Chapter One
Introduction

1.1 Background

Over the last ten years, the impact of wireless communications on the way we live and do business has been surpassed only by the impact of the Internet. Cellular phones, pagers, and wireless Personal Digital Assistants (PDAs) have become so commonplace in our lives that it is easy to forget those ten years ago, they were a rarity. But wireless communications technology is still in its infancy and the next stage of its development will be in supplementing or replacing the network infrastructure that was traditionally wired as well as enabling network infrastructures that previously could only be imagined. From local coffee shops to commercial inventory control systems, within restaurants and throughout public airports, wireless commerce is beginning to challenge the exchange system that our modern world currently embraces, by accessing central pools of information and communicating directly between users and between the devices themselves [1].

In the past few years the study on URC has become a topic of interest of many peoples. Hence there is sufficient work done on the universal remote control. The most advanced URC was produced by Ardiansyah, Deokjai Choi, Youngchul Kim, Ali Fahmi PN, Prayoga Budhi and Jongmin Song [2] in the year 2013 called Three Dimensional-to-Two Dimensional (3D-to-2D) projection algorithm for remote control using smartphone. In this system the smartphone itself works as URC. To activate any device the user just had to touch device name on smartphone display and after touching that name, whole menu of that particular device is displayed on the smartphone screen. To activate the device the user had to touch ON label likewise to deactivate OFF label. Another attempt to make the URC was made by Ting-Fang Chueh

and Yong-Yi FanJiang [3] in the year 2012 called the smartphone based universal remote control. Successive attempts were made to produce URC in year past years one of them was made by Bonhyun Koo, Taewon Ahn, JungSik In, Youngsuk Park, Taeshik Shon, Juhi Ranjan, Hiren Shah, Sanika Joshi, Brijesh Chokhra and Prabhat Ranjan called RF4CE-based Universal Remote Control (RURC)framework using smartphone[4-5] in year 2010. These devices were very good devices making things easy for the user but the smartphone based URC also has some disadvantages such as it is very expensive as we see. To overcome this drawback new URC at very low cost was introduced. The Smartphone based URT was also very delicate in terms even if it falls on the floor it's display gets damaged and repairing it is very costly as it itself very costly. Hence to overcome this drawback we are introducing a new URC with very robust structure immune to any physical damage. URC based on wrist watch type device was made by Dong-Woo Lee, Jeong-Mook Lim, John Sunwoo, Il-Yeon Cho and Cheol-Hoon Lee [6] in year 2009. They introduced universal remote control based on Infrared Radiation (IR) sensors capable of handling various electronic devices at home. It was a wrist-watch type device. The basic of this URC is to capture the unique hand motions and use it to activate the particular device. After activating the device a virtual menu of that device is created and the device is controlled with that virtual menu. It was a useful device but it had various drawbacks such as it was having very short range of 6-8 meters and it was unable to penetrate the physical solid objects [7].

Many people affected with cerebral palsy have trouble with finger movement, and cannot control their peripheral equipments such as fan, light and air condition. They need someone to assist them for doing these things. The remote control of "RFCePal" interprets rough hand/wrist gestures .This device opens up a way to provide self-reliance to persons with such issues and improve their quality of life by using microcontroller. A lot of work has been done in augmentative communication devices. BIGmack is a device with pre-

recorded messages on device with touch-screen that helps the child communicate, what he wishes to say, by touching different parts of the screen. Then there is a device called delta talker, which resembles a computer keyboard, but instead of writing words and sentences, different pictures and words are put together to make a sentence. There are hi-tech devices which include computer boards attached to electronic wheelchairs that allow a person with severe cerebral palsy related problems to both travel in the outside world and engage it with meaningful words and speech. Some other intuitive technology has made it possible for a camera to translate eye movements and blinks into computer input. The camera mounts just below the computer screen, and uses infrared light to track a person's eye movement and estimate with great accuracy what portion of the screen they are looking at. So a person would be able to simply look at the phrase they wanted to say on the computer screen and blink twice (for example) to select it [8].

The 3D hand remote controller is used instead of classic remote for many reasons, firstly the classic remote use the inferred radiation and it has many disadvantages especially over Radio Frequency (RF) control systems include the receivers and transmitters must be in direct line of sight of each other. This reduces the amount of flexibility you have in movement within the room without interrupting the signal and in this case to disable people that could be a problem for them, also unlike RF cannot cover the receiver or put it anywhere where the direct line of sight will be blocked. Secondly the classic remote need to change battery from time to time. For all reasons mentioned above, this system is designed to be easily portable, long battery life, easy to use, no extra accessories and all processing done on the glove.

1.2 Problem Statement:

Disability is a physical or mental impairment which has a substantial and term adverse effect on their ability to carry out normal day activities. The number of disable people is increasing rapidly for many reasons. People living with a severe disability suffer substantial personal and social

consequences that reduce quality of life. One potential negative impact on the life of disable person is the loss of the ability to control devices in their immediate environment; they cannot be able to life their live like normal people because of their limited mobility so they always need someone for help in small activities such as switching ON and OFF lights, opening and closing doors and switching ON and OFF television.

1.3 Objectives:

- To study the previous works.
- To interface a 3D accelerometer to the microcontroller.
- To implement a transmitter (control part) and receiver (controllable device) circuits.
- To program microcontroller to detect the sensor statues and respond according to it on the device.
- To evaluate the performance of 3D remote control system.

1.4 Methodology:

The methodology is undertaken according to these steps:

- Study the main components of the remote control and microcontroller.
- Testing the HMC5883L sensor module.
- Design the transmitter and receiver circuit.
- Evaluate the performance of the 3D remote control based on practical results.

1.5 Thesis Layout

This thesis consists of five chapters. Chapter one discusses the problem statement, objective and methodology. Chapter two discusses background and literature review, sensors and similar thesis almost the same idea and controlling method.

In chapter three, the basic component of transmitter and receiver circuits is briefly viewed. The experiment and result discussion are presented in chapter four. Lastly, chapter five contains a conclusion of this thesis and recommendations.

Chapter Two

Background and Literature Review

2.1 Introduction

In the past few years the study on URC has become a topic of interest. The number of electronic devices is increasing day by day. As the technology is developing these devices are coming with more and more functions hence as functionality is increasing the difficulty to use these devices are also increasing. As a result the users find it difficult to handle various electronic devices with separate remote controls. The most advanced URT was produced in December 21, 2015(Gold finger). The scientists have succeeded in the biggest challenge that confronted them and support this glove is simple and efficiency that allows user to perform his duties easily designs.

This glove is the most comfortable among similar devices after providing the simplest way to enter data. And according to glove work it is related to the different technological instruments to wirelessly and generates energy from finger movements without the need for power cables.

2.1.1 SENSORS

Different types of sensors are available like piezoelectric, capacitive etc that can be used to sense the movement. But the key problem with these sensors is that they generate the signals of single axis whereas in real practical world we require 3D motions to perform even the most trivial task. So taking into account all considerations the MEMS motion sensor was selected. Basically the MEMS accelerometer is selected as it provides the 3axis X, Y and Z signals depending upon the angular position of the sensor.

2.2 RF-CePal

RF-CePal is networked sensor device to assist people with restricted finger movements. Many electrical/electronic equipment can be operated

using IR based remote control. As these remote controls take user input using push buttons, persons with restricted finger movement (e.g. those with cerebral palsy) cannot operate such equipment. Taking advantage of MEMS accelerometer, researchers recognize gross movements of hand and map them to important functions of the equipment to be operated. Researchers had earlier developed a device in which IR transmitter was integrated in the device along with sensor. However many users have problem pointing it towards the equipment to operate it reliably. In this paper, the work reported on developing a two part networked system communicating via zigbee based wireless link to overcome this difficulty. First part of the device (body device) containing sensor is placed on the body part (e.g. hand/wrist) and the other part (base device) is pointing in direction of IR receiver of equipment. Tilt angle of hand is used as input to device (e.g. left tilt changes the channel on TV). Based on preliminary trials, researchers have made design modifications to make the system more suitable and cheaper. This system is now being made available to users [8].

Two different variants of this device had been made:

1. Single part device being called CePal. This device is cheaper, but may have some limitation based on degree of hand control of the user since it depends on line-of-sight from user's hand to equipment receiver.
2. Two part system connected through wireless link being called “RF-CePal” This system consists of a hand mounted device and a base device [8].

Hand mounted device has an accelerometer to sense hand tilt and a wireless communication link. When sensor detects appropriate tilt, it communicates to base device, what user action has happened. In this, equipment is always aligned with the IR transmitter and is always in line-of-sight. This device costs more as compared to the first one but is more flexible and reliable. Both the variants use a 3-axis accelerometer to monitor body part movement. In its simplest form, four movements could be recognized of the hand/wrist. One can use other parts of the body as well. Also recognize

up/down/left and right tilt of the hand and use these as inputs to operate the equipment in lieu of the buttons being pushed. This allows us to map four major functions of any IR controlled equipment to these movements [8].

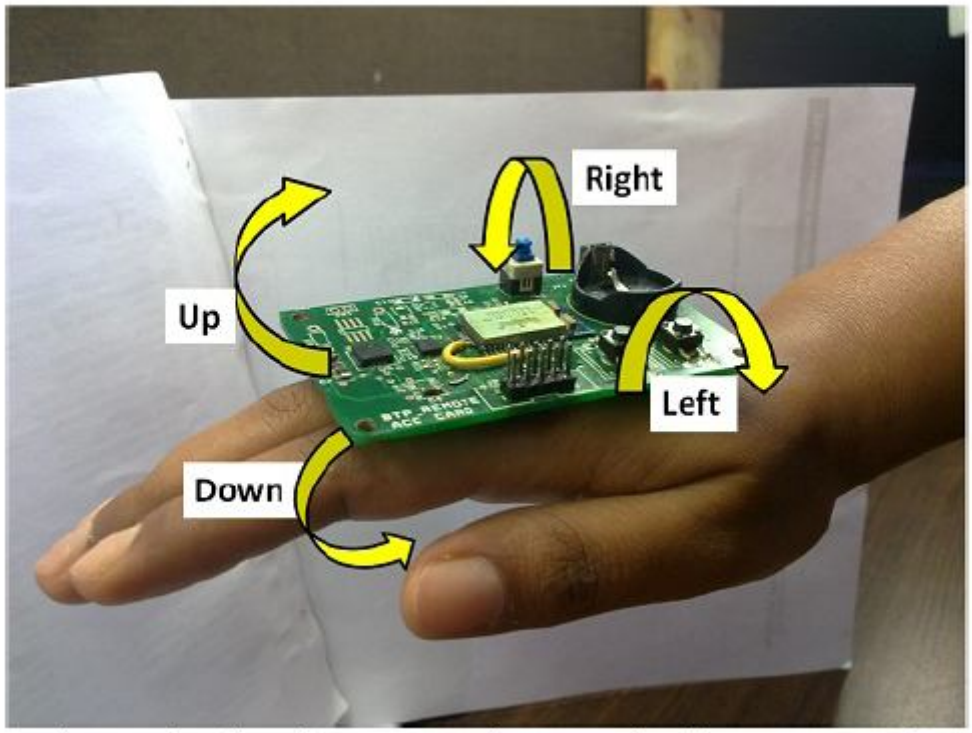

Figure 2.1: The directions currently recognized by “RF-CePal” remote

So that is why people with restricted finger movements needed to be assist by RF-CePal networked sensor device. Taking advantage of Micro Electro Mechanical System (MEMS) accelerometer, recognize gross movements of hand could be recognized and map them into different functions. Two part networked system communicating via zigbee based wireless link, first part of the device containing sensor and the other is pointing in direction of IR receiver of equipment [8].

2.3 Smart remote control: universal remote control using RF sensors and GSM technology

To reduce the user efforts of learning various remote controls researchers are introducing a smart remote control which can handle various household electronic devices itself without having a complex methodology despite some hand gestures [7]. The smart remote control is capable of activating as well as controlling the devices with simple hand gestures. The main component of the smart remote control is a MEMS accelerometer. It is a micro electro mechanical system which is capable of correctly measuring any acceleration, motion, speed, vibration or tilt. In response to any unique movement, it produces unique Frequency. The second important component is RF sensors including transmitter and receiver. The radio frequency sensors are capable of sending the signals to 20-25 meters and also penetrating physical solid objects. To increase the operating range of the device adding GSM technology to it so that the operating range should increase. The implementation process starts with the MEMS accelerometer which is most important part of the system.

Accelerometer is an electromechanical device which measures acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer. Accelerometer usually detects acceleration up to 3 axes. The MEMS accelerometer is fitted inside the smart remote control catches perfectly any hand movement of the user and produces a specific frequency in response to it. This specific frequency is then sent to the RF transmitter. Figure 2.2 shows many hand movements that user can make [7].

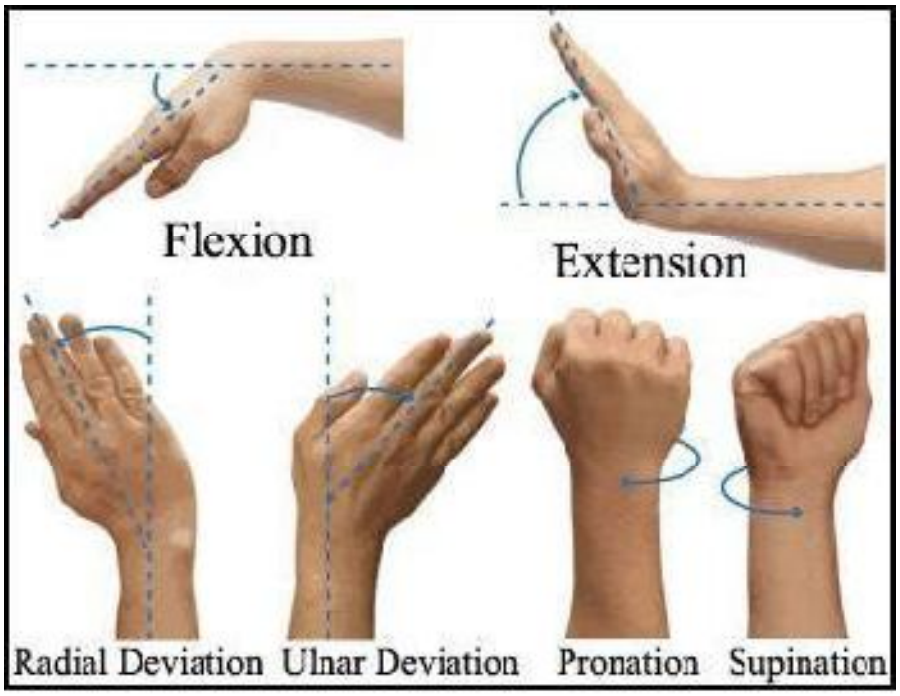

Figure 2.2: Hand motions

The RF transmitter receives the frequency produced by the accelerometer and sends it to the RF receiver in the control unit. The RF receiver receives the frequency and the control unit then activates the specific electronic device. Following block diagram shows the complete working procedure of the system:

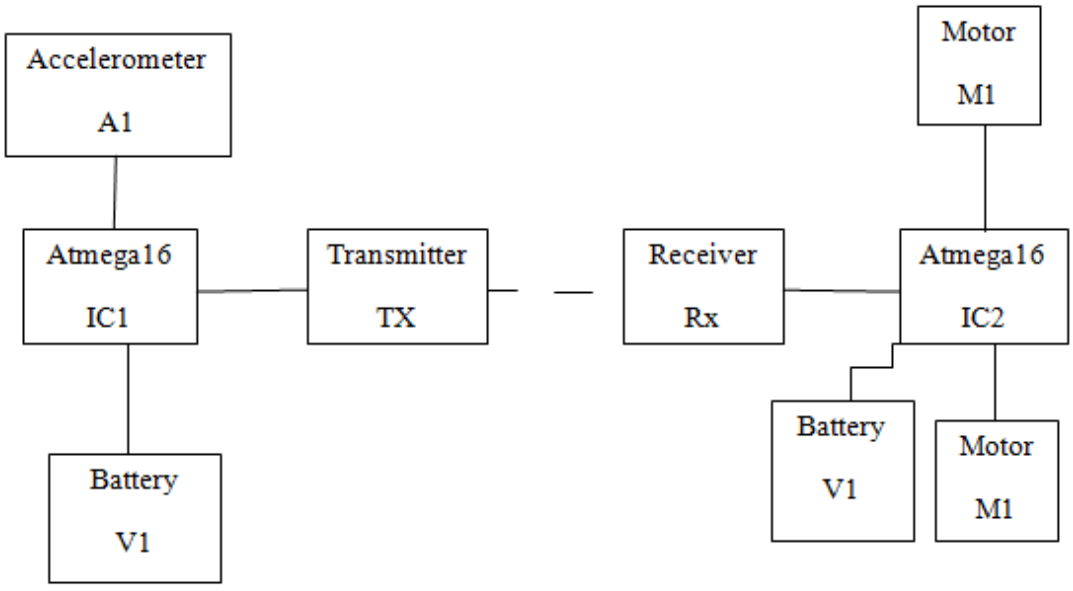

Figure 2.3: Block diagram of smart remote control

After activating the device it is controlled through some hand movements specially designed for that device. The GSM module is having two kits one with the actual remote control and one with the control unit. Whenever the off signal is sent from the user the GSM module at SRC sends that signal to the GSM module at control unit and through the RF transmitter and receiver it proceeded to the control unit and corresponding action [7].

2.4 Controlling home appliances remotely through voice command

Home Automation Control System (HACS) is not a new concept a lot of work has done in this field and many solutions has proposed. Some of them have used internet and wireless technology to communicate and control the appliances. Others have used the Bluetooth or GSM technology to send the command for controlling the home appliances. Problem domain related to proposed technique is telecommunication remote automation of home appliances thorough telecom technology. The proposed research provides the cost effective system that helps to satisfy their security concerns of home related to daily life such as controlling the home appliances and intrusion detection through voice message. This system can be used in any environment. It is free from the geographical limitations and can be used every where being the GSM network available. It is affordable to everyone as no expansive hardware is used in it. Cell phones are very common these days and almost everyone can make a call very easily. That’s why cell phone is used in this system that makes it real world application. It is free from the geographical boundaries and can be used from anywhere where GSM is available. The proposed solution is to implement the HACS through voice command that controls the home appliances by making a call from the

preconfigured number to system and receive the voice message from the system to preconfigured number about the status of appliances over the GSM network [10].

Research presented in this paper focuses mainly in three things:

First to understand the speech or voice of user:

Figure 2.4: Send the order from the user

Second is to control the home appliances through voice call:

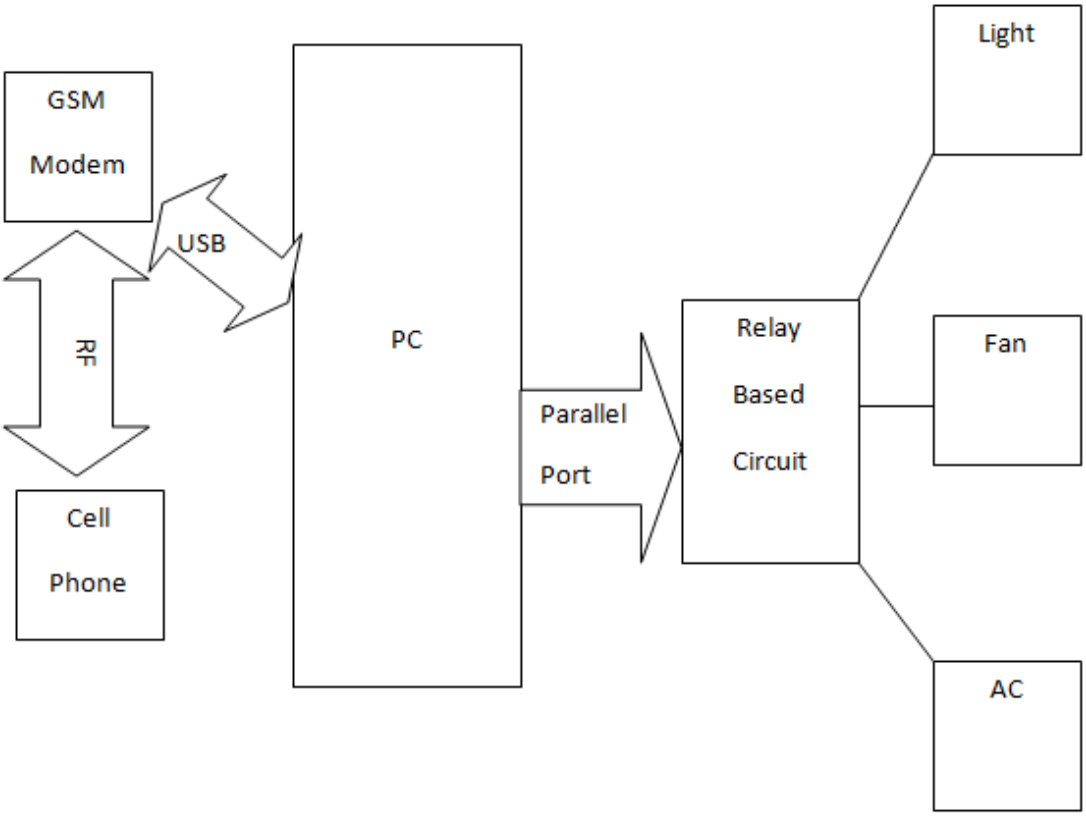

Figure 2.5: Block diagram of controlling home appliances through voice commands

Third is to finds intrusion in the house:

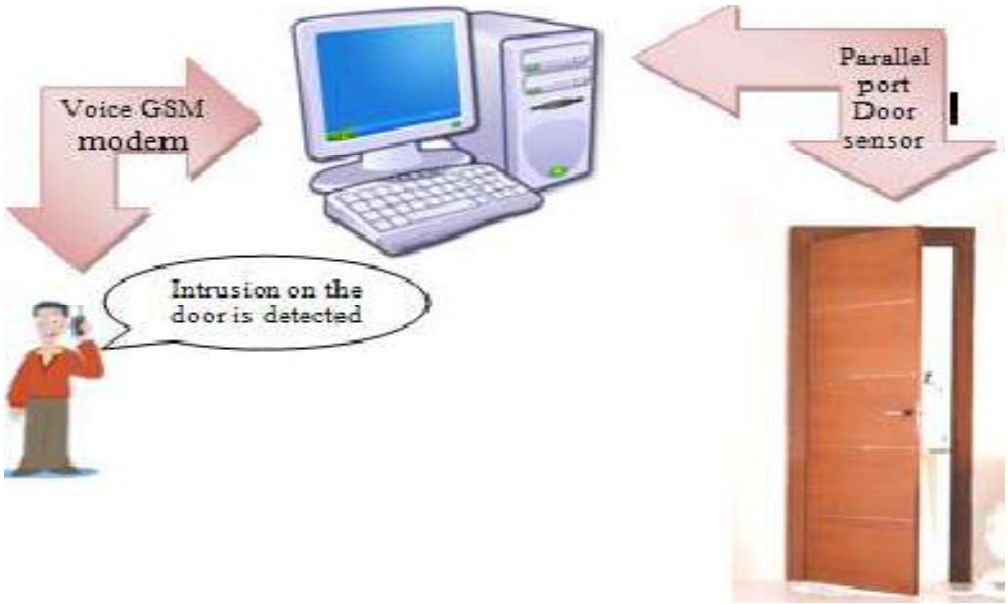

Figure 2.6: Send the statues to the user

The user can make a voice call in order to perform certain actions such as switching lights ON/OFF, getting the status of any appliance etc. And when system finds intrusion it sends an alert voice message to preconfigured cell when the user is away from the place. The proposed system is implemented using voice Global System for Mobile communications (GSM) and wireless technology based on. NET framework and Attention (AT) commands. Microsoft speech reorganization engine, speech SDK 5.1 is used to understand the voice command of user. As it is wireless so more cost effective and easy to use. The GSM technology used in system provide the everywhere access of the system for security. Experimental results show that the system is more secure and cost effective as compared to existing systems [10].

Researchers conclude that this system provides solution for the problems faced by home owner in daily life and make their life easy and comfortable by proposing cost effective and reliable solution. User from anywhere being GSM available can make a call to system to check the status of appliances or control them. System in return checks the authenticity of the number and if it is from the preconfigured number then it follows the instruction otherwise it discard the call. As computer receives a call timer starts and it automatically discard the call after few seconds. The voice is understood by the Microsoft speech reorganization engine that is installed in the system. If the command is about changing the status of appliances it passes the signal to parallel port to follow the instruction like turn the appliances on or off. This can be done through relay based circuit. If command is to check the status of appliances the system returns the voice message to preconfigured number using AT Commands telling the status of appliances. On the other hand if system finds any kind of intrusion like opening of entrance door etc in the home it sends the voice message to user telling him about the intrusion [10].

2.5 Analysis of Hand Gesture Recognition

Gesture recognition in real time from video sequences is one of the most important challenges in computer vision and behavior understanding since it offers to the machine the ability to identify, recognize and interpret the human gestures in order to control some devices, to interact with some human machine interfaces or to monitor some human activities. Generally defined as any meaningful body motion, gestures play a central role in everyday communication and often convey emotional information about the gesticulating person. During the last decades, researchers have been interested to recognize automatically human gestures for several applications: sign language recognition, socially assistive robotics, directional indication through pointing, control through facial gestures, alternative computer inter faces, immersive game technology, virtual controllers, affective computing and remote control. Recently human gesture recognition catches the peak attention of the research in both software and hardware environment. Gesture recognition is a form of biometric identification that relies on data acquired from the gesture of an individual. This data, which can be either two dimensional or three dimensional in nature, is compared against a database of individuals or compared with respective thresholds based on the way of solving the riddle. In recent years, face and gesture recognition has gained popularity among researchers all over the world. With applications ranging from security to entertainment, face recognition is an important subset of biometrics. Gesture made by human being can be any but few have a special meaning. Human hand can have movement in any direction and can bend to any angle in all available coordinates [11].

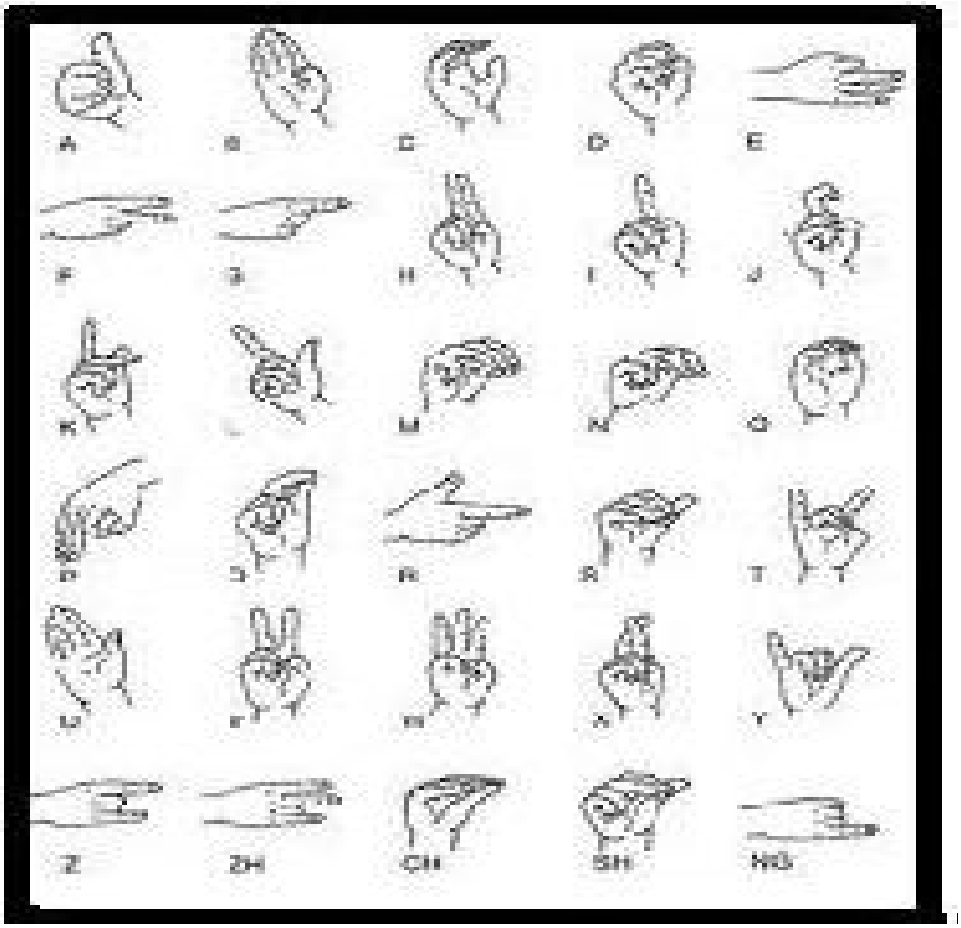

Figure 2.7: Hand signs describe letters

Many researchers have tried with different instruments and equipment to measure hand movements like gloves, sensors or wires, but in these techniques user have to wear the device which doesn't make sense in practical use. So people thought about a way of contact less gesture recognition that could be considered as a research area in machine vision or computer vision and which would be as natural as human to human interaction. Using this technique, researchers can easily interact with machines and can give them particular message according to the environment and application syntax. Even people who can't communicate orally (sick, old or young child); they would also get benefit from this technology. It is possible to make a gesture recognition system for these people. Mobile companies are trying to make handsets which can recognize gesture and could operate from little distance

also. Here researchers are focusing on Human to Machine Interaction (HMI), in which machine would be able to recognize the gesture made by human. There are approaches of two types.

a) Appearance based approaches where hand image is reconstructed using the image properties and extraction.

b) Model based approaches where different models are used to model image using different models to represent in Computers [11].

Approaches had been divided based on the method used in it not on how it is treating the image. Many approaches have been developed to interact with machines from glove based to neural networks. Users always like the easy and naturalness of technology in HMI and it was more convenient to interpret visual inputs. Human gesture recognition has been an exciting research area. Hand gesture and head gesture recognition can have tremendous applications in human computer interface and other robotic machineries. The keyboard and mouse are currently the main interfaces between man and computer. There has been a need of robotic hand that can perform actions alike human hand in real time applications, as it is not possible for human to reach up to every object due to difficult environment. In other areas where 3D information is required, such as computer games, robotics and design, other mechanical devices such as roller balls, joysticks and data gloves are used. User would perform gesture according to the action as he wants to be done by robotic hand. The ability to recognize human gestures open up a wide range of possible applications such as automatic recognition of sign language to facilitate communication with the hearing impaired, using gestures as input to explain the emotion of a gesturing person [11].

2.6 Consumer electronics control system based on hand gesture moment invariant

Human Computer Interaction (HCI) has become an increasingly important part of our lives because of massive technological infusion into our lifestyles. Whether it is our living room, bedroom or office room, there could be a range of electronic equipment that needs commands to perform some valuable tasks. It could be the television set, the VCR or the set top box waiting for our command to provide us with music or perhaps news and the command may reach them with a push of a button of a remote controller or a keyboard. People have long tried to replace these items using voice recognition or glove based devices with mixed results. Glove based devices are tethered to the main processor with cables which restricts the user's natural ability to communicate. Many of those approaches have been implemented to focus on a single aspect of gestures, such as hand tracking, hand posture estimation or hand pose classification using uniquely coloured gloves or markers on hands/fingers. The desire to develop a limited set of hand gestures that are distinctive has improved the processing accuracy of captured gestures with less computing power. This also requires a less sophisticated classification system using neural networks that does not need much processing power to work in real time. The system has been thoroughly tested under both incandescent and fluorescent lighting to simulate home environments. It also incorporates text overlaid feedback to restrict the system responding to unintentional hand movements. The system comprises a web camera, gesture processing unit, hardware interface for the control unit and a universal remote control [12].

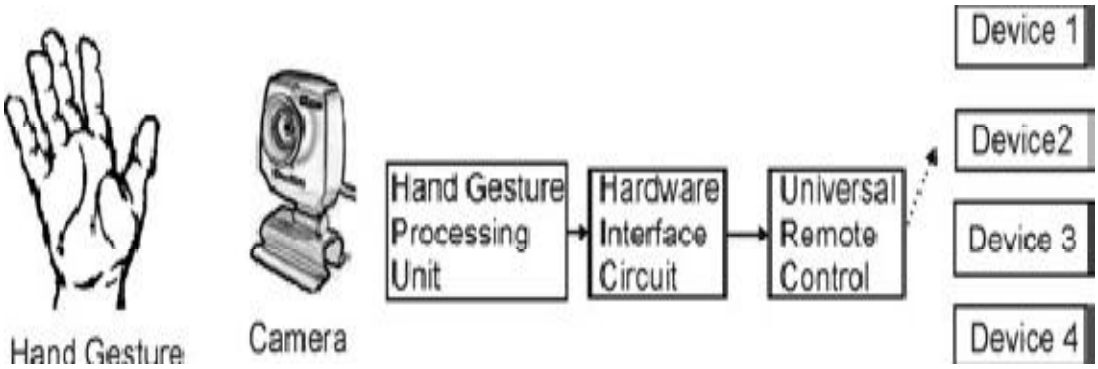

Figure 2.8: Schematic representation of basic components of Human computer interaction

The webcam is used to capture the hand gestures which are then registered, normalized and feature extracted for eventual classification to control the remote controller. Matlab is used throughout the project for real time data processing and classification and controlling through a parallel port. Once the user hand gesture matches with a predefined command, the command will be issued to the corresponding remote control via a parallel port. If an unknown gesture is issued, the system rejects it, notifying the user. The interface circuitry is used to map parallel port commands to the universal remote control. Four of the Personal Computer (PC) parallel port data pins are used for multiplexing that achieves 16 unique controllable switches for controlling the remote controller [12]. The system is designed to capture one image frame (static image) every second and is then segmented for skin region detection and other pre-processing before the invariant moments are calculated.

Figure 2.9: Smooth region output of the morphological filtering technique

These invariant moments will be the input to the neural network for classification and the subsequent action using the remote control and the feedback system. If any of the static images is captured when the hand is moving, the resultant image would be blurred. This will result in an unrecognized hand gesture and the user will be informed about it through the system feedback display. The designed neural network is a 'back propagation' network, in which input vectors (invariant moments of the sample set of user hand gestures) and the corresponding target vectors (the commands set) are used to train the network until it can approximate a function between the input and the output [12].

2.7 Gesture Actuated Robotic Arm

The breakthrough technological revolutions that changed the dimensions of the perception of manufacturing in the industry took place due to Robotic Arm. Traditionally and currently these Arms or machines are controlled either by preloaded code (i.e. automatic) or via Joystick (i.e. Manual). Now in industries or anywhere else minimum the robotic arm with 5DOF and a Gripper is required. So in all 6motors or actuators are required to drive it. And hence this calls for the need of (in case of manually operated) joystick or remote control that has 5 to 6 keys to control and actuate the individual motions/ motors of robotic arm respectively. Practically thinking simultaneously using 6keys and using them by analyzing the motion of robotic arm in 3D requires rigorous practice and judgment. That is the system is very less intuitive and this is the knack of the article, that is, to develop the system that would make the existing system more intuitive and user friendly [13].

Rather than hunting for some other kind of 'soft keys' etc I just thought of utilizing the super natural power of human i.e. to 'move our hands'. So the

system discussed in the paper is to control the motion of robotic arm by mere movements of human arm eradicating the species of keys and joysticks. So the aim of the paper can be briefed as “designing the system, the sensory part, which can be mounted on the human (rather operators) arm, synthesize the signals and ultimately generate the signals to actuate the robotic arm” and hence to Replicate the motion of the human arm [13].

Basically, an Accelerometer is a device that measures the proper acceleration. This is not the same as the coordinate acceleration (change of velocity with respect to time), but is rather the type of acceleration associated with the phenomenon of weight experienced by a test body / mass that resides in the frame of reference of the accelerometer device. For an example, an accelerometer will measure a value when sitting on the ground, because masses there have weights, even though they do not change velocity.

An accelerometer thus measures weight per unit of (test) mass, a quantity also known as specific force or g-force. These sensors are basically used in the Smart Phones for tilt sensing applications. MEMS accelerometer provides the 3axis analog signals(X, Y, Z) corresponding to its position and applied g-force. Its features are:

- Low current / power consumption
- Low operating voltage MEMS are available.
- High sensitivity
- Static and dynamic acceleration.
- Robust design, high shocks survivability.

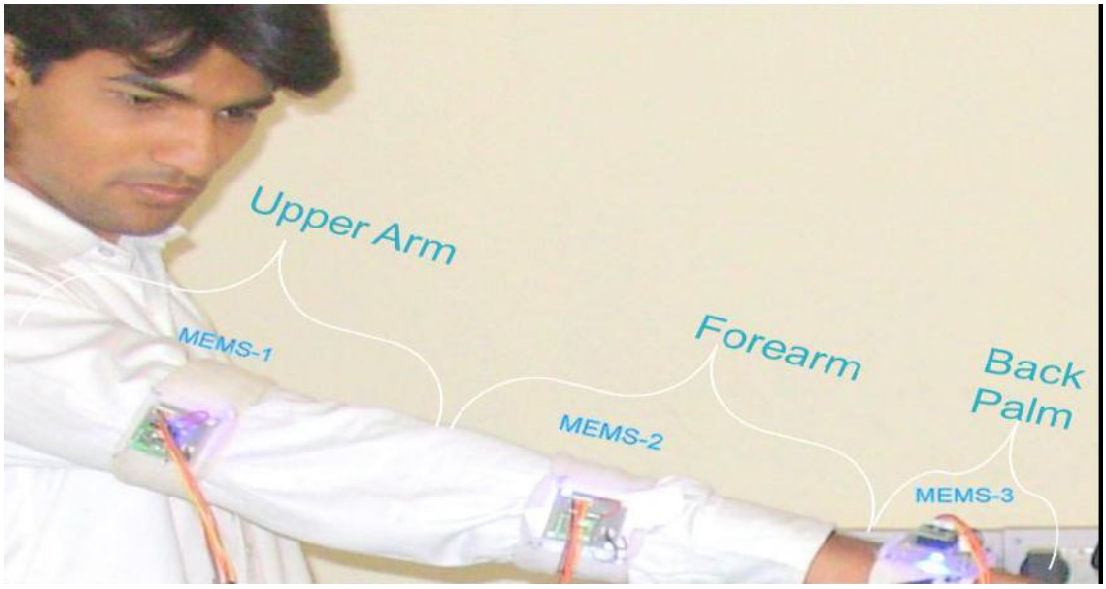

Figure 2.10: Placement of Sensors Robotic Arm

Here the static acceleration feature of MEMS is harnessed and not the dynamic one. Here, MEMS Accelerometer sensors are used for detecting the motion of the human arm. As the human arm has 3 major joints (shoulder, elbow and wrist) the normally used robotic arm also has nearly the same kind of structure, so for detecting the motion of each joint an individual or separate sensor is required. The controller selected should be fast enough and should respond or perform operations in real time. Here the controller does sinking the input data, processing it and running the predefined algorithm stored in memory and accordingly provides the signals to the outside world. This is very basic requirement and the system has a dedicated and specific task. So a controller that satisfies the basic requirement as well as have the desired peripherals like ADC (>8bit) and PWM generator can be used [13].

2.8 To analyze hand gesture recognition for wirelessly electronic device control

Vision based automatic hand gesture acknowledgement has been a very active research theme in recent years with inspiring applications such as Human Computer Interaction (HCI), electronics device command, and signal language understanding. The general difficulty is quite demanding due a

number of matters encompassing the complicated environment of static and dynamic hand signs, complex backgrounds, and occlusions. Striking the difficulty in its generality needs complicated algorithms needing intensive computer assets. Which motivates us for this work is robot navigation troubles in which we are interested in controlling an electronics apparatus by hand pose signals granted by a human. Due to real time operational requirements researchers are interested in a computationally effective algorithm. Early approaches to the hand gesture acknowledgement difficulty in a electronic apparatus command involved the use of markers on the digit tips An associated algorithm is utilized to detect the occurrence and hue of the markers , through which one can identify are hardworking in the inconvenience of putting markers on the user's hand makes this an infeasible approach in perform. Recent procedures use more sophisticated computer dream procedures and do not need markers. Hand sign recognition is presented through a curvature space procedure in which engages finding the boundary contours of the hand. This is a robust approach that is scale, translation and rotation invariant on the hand poses yet it is computationally demanding. In a vision-based hand pose acknowledgement technique utilizing skeleton images is suggested, in which a multi-system camera is utilized to choose the center of gravity of the hand and points with most distant distances from the center, supplying the positions of the digit tips, which are then used to get a skeleton image, and eventually for signal acknowledgement. A method for signal acknowledgement for signal language understanding has been proposed in other computer vision [22].

Many methods for hand sign acknowledgement using visual investigation has been suggested for hand gesture recognition. Premaratne and Q. Nguyen [12] to evolve a restricted set of hand signs that are characteristic has advanced the processing accuracy of captured gestures with less computing power. This furthermore needs a less sophisticated classification scheme utilizing neural networks that does not need much processing power

to work in real-time. Silas Wan and Hung T. Nguyen[14] hand sign is a very natural form of human costly and in general do not encourage free movement of interaction and can be utilized competently in human computer interaction (HCI), utilizing a little hand-worn wireless module with a 3axis accelerometer as the shift sensor. S. Sadhana Rao[15] The sign founded expertise is utilized for kind of submissions like performing rudimentary activities, pin pointing points in the chart, watching video in report paper, dialing number in hand etc. The slight modification of this procedure leads to the use of commands that is analog data into genuine world. It permits user to connect with the internet seamlessly. Without use of keyboard or mouse user can glimpse videos get access to, change, move facts and figures simply .But this concept bottle necks lead to modification of the same by utilizing instructions rather than of gestures. Muhammad Fajri Bayu Anbya [16, 17] electric power supervising system is now using real-time estimation facility via wireless network submissions. By utilizing Zigbee is utilized as wireless protocol. Dominik Bunyai [18] Wireless connection has numerous interesting submissions in the area of home and building automation. In addition to the reduced power utilization and the reduced hardware charges, ZigBee supports flexible topologies convenient for little systems where localized facts and figures are exchanged inside the network. Yikai Fang [19, 17] the process of hand sign acknowledgement is very time consuming, which often brings much annoyance to users. Proposes a very quick feature detection and recount approach which can considerably speed up hand sign acknowledgement. Foremost, integral likeness is used to about Gaussian derivatives to assess likeness convolution in characteristic detection. Ren, Z. [20, 21] in human body following, face acknowledgement and human activity acknowledgement, robust hand sign acknowledgement continues an open difficulty. Contrasted to the whole human body, the hand is a smaller object with more convoluted articulations and more effortlessly affected by segmentation errors. It is therefore a very demanding problem to identify hand

gestures. He focuses on construction a robust part-based hand gesture acknowledgement scheme using Kinect sensor [22].

Aim of the project to develop the novel method of hand gesture recognition for communication electronic device control. According to publications reconsider researchers arrive into deduction that the productive locality between the interaction of hand and PC is less, researchers have try to increase the productive locality of the scheme by spanning successive details and numbers deduction from PC to wireless apparatus supervisor circuits. It is an unaligned module. As it is wireless and hand gesture interfacing researchers are doing here for that they decode the data and with the help of zigbee researchers are initiating it forward. Here the camera read the signal from the hand and then propel the sign to the design. Scheme utilizing application programs converts the signal into the command/text which is place into the transmitter brim. According to this order, it operates the appliance from the receiver brim. In this way user can command any appliance which is location at a distinct position pattern the transmitter without utilizing key board and mouse [22].

This paper is also deals with the design of a system that acquires a user's hand gesture and classifies it based on the predefined hand gestures, stored in a database. The work benefits low-resolution web cam for apprehending the hand signs and an algorithm that methods the came by images and then classifies the hand gesture rightly. The work mostly emphasizes on the characteristic extraction from the hand signs and use that features in the acknowledgement algorithms. Initially, the scheme will comprise a setup method, in which, the algorithm is trained founded on significant characteristic extracted for different hand signs. Once the setup in completed, the scheme will be adept to classify the granted hand sign based on the database knowledge. This work mainly concentrates on the communication aspect of a human hand, in particular the use of hand gestures for spatial communication. A hand gesture is a meaningful part of the hand

motion that can be used to express both symbolic and parametric information. Researchers selected hand gestures as a modality to convey parametric information such as speed, angles or positions in three-dimensional space where human robot interactions take place. Key requirements for our framework are speed, accuracy, and adaptability. Speed is required for the parameters to be extracted and transferred to the robot that is moving in Real-time. Accuracy is required in two ways: recognition accuracy, and parameter extraction accuracy. In our implementation, spontaneous hand gesture is translated and recognition into particular no of count using an off-the-shelf gesture recognition in window. Work implemented for this purpose has been preceded via two main algorithm viz. Mean Deviation & Fast algorithm [22].

Chapter Three

Methodology

3.1 Circuit Components

The main circuit components are:

3.2 Microcontroller

A microcontroller is a computer-on-a-chip or a single-chip computer as shown in Figure 3.1. Micro suggests that the device is small, and controller tells that the device might be used to control objects, processes, or events. Another term to describe a microcontroller is embedded controller, because the microcontroller and its support circuits are often built into, or embedded in, the devices they control.

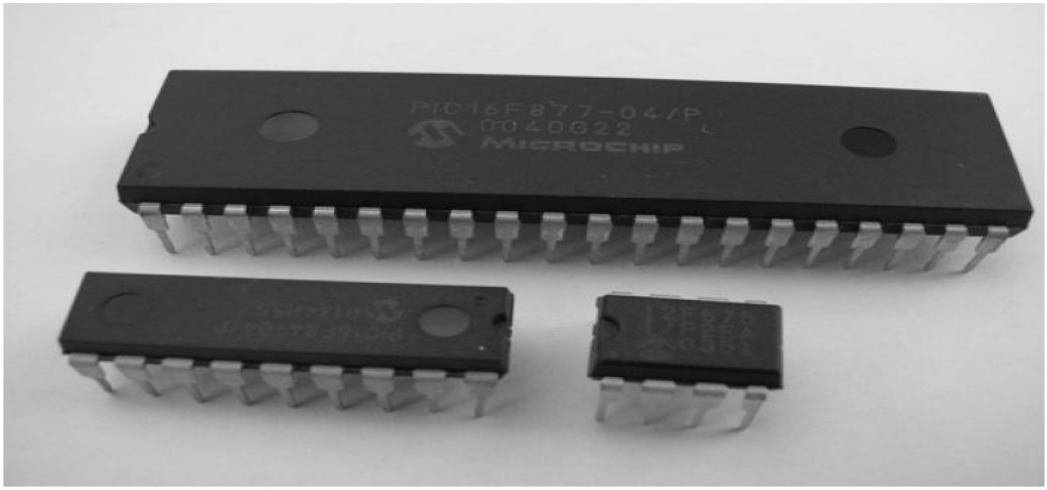

Figure 3.1: Microcontroller chip

Microcontrollers involves in all kinds of things these days. Any device that measures, stores, controls, calculates, or displays information is a candidate for putting a microcontroller inside. The largest single use for microcontrollers is in automobiles just about every car manufactured today includes at least one microcontroller for engine control, and often more to

control additional systems in the car. In desktop computers, microcontrollers, inside keyboards, modems, printers, and other peripherals, in test equipment, microcontrollers make it easy to add features such as the ability to store measurements, to create and store user routines, and to display messages and waveforms. Consumer products that use microcontrollers include cameras, video recorders, compact-disk players, and ovens [23]. Microcontrollers are characterized by how many bits of data they process at once, with a higher number of bits generally indicating a faster or more powerful chip. Eight-bit chips are popular for simpler designs, but 4-bit, 16-bit, and 32-bit architectures are also available.

3.2.1 Microcontroller features

Microcontrollers from different manufacturers have different architectures and different capabilities. Some may suit a particular application while others may be totally unsuitable for the same application.

3.2.2 Memories types

There are many types of memory inside the microcontroller, these memories can be found all of them or some of them in microcontroller chip. The main types of microcontroller are:

(a) Random access memory

Random Access Memory (RAM) is a general-purpose memory which usually stores the user data used in a program. RAM is volatile, i.e. data is lost after the removal of power. Most microcontrollers have some amount of internal RAM. 256 bytes is a common amount, although some microcontrollers have more, some less. In general it is possible to extend the memory by adding external memory chips.

(B) Read only memory

Read Only Memory (ROM) is a type of memory usually holds program or fixed user data. ROM memories are programmed at factory during the manufacturing process and their contents cannot be changed by the user.

ROM memories are only useful if you have developed a program and wish to order several thousand copies of it.

(c) Erasable programmable read only memory

Erasable Programmable Read Only Memory (EPROM) is similar to ROM, but the EPROM can be programmed using a suitable programming device. EPROM memories have a small clear glass window on top of the chip where the data can be erased under UV light. Many development versions of microcontrollers are manufactured with EPROM memories where the user program can be stored. These memories are erased and re-programmed until the user is satisfied with the program. Some versions of EPROMs, known as One Time Programmable (OTP), can be programmed using a suitable programmer device but these memories cannot be erased. OTP memories cost much less than the EPROMs. OTP is useful after a project has been developed completely and it is required to make many copies of the program memory.

3.2.3 Input/output of microcontroller

Input-output unit consists of many locations group; these locations are called ports. There are several types of ports: input, output or bidirectional ports. When working with ports (interfacing), first of all it is necessary to choose which port we need to work with, and then to send data to, or take it from the port. Figure 5.1 shows the input and output of the microcontroller.

When working with it the port acts like a memory location. Something is simply being written into or read from it, and it could be noticed on the pins of the microcontroller, so microcontrollers are useful to the extent that they communicate with other devices, such as sensors, motors, switches, keypads, displays, memories and even other microcontrollers. Many interface methods have been developed over the years to solve the complex problem of balancing circuit design criteria such as features, cost, size, weight, power consumption, reliability, availability and manufacturability. Many microcontrollers' designs typically mix multiple interfacing methods. In a very simplistic form, a microcontroller system

can be viewed as a system that reads from inputs, performs processing and writes to (controls) outputs.

3.2.4 Microcontroller architecture

The relation between the data bus and address bus inside the microcontroller specified the speed of data transfer, and the size of the chip. During manufacturing microcontrollers is made by one of two architectures which are:

(a) Von Neuman architecture

In von Neumann architecture the process of accessing the code or data could cause them to get in each other's way and slow down the processing speed of the CPU, because each had to wait for the other to finish fetching. The data and instructions use the same buses.

(b) Harvard architecture

To speed up the process of program execution, some CPUs use Harvard architecture. In Harvard architecture, the instruction memory and the data memory are separate, have separate bus for the code and data memory, and sometimes have different sizes.

3.2.5 ATmega16

The Atmel ATmega16 is equipped with 32 general purpose 8-bit registers that are tightly coupled to the processor’s arithmetic logic unit within the CPU. Also, the processor is designed following the Harvard architecture format. That is, it is equipped with separate, dedicated memories and buses for program and data information. The register-based Harvard architectures coupled with the RISC-based instruction set allows for fast and efficient program execution and allows the processor to complete an assembly language instruction every clock cycle. Atmel indicates the ATmega16 can execute 16 million instructions per second when operating at a clock speed of 16MHz [23].

3.3 TX Module

Figure 3.2 shows the transmitter module.

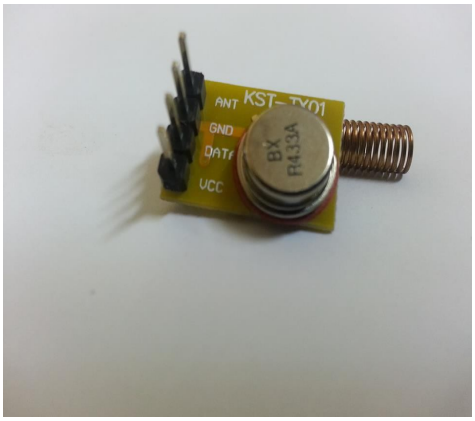

Figure 3.2: Transmitter module

3.4 RX Module

Figure 3.3 shows the receiver module.

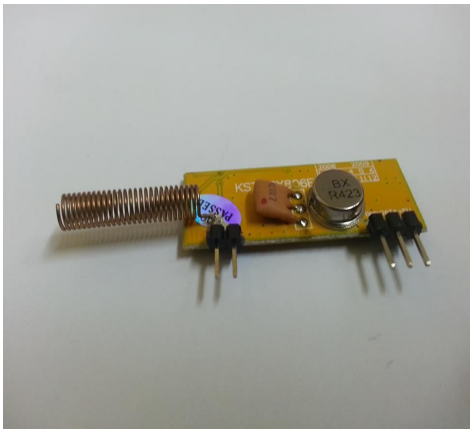

Figure 3.3: Receiver module

433MHz ASK transmitter and receiver modules to transmit and receive serial data with 100m range in open space. This RF module comprises of an RF transmitter and an RF receiver. The transmitter/ receiver (TX/RX) pair operates at a frequency of 433MHz and with a modulation technique ASK. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of

1Kbps-10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. It is important to know that this device will not support direct UART communication when connected to PC or microcontrollers as there is a lot of noise always available on these frequencies. For remote control applications encoder and decoder ICs are used.

3.5 Sensor

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing. Micro Electro Mechanical Systems (MEMS) accelerometers are one of the simplest but also most applicable micro-electromechanical systems. They became indispensable in automobile industry, computer and audio-video technology. Figure 3.4 shows the HMC5883L sensor.

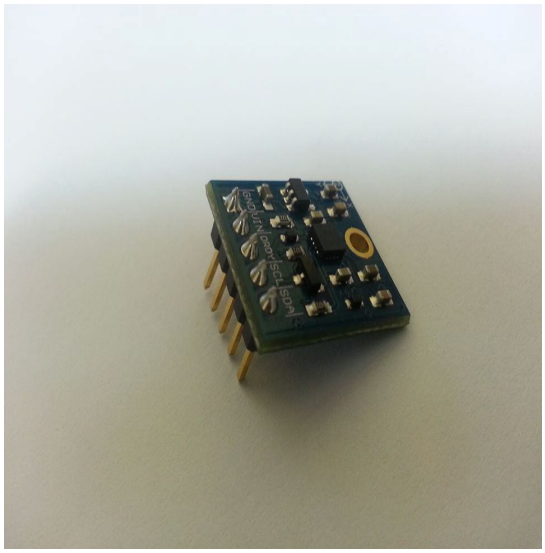

Figure 3.4: HMC5883L sensor

Accelerometer is an electromechanical device that measure acceleration forces. These forces may be static, like the constant force of gravity pulling at feet, or they could be dynamic caused by moving or vibrating the accelerometer. By measuring the amount of static acceleration due to gravity, the angle the device is tilted at could be found with respect to the earth. The HMC5883L utilizes honeywell's Anisotropic Magneto Resistive (AMR) technology that provides advantages over other magnetic sensor technologies. These anisotropic, directional sensors feature precision in-axis sensitivity and linearity. These sensors' solid-state construction with very low cross-axis sensitivity is designed to measure both the direction and the magnitude of Earth's magnetic fields; honeywell's magnetic sensors are among the most sensitive and reliable low-field sensors in the industry.

3.6 HT12E Encoder

HT12E is an encoder integrated circuit of 2^{12} series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format. Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

3.7 HT12D Decoder

HT12D is a decoder integrated circuit that belongs to 2^{12} series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 2^{12} series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format. In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data

received by, say, an RF receiver, into parallel data and sends them to output data pins.

3.8 Voltage Regulator

Figure 3.5 shows the voltage regulator.

Figure 3.5: Voltage regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. A voltage regulator may be a simple feed forward design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC. Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

3.9 Resistor

Figure 3.6 shows the resistor

Figure 3.6: Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. Thus, the ratio of the voltage applied across a resistor's terminals to the intensity of current through the circuit is called resistance. This relation is represented by Ohm's law:

$$I = V / R \qquad (3.1)$$

Where:

I= the current.

V= voltage across resistor.

R= resistance.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

3.10 Light Emitting Diode

Figure 3.7 shows the light emitting diode.

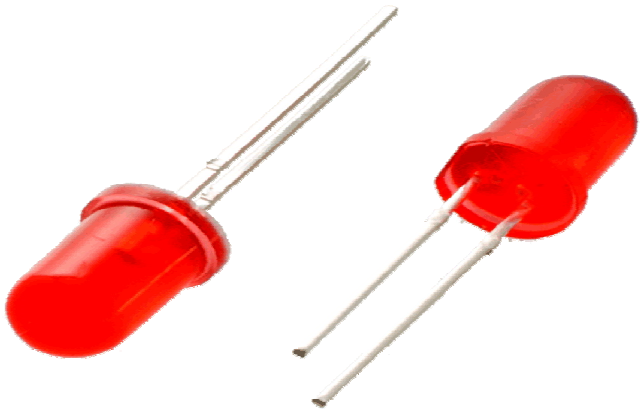

Figure 3.7: Light emitting diode

A Light Emitting Diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Appearing as practical electronic components in 1962, early LEDs emitted low intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness. When a light emitting diode is switched on, electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. A LED is often small in area (less than 1 mm^2) and integrated optical components may be used to shape its radiation pattern. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size and faster switching. However, LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output. Light emitting diodes are used in applications as diverse as aviation lighting, digital

microscopes, automotive lighting, advertising, general lighting and traffic signals. LEDs have allowed new text, video displays and sensors to be developed, while their high switching rates are also useful in advanced communications technology. Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players and other domestic appliances. LEDs are also used in seven segment display.

3.11 Relay

Relay is the first control system component to be invented, originally to boost telephone signals. It is an electromechanical switching device, which allows a high power load to be controlled by a small input current, using an electromagnetic coil to operate a set of changeover switches. Relays can be wired up to operate in sequence, with time-delayed switching. If required, to operate as a process controller. Before the development of transistors and digital logic, even before the development of valves, relays could be used to make simple industrial controllers. For example, a relay can be used to switch a machine tool, using on and off 'push' button and safety interlocks to make its operation safer.

The small input current through the coil creates an electromagnetic field that attracts a steel yoke, which operates a set of contacts, which in turn switch a load (motor, heater, pump, etc.) on and off. The coil typically operates at 12V or 24V DC. But a 5V coil allows the relay to be connected directly to a digital or microcontroller.

3.12 Battery and Connector

Figure 3.8 shows the 9V battery.

Figure 3.8: Nine volt battery

The most common form of nine-volt battery is commonly called the transistor battery, introduced for the early transistor radios. This is a rectangular prism shape with rounded edges and a polarized snap connector at the top. This type is commonly used in pocket radios they are also used as backup power to keep the time in certain electronic clocks. Most nine-volt alkaline batteries are constructed of six individual 1.5V cells enclosed in a wrapper. Figure 3.9 shows the snap connector.

Figure 3.9: Snap connector

The battery has both terminals in a snap connector on one end. The smaller circular (male) terminal is positive, and the larger hexagonal or octagonal (female) terminal is the negative contact. The connectors on the battery are the same as on the connector itself; the smaller one connects to the larger one and vice versa. An advantage is that several nine-volt batteries can be connected to each other in series to provide higher voltages.

3.13 System Operation:

The sensor has six different signals for respective angular positions. MEMS is quite low as its output current is low, that is why there is a need to placed it as close as possible to the controller. It is also affected by the human body static charge. The sensor actually is linear in nature and hence the change in voltage/signal per degree can be calculated mathematically. It can actually provide the accuracy of 1degree tilt which is = 800mV/90.

Change in Volts / degree tilt = 8.88 or 9 mV.

3.14 Transmitter and receiver bock diagrams:

Figure 3.11 and 3.12 shows the transmitter block diagram and receiver bock diagram

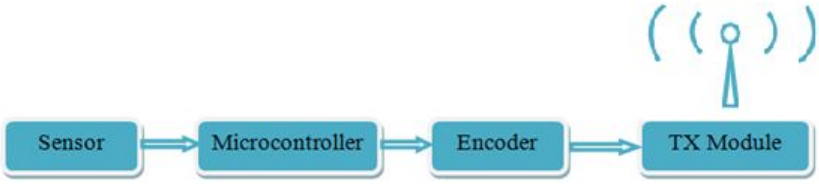

Figure 3.10 Transmitter block diagram

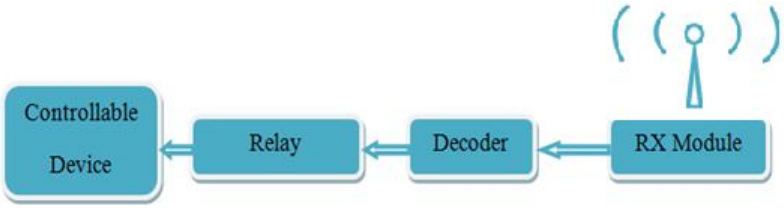

Figure 3.11 Receiver block diagram

The user tilt his hand first that is how the sensor detect the movement at the beginning, after that the sensor sends the axis which the hand is tilt to the MCU to handle with it. MCU checks if the axis which he gets are one of the program code. If they are not in the program code MCU will not do anything. If it is being in code MCU_will send that data to the receiver circuit throw the Encoder and TX Module.

TX Module will send the received data which is came from the sensor when it detects the movement throw its antenna. Digital data is represented by different amplitudes of the carrier wave. Radio Frequency (RF) transmission is more strong and reliable than Infrared Radiation (IR) transmission because: RF signals can travel longer distance, signals can be transmitted even when there is an obstacle and signals will not interfere by other frequency RF signals.

Next after data transmitted the RX Module receives it and the Decoder convert the received serial data to 4 bits parallel data D0-D3 the status of these address pins A0-A7 should match with statues of address pin in the HT12E at the transmitter of the transmission of data. After that the Decoder connected to the coil of the relay to change its switch and lit the lamp.

3.15 System Flow Chart

Figure 3.12 shows the system flow chart.

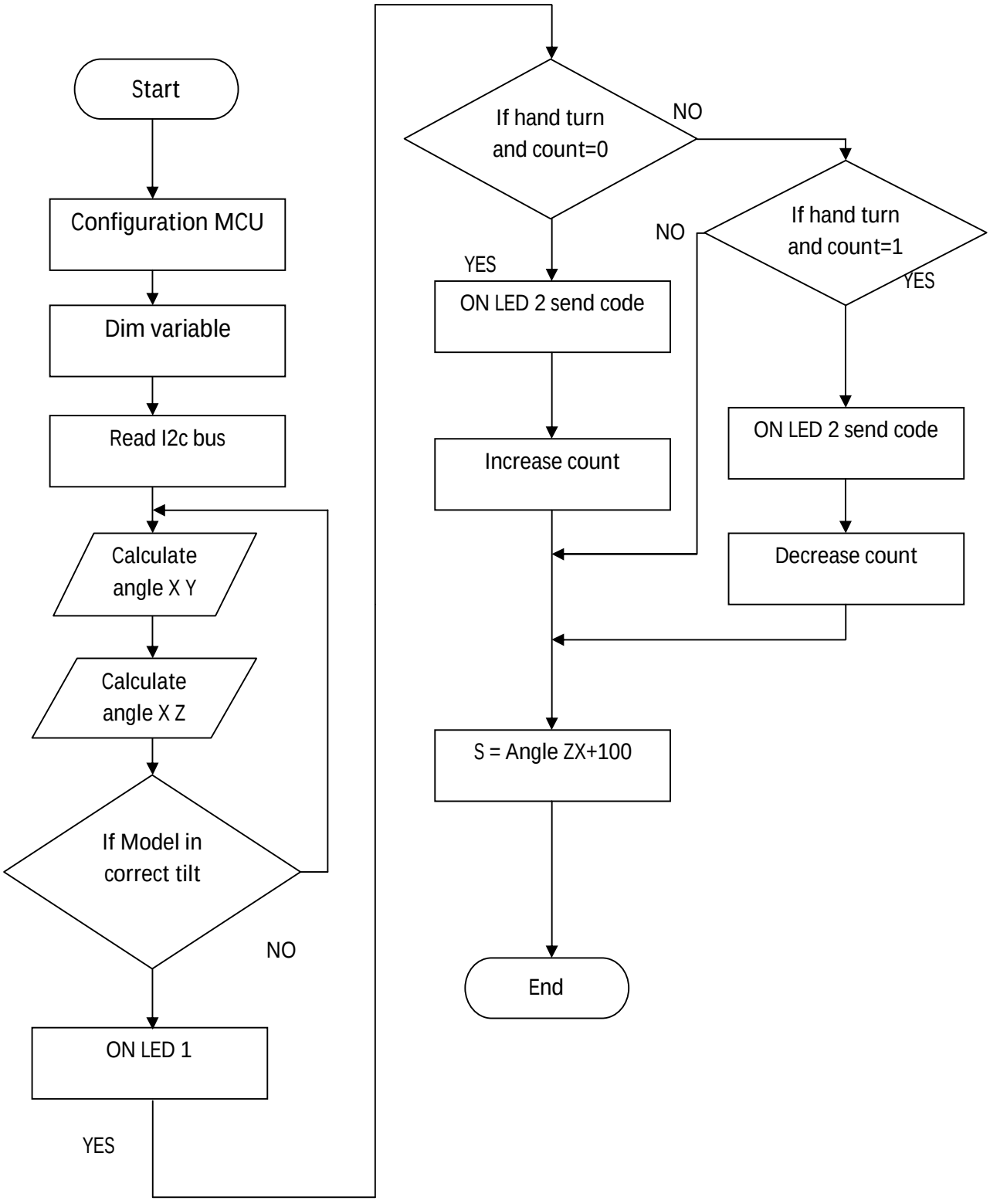

Figure 3.12 The system flow chart.

3.15.1 Steps of response of the system:

- MCU Configurations
- Read Variable
- Read I2c bus
- Calculate the angle between axis X and Y
- Calculate the angle between axis X and Z
- If module in the correct tilt “depending on the reference range of S”

(

- ON LED 1
- If hand turn and count = 0

(

- ON LED 2 and send the code to the receiver
- Increase count

)

- If hand turn and count = 1

(

- ON LED 2 and send the code to the receiver
- Decrease count

)

)

- S= angle ZX+100 “change the reference range of S to keep the statues of the device”
- End

Chapter Four

Result and Discussion

4.1 Introduction

In this chapter the transmitter and receiver circuits are introduced. The performance of the system has been verified through practical results under different operation condition. Also, the practical results obtained are discussed.

4.2 Transmitter Circuit

Figure 4.1 shows the transmitter circuit.

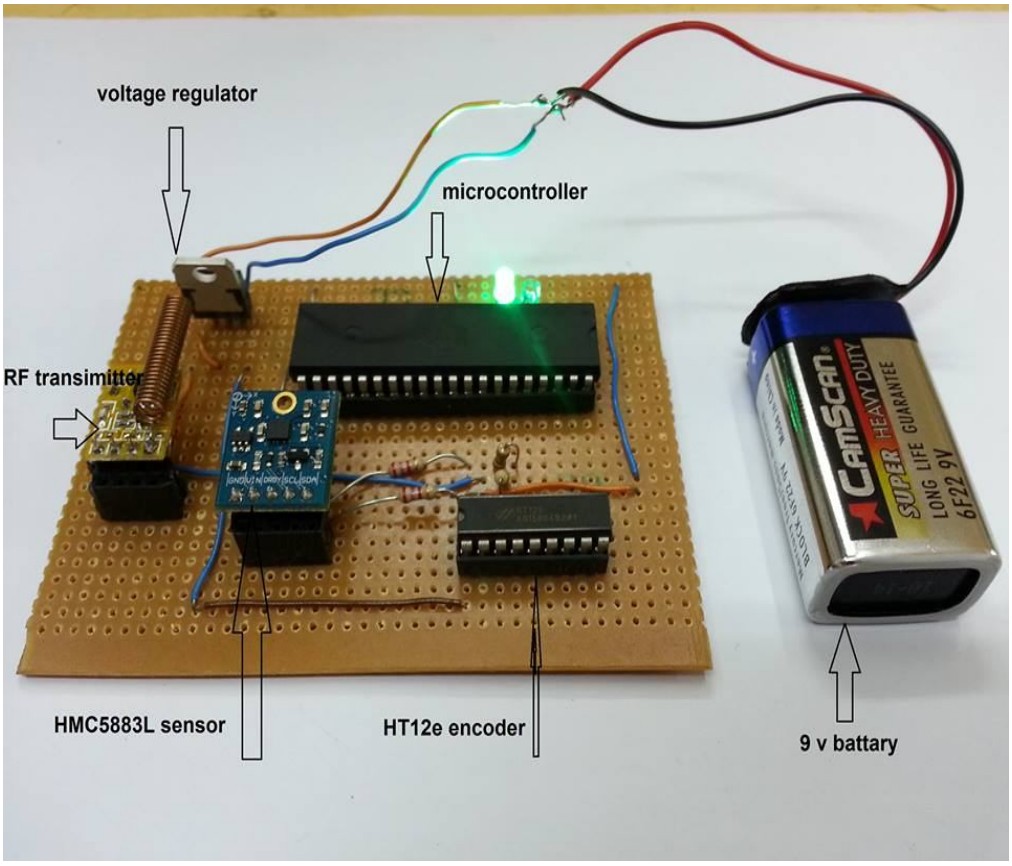

Figure 4.1: The transmitter circuit

The main components are 3D accelerometer sensor, microcontroller, encoder, TX module and 9 volt battery. The voltage regulator is used to regulate 9V to 5V to feed the circuit. The 3D accelerometer sensor major the acceleration of 3axis X, Y and Z with the digital compass to determine

direction. Sensor and digital compass both are in one module HMC5883L connected with microcontroller with I2C bus technique. SDA and SCL lines at pins pc1 and pc0 respectively. Two pull up resister should connected with SDA and SCL lines .The MCU read the data from HMC5883L module and calculate the angles between each two axis. The angles process can be described as the following equations:

$$Anglezx = Atn2(z, x) \quad (4.1)$$

$$Anglezx = Anglezx * 57.29577951 \quad (4.2)$$

$$Anglezx = Anglezx + 180 \quad (4.3)$$

Then appending to the place of the hand and according to the MCU program (the code), the MCU decide turn on or turn of the device. After that the MCU send the order to the receiver circuit through the TX module. The TX module doesn't support the direct communication with the MCU. For that reason the HT12E encoder must connect between the MCU and the TX module. The pins AD8 to AD11 are connected with MCU and the pin DOUT with TX module, HT12E converts the parallel inputs into serial output for transmission through the RF transmitter module.

4.3 Receiver circuit

The receiver circuit consists of necessary components as shown in Figure 4.2.

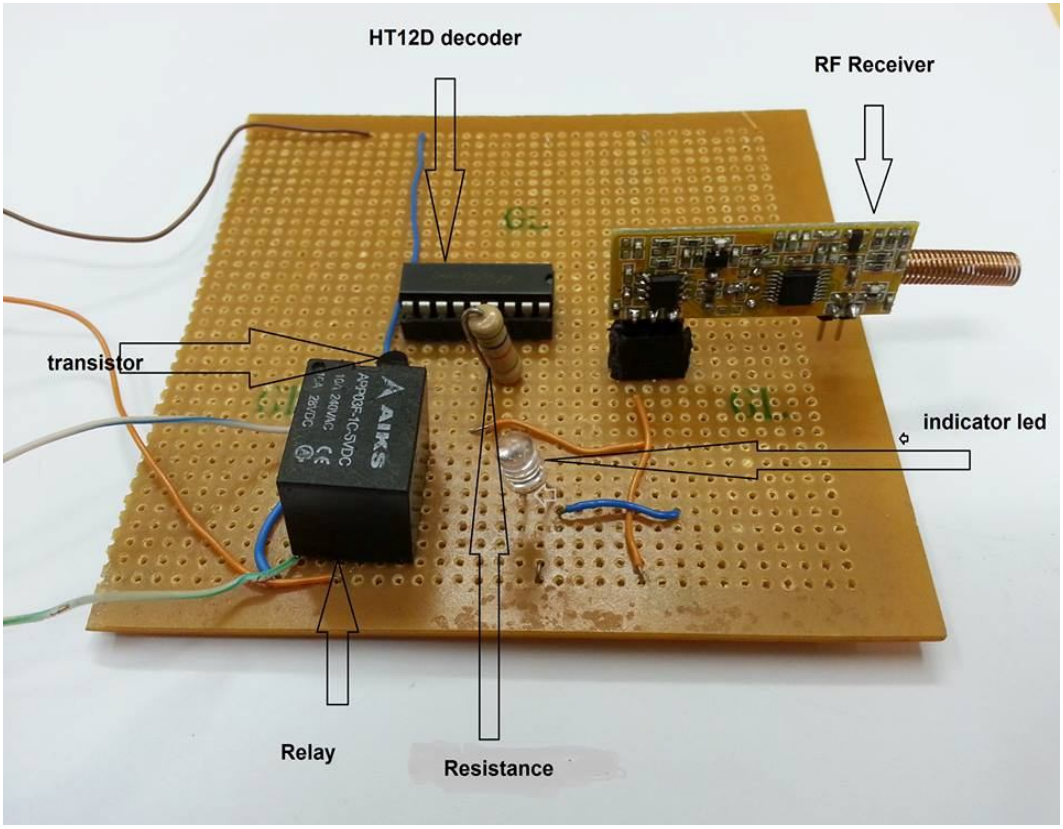

Figure 4.2: The receiver circuit

The main components are RX module, decoder, LED and relay. The RX module receive data from the TX module that operating at the same frequency as that of the receiver. The RX module is connected with decoder at DIN pin, the HT12D decoder converts the serial data into parallel outputs, the relay connect with the decoder through the transistor which is used as the switch for relay when the relay connected with a controllable device.

4.4 Practical results

The sequence of the events that take place is:

1'st: Connecting power supply to the transmitter circuit and the LED lit as a sign as figure 4.3 shows.

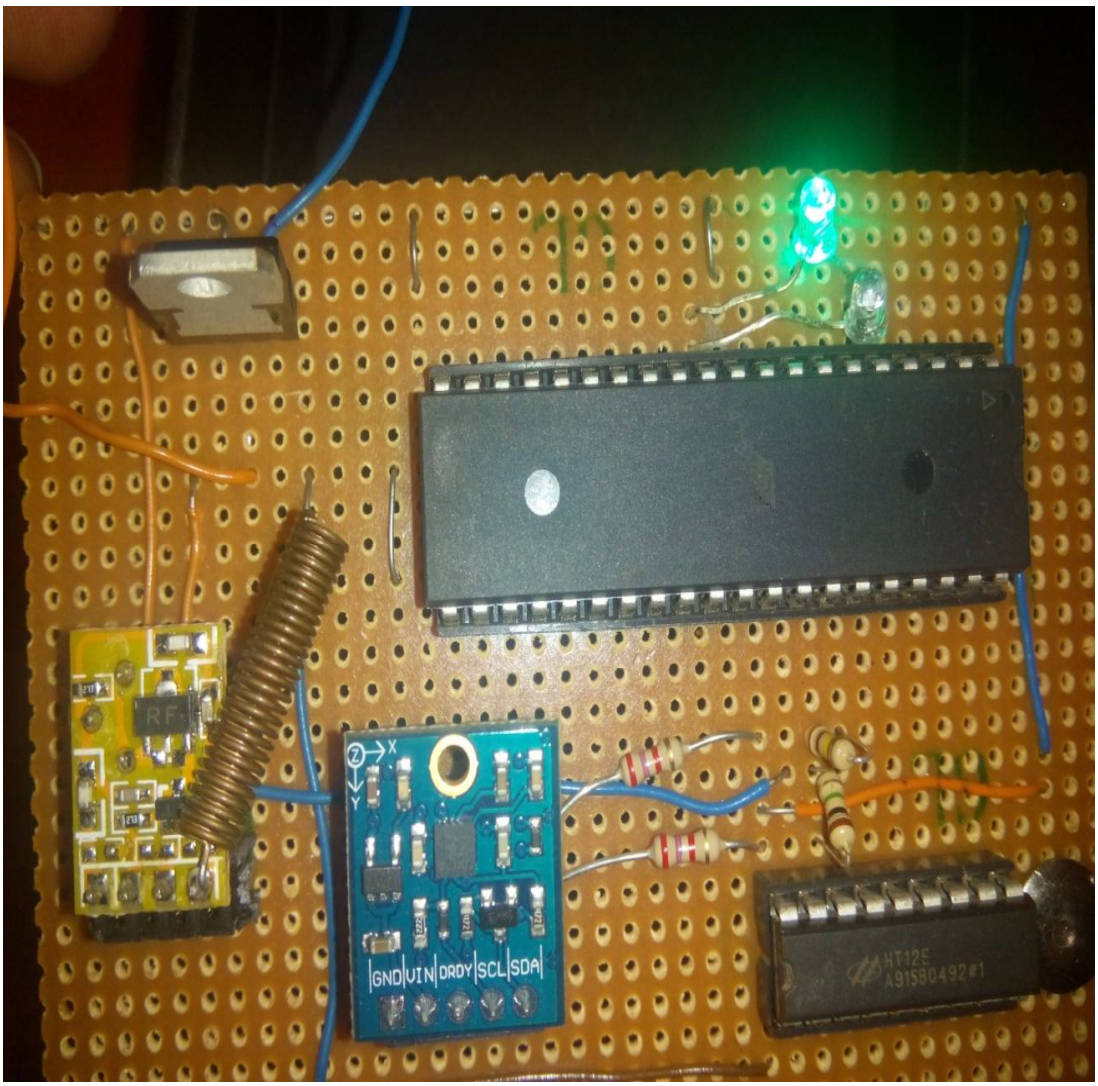

Figure 4.3: Control circuit is ready

The device could be controlled when the user tilt his hand.

2'nd: A LED in the receiver circuit has to be lit as an indicator of standby as figure 4.4 shows.

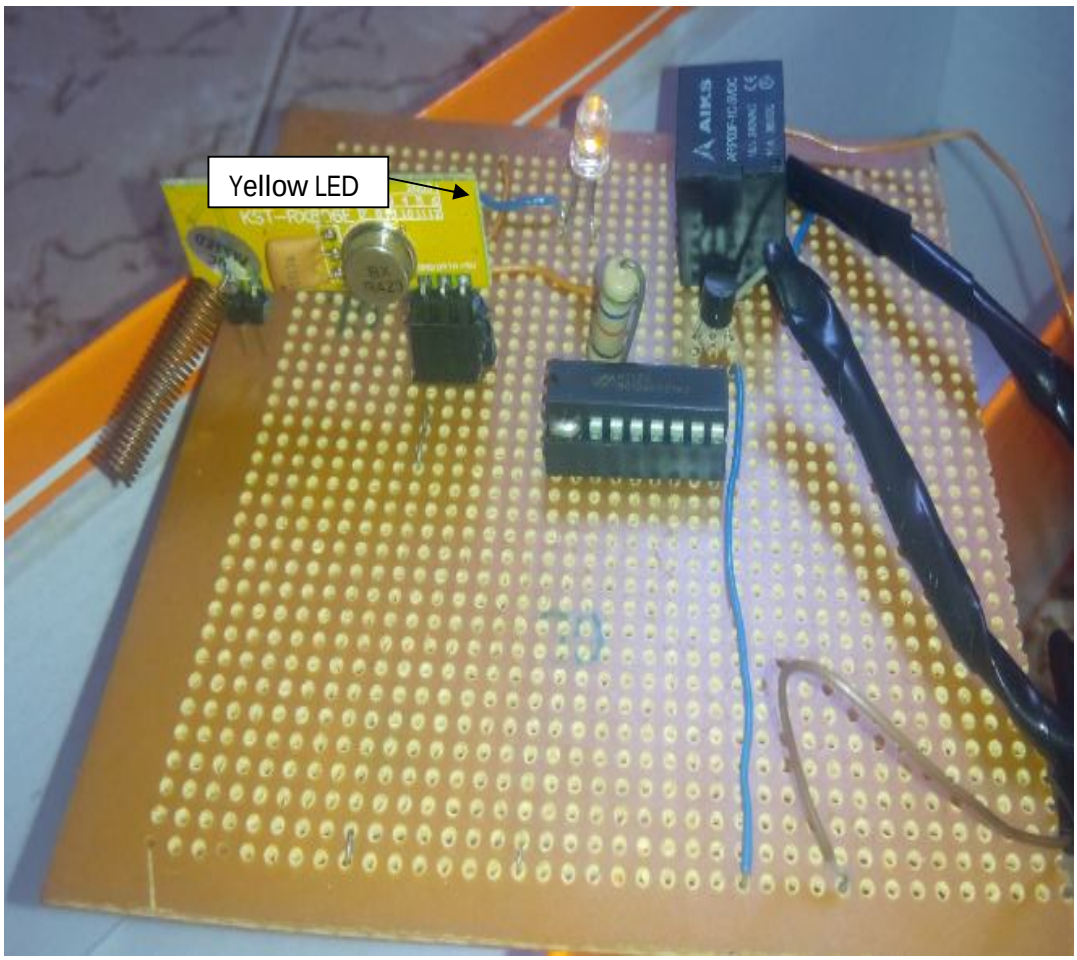

Figure 4.4: Receiver circuit is ready

3'th: MCU on the transmitter circuit checks if the tilt exceeds a set threshold. If the tilt detected by the accelerometer exceeds the threshold set of the two axis, then the signal sent to the receiver circuit through the TX module.

4'th: The receiver circuit receive the signal through RX module and the relay response according to it (ON) as figure 4.5 shows.

Figure 4.5: Lamp is turned ON

Tilt again to switch OFF the lamp.

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

- The goals of the project were achieved and it worked as expected.
- 3D accelerometer interfaced to MCU.
- Transmitter and receiver circuits were implemented.
- MCU programmed to detect the tilt of the sensor statues.
- The device (lamp) switched (ON/OFF) from a distance.
- Users found it easy and funny way to control an object.

5.2 Recommendations

There are a lot of works to make the project better than now in the future.

- More movements can be done to control the devices.
- Adding more devices to the receiver circuit just by adding more relays and reprogram the MCU again.
- Double tilt is also another way to add more devices.
- A nice shape could be also given to the control circuit and make it modern in a good way.
- Add a chargeable battery to the control circuit.
- As an alert mechanism some kind of vibrations or sound could be added to form the user it response to the gesture in the transmitter circuit.
- For protection either the ‘Anti-static wrist band ‘or ‘earthing or grounding band should be used at the time of designing or working over it.

- While designing circuitry special protection or shielding should be provided for the MEMS sensors.

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APPENDIX A

Main Microcontroller Program

```
/*****************************************************
Project:  Design and Implementation of A Three Dimensional Remote Controller For Disabled People

Chip type               : ATmega16L
Program type            : Application
AVR Core Clock frequency: 16.000000 MHz
Memory model            : Small
External RAM size       : 0
Data Stack size         : 256
*****************************************************/

$regfile = "m16def.dat"
$crystal = 4000000
Config Sda = Portc.1
Config Scl = Portc.0
Dim F As Integer
Config Porta.0 = Output
Config Portb.3 = Output
Config Portb.4 = Output
 Const W = &H3C
 Const R = &H3D
 Dim Hmc_x As Integer
Dim Hmc_y As Integer
 Dim Hmc_z As Integer
Dim Hmc_status As Byte
```

```
 Dim X As Single
 Dim Y As Single
 Dim Zz As Single
 Dim Xm As Word
 Dim Z As Word
 Dim Anglexy As Single
 Dim Anglezy As Single
 Dim Anglezx As Single
 Dim Count As Byte
  Count = 0
 Dim S As Single
 S = 400
Const Hmc_w = &H3C
Const Hmc_r = &H3D
I2cinit
Gosub Hmc_initialize
Do
Gosub Hmc_readdata
Gosub Hmc_readz
Gosub Hmc_readx
X = Hmc_x
Y = Hmc_y
Zz = Hmc_z
Anglezx = Atn2(zz , X)
Anglezx = Anglezx * 57.29577951
Anglezx = Anglezx + 180
Anglezx = Round(anglezx)
If S < Anglezx And Count = 0 Then
Count = 1
Portb.3 = 1
```

```
Porta.0 = 1
Waitms 500
Portb.3 = 0
Elseif S < Anglezx And Count = 1 Then
Count = 0
Portb.3 = 1
Porta.0 = 0
Waitms 500
Portb.3 = 0
End If
Waitms 15
Anglexy = Atn2(y , X)
Anglexy = Anglexy * 57.29577951
Anglexy = Anglexy + 180
Anglexy = Round(anglexy)
Waitms 100
If Anglexy > 40 And Anglexy < 100 Then
Portb.4 = 1
Else
Portb.4 = 0
End If
S = Anglezx + 100
Loop
End
Hmc_initialize:
I2cstart
I2cwbyte Hmc_w
I2cwbyte &H00
I2cwbyte &B0101_1000
I2cwbyte &H0010_0000
```

```
I2cwbyte &H0000_0000
I2cstop
Waitms 3
Return

Hmc_readz:
I2cstart
I2cwbyte Hmc_w
I2cwbyte &H05
I2cstart
I2cwbyte Hmc_r
I2crbyte Z , Nack
I2cstop
Waitms 3
Return

Hmc_readx:
I2cstart
I2cwbyte Hmc_w
I2cwbyte &H03
I2cstart
I2cwbyte Hmc_r
I2crbyte Xm , Nack
I2cstop
Waitms 3
Return

Hmc_readdata:
I2cstart
I2cwbyte Hmc_w
```

```
I2cwbyte &H03
I2cstart
I2cwbyte Hmc_r
I2crbyte Hmc_xh , Ack
I2crbyte Hmc_xl , Ack
I2crbyte Hmc_zh , Ack
I2crbyte Hmc_zl , Ack
I2crbyte Hmc_yh , Ack
I2crbyte Hmc_yl , Nack
I2cstop
Waitms 3
Return
```

Reading:

```
I2cstart
I2cwbyte W
I2cwbyte 0
I2cstart
I2cwbyte R
I2crbyte F , Nack
I2cstop
Return
```

Writing:

```
I2cstart
I2cwbyte W
I2cwbyte 0
I2cwbyte &H03
I2cstop
Return
```

Appendix B

Architecture and Pins Diagram of the Components

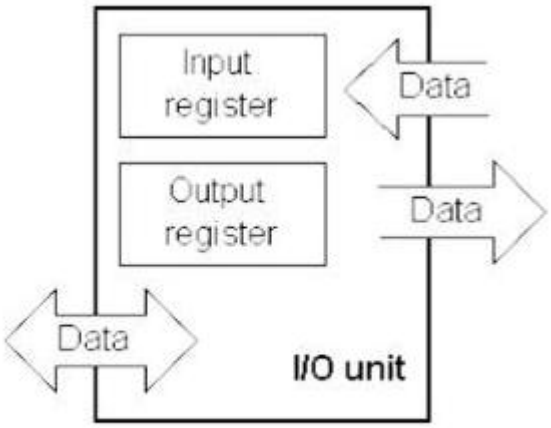

Figure B.1: Simplified input/output unit

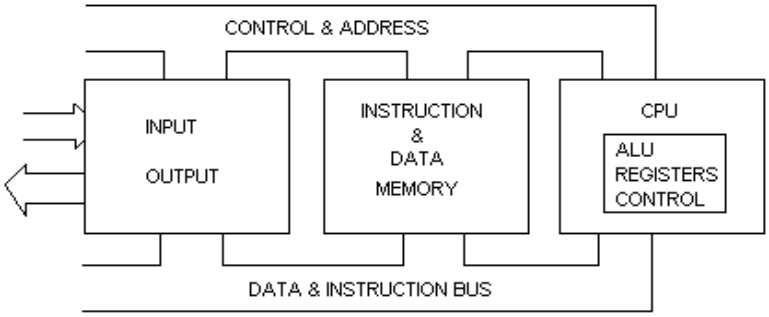

Figure B.2: Von Neumann architecture

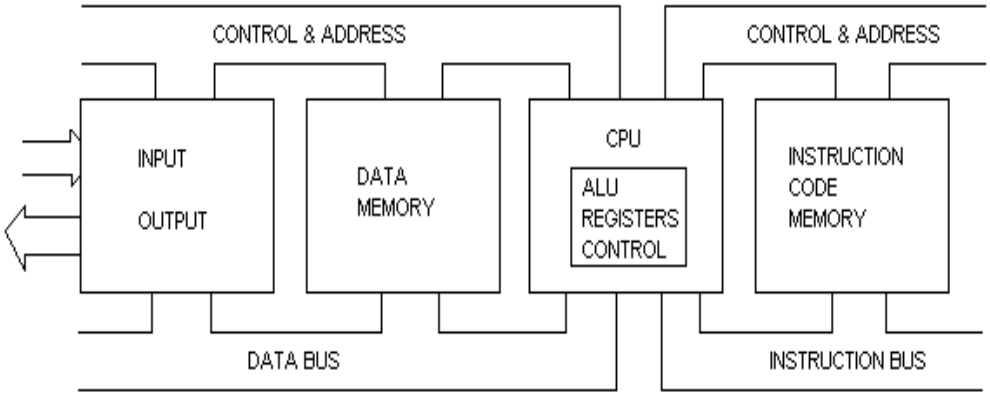

Figure B.3: Harvard architecture

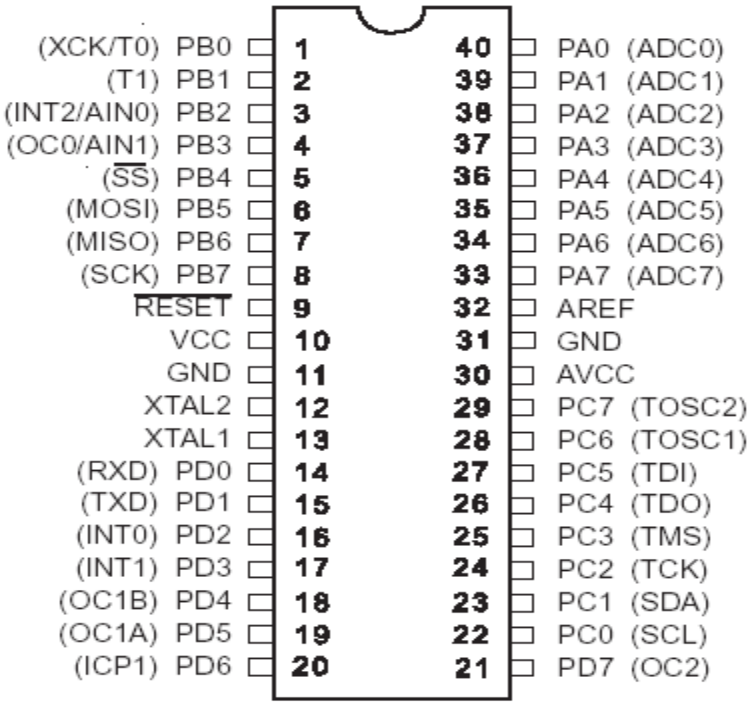

Figure B.4: Atmega16 pins diagram

The Pin Description of atmega16 microcontroller are:

VCC

Digital supply voltage.

GND

Ground

Port A (PA7..PA0)

Port A serves as the analog inputs to the digital (ADC). Port A also serves as an 8-bit bi-directional I/O port, if the (ADC) is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7..PB0)

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors

(selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functions of various special features of the Atmega16 as listed on table below.

Port C (PC7..PC0)

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs. Port C also serves the functions of the JTAG interface and other special features of the Atmega16 as listed on table below.

Port D (PD7..PD0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the Atmega16 as listed on table below.

RESET

Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

XTAL1

Input to the inverting Oscillator amplifier and input to the internal clock

operating circuit.

XTAL2

Output from the inverting oscillator amplifier.

AVCC

AVCC is the supply voltage pin for Port A and the ADC. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF

AREF is the analog reference pin for the ADC.

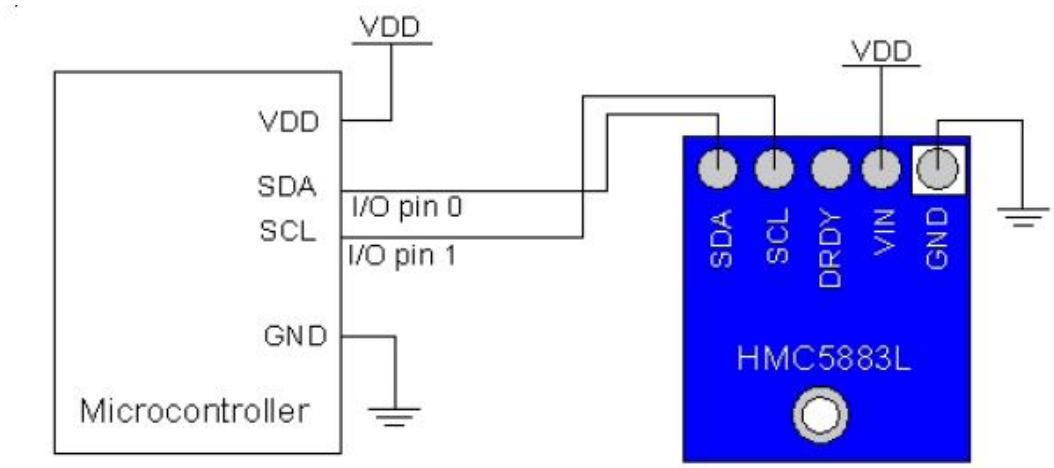

Figure B.5: The schematic of HMC5883L and MCU

HMC5883L features

- 3-Axis magneto resistive sensors and ASIC in a 3.0x3.0x0.9mm LCC surface mount package.
- 12-Bit ADC Coupled with Low Noise AMR Sensors Achieves 2 milli-gauss Field Resolution in ±8 Gauss Fields.
- Built-In Self-Test.
- Low Voltage Operations (2.16 to 3.6V) and Low Power Consumption (100 μa).
- Built-In Strap Drive Circuits.

- I²C Digital Interface.
- Lead Free Package Construction.
- Wide Magnetic Field Range (+/-8 Oe).
- Software and Algorithm Support Available.
- Fast 160 Hz Maximum Output Rate.

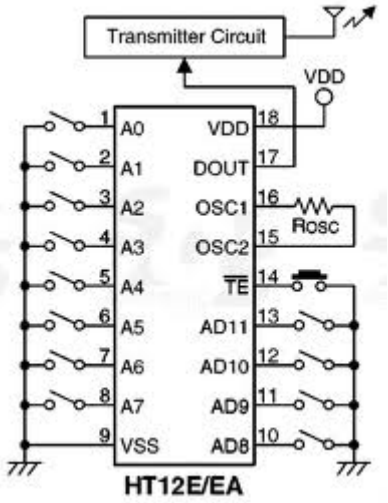

Figure B.6: HT12E encoder

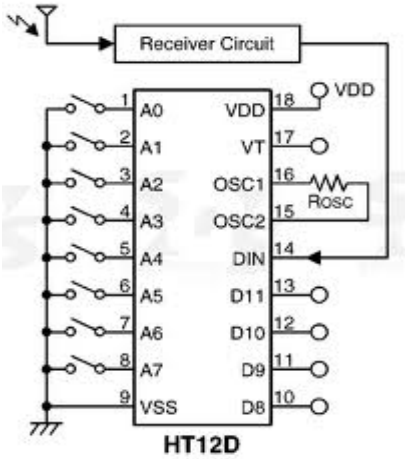

Figure B.7: HT12D decoder

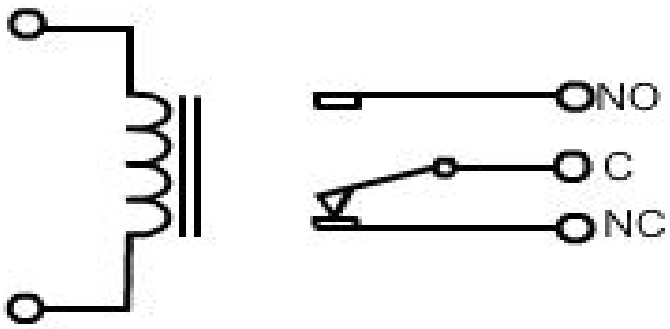

Figure B.8: Relay