board that can plug into solderless breadboards.

Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility.

6.SOFTWARE SPECIFICATIONS

6.1 ARDUINO IDE:

The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and is called a "sketch".

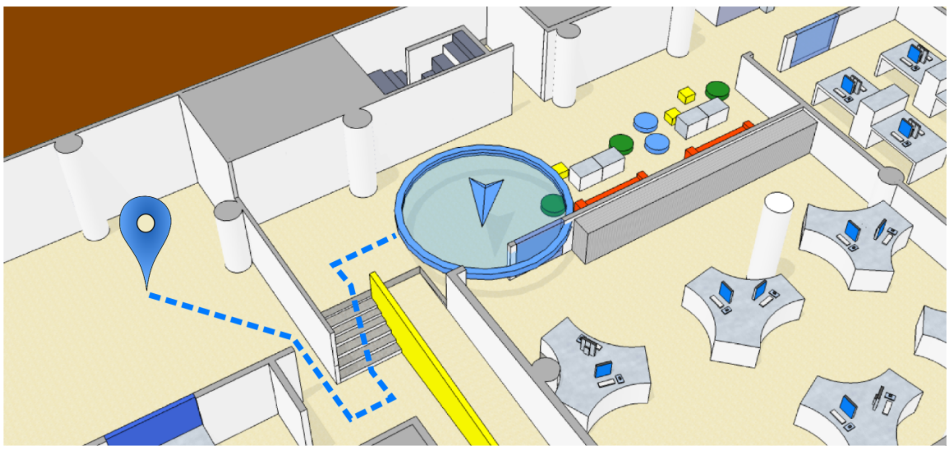
Arduino programs are written in C or C++. The Arduino IDE comes with a software library called "Wiring" from the original Wiring project, which makes many common input/output operations much easier. The users need only to define two functions to make an executable cyclic executive program:

- `setup()`: a function that runs once at the start of a program and that can initialize settings.
- `loop()`: a function called repeatedly until the board powers off.

The Arduino IDE uses the GNU toolchain and AVR Libc to compile programs, and uses avrdude to upload programs to the board. As the Arduino platform uses Atmel microcontrollers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

7. APPLICATIONS

The major consumer benefit of indoor positioning is the expansion of location-aware mobile computing indoors. As mobile devices become ubiquitous, contextual awareness for applications has become a priority for developers. Most applications currently rely on GPS, however, and function poorly indoors.



Applications benefiting from indoor location include:

- Augmented reality,
- School campus,
- Guided tours of museums,
- Shopping malls,
- Store navigation,
- Warehouses,
- Airports, bus, train and subway stations,
- Parking lots,
- Targeted advertising,
- Social networking,
- Hospitals,

- Hotels, and
- Sports.

8. FUTURE SCOPE

This project can also be implemented using the third z-axis which will let you know the floor level wherever the tag is present.

The outcome of the position can be displayed using a Graphical User Interface which will make it easier to track the person or an object. The hardware implementation is carried out in which the communication between the device and the displaying device is based on a wireless protocol.

The sensor will decide the location of the device, whether it is at a floor or inside a room will be selected based upon various parameters.

9. CONCLUSION:

This project serves the purpose of implementing a system of measuring the position with the help of an acceleration sensor.

The trend of the indoor positioning systemhas been widely applied in supply chain fortracking goods, the technology of MEMS Sensors applications isquite mature, and there is a trend of developingpositioning systems to meet the demands of indoorlocation sensing applications, driving more research topics on accelerometer positioning issues. Therefore, there is aneed to develop a positioning system that employs accelerometer sensor technology.

Thus by the use of the accelerometer sensor we will be able to determine the position of a moving target using appropriate algorithms. The property of accelerometer sensors are deployed for the measurement of the indoor position of an object or a person.

This will lead to a new implementation of an indoor tracking system using only an accelerometer sensor to provide more accuracy and positioning.

10. REFERENCES:

1. BogdanMuset, SiminaEmerich Technical University of Cluj-Napoca, Communication Department, **Distance Measuring using Accelerometer and Gyroscope Sensors**.

2. Junhui Zhao, Yongcai Wang NEC Labs, Beijing, China2008 International Symposium on Parallel and Distributed Processing with Applications,**Autonomous Ultrasonic Indoor Tracking System.**

3. Carlos Medina, Jose´ Carlos Segura and A´ngel De la Torre Sensors 2013, 13, 3501-3526; doi:10.3390/s130303501 Ultrasound Indoor Positioning System Based on a **Low-Power Wireless Sensor Network Providing Sub-Centimeter Accuracy**.

4. Kouji Murakami, Kazuya Matsuo, Tsutomu Hasegawa, YasunobuNohara, Ryo Kurazume Faculty of Information Science and Electrical EngineeringKyushu University **Position Tracking System for Commodities in an Indoor Environment.**

5. Kouji Murakami, Tsutomu Hasegawa, KousukeShigematsu, FumichikaSueyasu, YasunobuNohara, Byong Won Ahn, Ryo KurazumeThe 2010 IEEE/RSJ International Conference onIntelligent Robots and Systems October 18-22, 2010, Taipei, Taiwan **Position Tracking System of Everyday Objects in an Everyday Environment.**

6. ADXL202E Low-Cost 2g Dual-Axis Accelerometer with Duty Cycle Output Datasheets.

7. ADXL335E Low-Cost 3 Axis Accelerometer.

8. TCS3200, TCS3210 Programmable Color LIGHT-TO-FREQUENCY CONVERTER

11. APPENDIX

Program for the Accelerometer Sensors:

```
constint ap1=A0;

constint ap2=A1;

constint ap3=A2;

constint ap4=A3;


int sv1=0;

int ov1=0;

int sv2=0;

int ov2=0;

int sv3=0;

int ov3=0;

int sv4=0;

int ov4=0;

void setup() {

Serial.begin(9600);

}
```

```
void loop() {
analogReference(EXTERNAL);
sv1=analogRead(ap1);
ov1=map(sv1,0,1023,0,255);
delay(2);

sv2=analogRead(ap2);
ov2=map(sv2,0,1023,0,255);
delay(2);

sv3=analogRead(ap3);
ov3=map(sv3,0,1023,0,255);
delay(2);

sv4=analogRead(ap4);
ov4=map(sv4,0,1023,0,255);

Serial.print("X1 Sensor 1 = ");
Serial.print(sv1);
Serial.print("\t output 1= ");
Serial.println(ov1);
```

```
Serial.print("Y1 Sensor 2 = ");
Serial.print(sv2);
Serial.print("\t output 2= ");
Serial.println(ov2);
Serial.print("X2 Sensor 3 = ");
Serial.print(sv3);
Serial.print("\t output 3= ");
Serial.println(ov3);
Serial.print("Y2 Sensor 4 = ");
Serial.print(sv4);
Serial.print("\t output 4= ");
Serial.println(ov4);
delay(3000);
}
```

Program for Color Sensor:

```
int S0 = 8;

int S1 = 9;

int S2 = 12;

int S3 = 11;

inttaosOutPin = 10;

int LED = 13;



void setup() {

TCS3200setup();

Serial.begin(9600);

delay(100);

}

void loop() {

detectColor(taosOutPin);

Serial.print("\n\n\n");

delay(1000);
```

```
}

intdetectColor(inttaosOutPin){

float red = colorRead(taosOutPin,1,1);

float blue = colorRead(taosOutPin,2,1);

Serial.print("red ");

Serial.println(red);

Serial.print("blue ");

Serial.println(blue);

}

/* This section will return the pulseIn reading of the selected color. It will turn on the sensor at the start taosMode(1), and it will power off the sensor at the end taosMode(0) color codes: 0=white, 1=red, 2=blue, 3=green if LEDstate is 0, LED will be off. 1 and the LED will be on. taosOutPin is the ouput pin of the TCS3200. */

floatcolorRead(inttaosOutPin, int color, booleanLEDstate){

//turn on sensor and use highest frequency/sensitivity setting

taosMode(1);

//setting for a delay to let the sensor sit for a moment before taking a reading

intsensorDelay = 100;

//set the S2 and S3 pins to select the color to be sensed
```

```
if(color == 1){

digitalWrite(S3, LOW);

digitalWrite(S2, LOW);

// Serial.print(" Red")

}

else if(color == 2){

digitalWrite(S3, HIGH);//blue

digitalWrite(S2, LOW);

// Serial.print(" Blue");

}

// create a var where the pulse reading from sensor will go

floatreadPulse;

// turn LEDs on or off, as directed by the LEDstatevar

if(LEDstate == 0){

digitalWrite(LED, LOW);

}

if(LEDstate == 1){

digitalWrite(LED, HIGH);
```

```
}

// wait a bit for LEDs to actually turn on, as directed by sensorDelayvar

delay(sensorDelay);

// now take a measurement from the sensor, timing a low pulse on the sensor's "out" pin

readPulse = pulseIn(taosOutPin, LOW, 80000);

//if the pulseIn times out, it returns 0 and that throws off numbers. just cap it at 80k if it happens

if(readPulse< .1){

readPulse = 80000;

}

//turn off color sensor and LEDs to save power

taosMode(0);



// return the pulse value back to whatever called for it...

returnreadPulse;

}

// Operation modes area, controlled by hi/lo settings on S0 and S1 pins

//setting mode to zero will put taos into low power mode
```

```
voidtaosMode(int mode){

//power OFF mode- LED off and both channels LOW

if(mode == 0){

digitalWrite(LED, LOW);

digitalWrite(S0, LOW);

digitalWrite(S1, LOW);

// Serial.println("LED off, both channels low");

//this will put in 1:1, highest sensitivity

}else if(mode == 1){

digitalWrite(S0, HIGH);

digitalWrite(S1, HIGH);

// Serial.println("Frequency Scaled at 100%");

//this will scale down the frequency down 20%

}else if(mode == 2){

digitalWrite(S0, HIGH);

digitalWrite(S1, LOW);

//Serial.println("Frequency Scaled Down to 20%");
```

```
//this will scale down the frequency down to 2%
}else if(mode == 3){
digitalWrite(S0, LOW);
digitalWrite(S1, HIGH);
//Serial.println("Frequency Scaled Down to 2%");
}
return;
}
void TCS3200setup(){

pinMode(LED,OUTPUT);
//color mode selection
pinMode(S2,OUTPUT);
pinMode(S3,OUTPUT);
pinMode(taosOutPin, INPUT);
pinMode(S0,OUTPUT);
pinMode(S1,OUTPUT);
return;
```

```
}
```