Sudan University of Science and Technology

College of Engineering

Electrical Engineering

Measuring the speed and the direction of the wind by using microcontroller

قياس سرعة و اتجاه الرياح باستخدام المتحكم الدقيق

A Project Submitted In partial Fulfillment for the Requirements of the Degree of B.Sc (Honor) In Electrical Engineering

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الآية

قال تعالى

بسم الله الرحمن الرحيم

(وَتَصْرِيفِ الرِّيَاحِ وَالسَّحَابِ الْمُسَخَّرِ بَيْنَ السَّمَاءِ وَالْأَرْضِ لَآيَاتٍ لِقَوْمٍ يَعْقِلُونَ)

صدق الله العظيم

سورة البقرة الآية (164)

DEDICATION

To those who illuminate our path and support us and give up their rights to satisfy us and to live in our homes, our fathers and our mothers. To our brothers and sisters. To the candles that burn to glorify others, our teachers and all who contributed to our education.

We dedicate you this research, asking God to find acceptance and success.

ACKNOWLEDGEMENT

We must take our last steps in university life from a stand back to the years we have spent in the university with our distinguished professors who have given us so much, making great efforts in building the future generation to re-emit the nation .

Before we proceed, we offer our highest thanks, gratitude, appreciation and love to those who carry the greatest message in life. To those who paved the way for us the path of science and knowledge. To all our distinguished professors in the Department of Electrical Engineering.

And we offer all thanks and gratitude to that who helped us to complete this research under his supervision and giving us the necessary information to complete the research Ust. Galal Abdalrahman Mohammed.

ABSTRACT

Climatology or climatic elements of heat, wind, rain. Its importance to know the air condition of a particular place which can affect the activity of the population, snow, distubance.
Meteorological devices appeared since long time ago, currently the temperature is measured by the thermometers, atmospheric pressure is measured by Barometers and wind speed and direction measured by Anemometer.
And in our project we designed a device that can determine the direction and the speed of wind using
wind transmitter and compass for measuring and LCD and vibration motors for presenting.

المستخلص

علم المناخ أو العناصر المناخية من حرارة و رياح و أمطار،أهميته هي معرفة الالة الجوية لمكان معين و التي يمكن ان تؤثر على نشاط السكان، الثلوج و اضطراب الملاحة.

و ظهرت أجهزة الارصاد الجوي منز القدم، حاليا الثيرموميتر يقيس درجة الحرارة، و يقيس البارومیتر الضغط الجوي،بينما يقوم المرياح بقياس شدة الرياح، حيث يمكن من معرفة السرعة و الاتجاه الزي تهب منه الرياح.

في مشروعنا هزا استطعنا ان نصمم جهاز له المقدرة على تحديد اتجاه و سرعة الرياح و زلك باستخدام المرياح و البوصلة للقياس، و شاشة و محركات اهتزازية لعرض السرعة و الاتجاه.

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CHAPTER ONE

INTRODUCTION

1.1 General Concepts

Winds are elements of the climate that determine life on the earth's surface. They are moving air masses from one place to another on the surface of the earth, and its intensity changes according to the difference in atmospheric pressure in the areas they pass. The wind has several benefits such as maintaining the temperature on the surface of the earth and rain and its usefulness in moving ships and sailboats in the sea and so on. This project is related to the importance of wind in moving sailboats.

1.2 Problem Statement

When sailing a boat, one of the most important factors is the direction of the wind. If they want to keep a steady heading. Sailors need to be able to dynamically adjust the direction they steer as the wind changes. Another important factor to know is the speed of the wind, because of its impact on the movement of the sailing boat. Unfortunately, the ability to tell exactly which direction the wind is blowing, and determines the speed of the wind, can be a difficult skill to learn.

1.3 Objectives

So the goals of this project is to facilitate the process of determining the direction of the wind, and the speed of its movement for the owners of sailboats or fishermen or the simple category of sailors, and that by using a device that can determine the direction of the wind and how fast it is moving, to improve their abilities and give good results.

1.4 Methodology

To achieve these goals we built a haptic feedback belt that uses embedded feedback vibration motors to vibrate in the direction of the wind and matching weathervane that streams wind readings to the belt over Bluetooth. To determine the speed we used a small display LCD to show readings that given by the weathervane.

1.5 Project Layout

We divided this project into five chapters. The first chapter is an introduction to the project that addresses the objectives and the approach of the work of the project. In the second chapter we will talk about general concepts such as control and its main two types, we will also talk about microcontrollers and will know their components and applications. And we will touch on the electrical motors and the components of the electrical motor, and we will talk about compass and how it works and types.

In the third chapter we will discuss the components of this project; we will talk about each component in detail in terms of definition, method of work, function composition and place in the project circle. And we will include with each component its shape, which shows its composition.

Chapter four will be practical and software, we will talk about the project circuit in detail and how to connect all the components with each other.

Finally, in chapter five we talked about the conclusion of this project and the recommendations we recommend.

CHAPTER TWO

GENERAL CONCEPT

2.1 Introduction

Wind speed, or wind flow velocity, is a fundamental atmospheric quantity caused by air moving from high to low pressure, usually due to changes in temperature. Note that wind direction is usually almost parallel to isobars ، due to Earth's rotation. Wind speed is now commonly measured with an anemometer, but can also be classified using the older Beaufort scale, which is based on personal observation of specifically defined wind effects.

Modern day anemometer used to capture wind speed. An anemometer is one of the tools used to measure wind speed. A device consisting of a vertical pillar and three or four concave cups, the anemometer captures the horizontal movement of air particles (wind speed). Another tool used to measure wind velocity includes a GPS combined with pitot tube. A fluid flow velocity tool, the Pitot tube is primarily used to determine the air velocity of an aircraft.

2.2 Control System

A system is a combination of components that act together and perform a certain objective. A Control system is an interconnection of components forming a system configuration that will provide a desired system response. Control theories commonly used today are classical control theory (also called conventional control

theory) and modern control theory. Classical control theory, which deals only with single-input, single-output systems, becomes powerless for multiple-input, multiple outputs systems. Since about 1960, because the availability of digital computers made possible time domain analysis of complex systems, modern control theory based on time-domain analysis and synthesis using state variables, has been developed to cope with the increased complexity of modern plants and the stringent requirements on accuracy, weight, and cost in military, space, and industrial applications. Modern control theory made the design of control systems simpler because the theory is based on a model of an actual control system as shown as figure 2.1.

And we use control systems in :Automatic assembly line, Machine tool control , Space technology and weapon systems, Computer control, Power Systems, Robotics, Micro Electro Mechanical Systems(MEMS), Nano technology, Smart transportation systems, Ship stabilization systems, Intelligent Systems, Temperature control systems, Steering control of automobiles, Missile launching systems, Voltage stabilizer systems, Idle speed control of automobiles, Industrial sewing machine, Sun tracking control of solar collectors. There are two main types of control loops: Open loops, which operate with human input, and closed loops, which are fully autonomous. Some loops can be switched between closed and open modes. When open, a switchable loop is manually controlled and when closed it is fully automated.

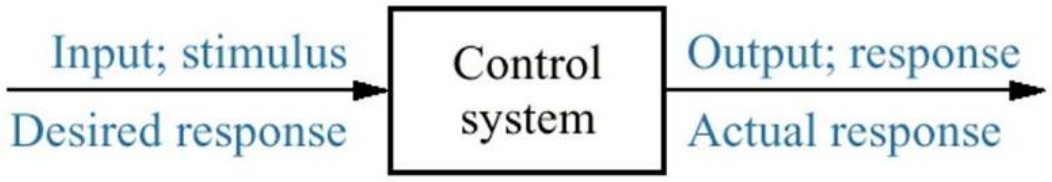


Figure 2.1: Control system

2.2.1 Open-loop control systems

Those systems in which the output has no effect on the control action are called open-loop control systems. In other words, in an open loop control system the output is neither measured nor fed back for comparison with the input as shown as Figure 2.2. One practical example is a washing machine. Soaking, washing, and rinsing in the washer operate on a time basis. The machine does not measure the output signal, that is, the cleanliness of the clothes.

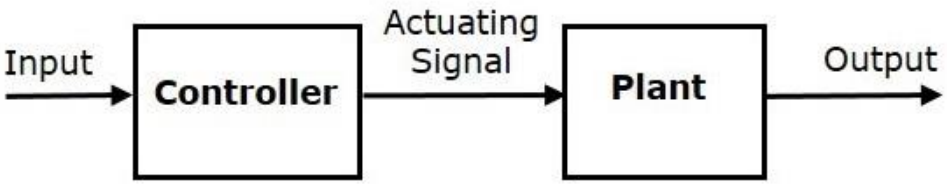


Figure 2.2: Open loop control system

2.2.2 Closed-loop control systems

Feedback control systems are often referred to as closed-loop control systems. In practice, the terms feedback control and closed-loop control are used interchangeably. In a closed-loop control system the actuating error signal, which is the difference between the input signal and the feedback signal (which may be the output signal itself or a function of the output signal and its derivatives and/or integrals), is fed to the controller so as to reduce the error and bring the output of the system to a desired value. The term closed-loop control always implies the use of feedback control action in order to reduce system error. Figure 3.3 shows the closed-loop control system.

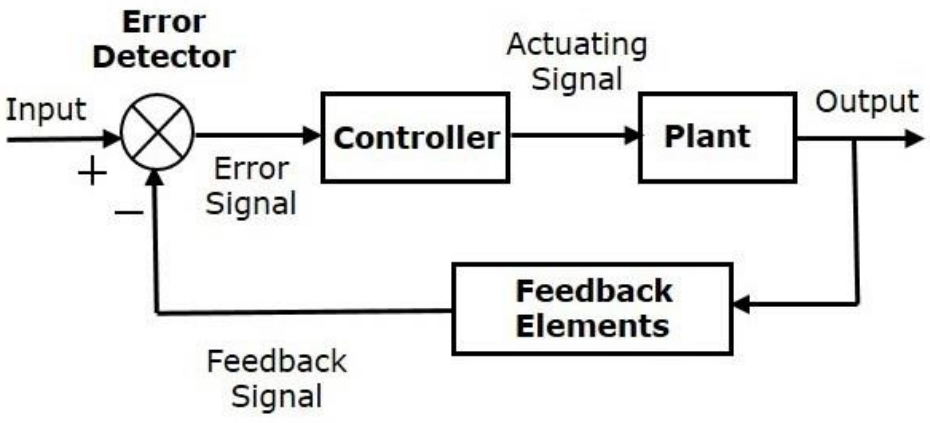


Figure 2.3: Closed loop control system

2.3 Microcontroller

A microcontroller is a single-chip computer .Micro suggests that the device is small, and controller suggests that it is used in control applications. Another term for microcontroller is embedded controller, since most of the microcontrollers are built into or embedded in the devices that controlling. Microcontrollers have traditionally been programmed using the assembly language of the target device. Although the assembly language is fast, it has several disadvantages. An assembly program consists of mnemonics, which makes learning and maintaining a program written using the assembly language difficult. Also, microcontrollers manufactured by different firms have different assembly languages, so the user must learn a new language with every new microcontroller he or she uses. Microcontrollers can also be programmed using a high-level language, such as BASIC, PASCAL, or C. High-level languages are much easier to learn than assembly languages and also facilitate the development of large and Complex programs.

Microcontroller is a highly integrated chip that contains Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM) and Input/ Output (I/O) ports. Unlike general purpose computer, which also includes all of these components, microcontroller is designed for a very specific task to control a particular system. As a result, the parts can be simplified and reduced, which cuts down on production cost.

2.3.1 Architecture of microcontroller

The von Neumann architecture: **(**also known as the von Neumann model or Princeton architecture) is a computer architecture based on a 1945 description by the mathematician and physicist John von Neumann and others in the First Draft of a Report on the EDVAC. That document describes a design architecture for an electronic digital computer with a processing unit that contains an arithmetic logic unit and processor registers, a control unit that contains an instruction register and program counter. Memory that stores data and instructions, external mass storage ,input and output mechanisms.

The word has evolved to mean any stored-program computer in which an instruction fetch and a data operation cannot occur at the same time because they share a common bus. This is referred to as the von Neumann bottleneck and often limits the performance of the system. The design of a von Neumann architecture machine is simpler than a Harvard architecture machine which is also a stored program system but has one dedicated set of address and data buses for reading and writing to memory, and another set of address and data buses to fetch instructions.

A stored-program digital computer keeps both program instructions and data in read-write, random-access memory (RAM). Stored-program computers were an advancement over the program-controlled computers of the 1940s, such as the Colossus and the ENIAC. Those were programmed by setting switches and

inserting patch cables to route data and control signals between various functional units. The vast majority of modern computers use the same memory for both data and program instructions. The von Neumann vs. Harvard distinction applies to the cache architecture, not the main memory (split cache architecture).

The **Harvard Architecture** is a computer architecture with physically separate storage and signal pathways for instructions and data. The term originated from the Harvard Mark I relay-based computer, which stored instructions on punched tape (24 bits wide) and data in electro-mechanical counters. These early machines had data storage entirely contained within the central processing unit, and provided no access to the instruction storage as data. Programs needed to be loaded by an operator; the processor could not initialize itself.

The microcontroller has many families such as:Altera, Analog Devices, Atmel, Cypress Semiconductor, Maxim Integrated, ELAN Microelectronics Corp., EPSON Semiconductor, Freescale Semiconductor, Fujitsu, Holtek, Hyperstone, Infineon, Intel, Lattice Semiconductor, Microchip Technology, National Semiconductor, NEC, NXP Semiconductors, Nuvoton Technology, Panasonic, Parallax, Rabbit Semiconductor, Renesas Electronics, Rockwell , Silicon Laboratories, Silicon Motion, Sony , Spansion, STMicroelectronics, Texas Instruments, Toshiba , Ubicom , Xemics , Xilinx , XMOS , ZiLOG .

2.3.2 Microcontroller application

Microcontrollers are widely used in modern electronic equipment. Some basic applications of microcontroller are given below:

- ✓ Used in biomedical instruments.
- ✓ Widely used in communication systems.
- ✓ Used as peripheral controller in Personal Computer (PC).

- ✓ Used in robotics.
- ✓ Used in automobile fields.

Microcontroller application s found in many lives filed, for example in Cell phone, watch, recorder, calculators, mouse, keyboard, modem, fax card, sound card, battery charger, door lock, alarm clock, thermostat, air conditioner, TV Remotes, in Industrial equipment like Temperature and pressure controllers, counters and timers .Figure 2.4 shows the ATMega microcontroller pins configuration.

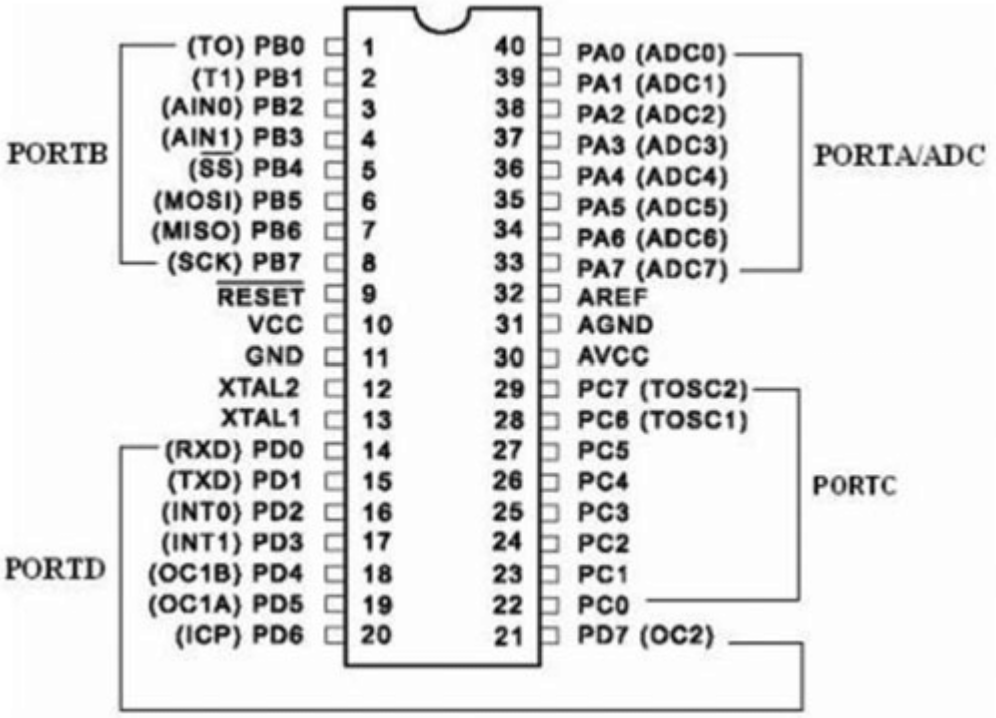


Figure 2.4: ATMega microcontroller

2.4 Motors

Motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and winding currents to generate force in the form of rotation. Electric motors can be powered by Direct Current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by Alternating Current (AC) sources, such

as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates in the reverse direction, accepting mechanical energy (such as from flowing water) and converting this mechanical energy into electrical energy.

Electric motors may be classified by considerations such as power source type, internal construction, application and type of motion output. In addition to AC versus DC types, motors may be brushed or brushless, may be of various phase (see single-phase, two-phase, or three-phase), and may be either air-cooled or liquid-cooled. General-purpose motors with standard dimensions and characteristics provide convenient mechanical power for industrial use. The largest electric motors are used for ship propulsion, pipeline compression and pumped-storage applications with ratings reaching 100 megawatts. Electric motors are found in industrial fans, blowers and pumps, machine tools, household appliances, power tools and disk drives. Small motors may be found in electric watches.

In certain applications, such as in regenerative braking with traction motors, electric motors can be used in reverse as generators to recover energy that might otherwise be lost as heat and friction. There are two types of motors, AC and DC motor, A **DC motor** is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor.

2.4.1 Components of DC motor

DC motors contain many components such as:

- **Armature:** The armature is the part of a DC motor that rotates and provides energy at the end of the shaft. It is basically an electromagnet, since it is a coil of wire that has to be specially designed to fit around core material on the shaft. The core of the armature is made of laminated steel and provides slots for the coils of wire to be pressed onto.
- **Motor frame:** The armature is placed inside the frame of the motor where the field coils are mounted. When the field coils and the armature coils become magnetized, the armature will begin to rotate. The field winding is made by coiling up a long piece of wire. The wire is mounted on laminated pole pieces called field poles. Similar to an armature, these poles are made of laminated steel or cast iron to prevent eddy current and other flux losses.
- **End plates:** The end plates of the motor are mounted on the ends of the motor frame. The end plates are held in place by four bolts that pass through the motor frame. The bolts can be removed from the frame completely so that the end plates can be removed easily for maintenance. The end plates also house the bearings for the armature shaft. These bearings can be either sleeve or ball type. If the bearing is a ball-bearing type, it is normally permanently lubricated. If it is a sleeve type, it will require a light film of oil to operate properly. The end plates that house a sleeve-type bearing will have a lubrication tube and wicking material. Several drops of lubricating oil are poured down the lubrication tube, where they will saturate the wicking material. The wicking is located in the bearing sleeve so that it can make contact with the armature shaft and transfer a light film of oil to it. Other types of sleeve bearings are made of porous metal so that it can absorb oil to be used to create a film between the bearing and the shaft.
- **Brushes and Brush Rigging:** The brush rigging is an assembly that securely holds the brushes in place so that they will be able to ride on commutator. It is mounted on the rear end plate so that the brushes will be

accessible by removing the end plate. An access hole is also provided in the motor frame so that the brushes can be adjusted slightly when the motor is initially set up. The brush rigging uses a spring to provide the proper amount of tension on the brushes so that they make proper contact with commutator. If the tension is too light, the brushes will bounce and arc, and if the tension is too heavy, the brushes will wear down prematurely.

2.4.2 DC Motors applications

DC motor is used in **Smart Home**, such as Intelligent electric curtains, Intelligent escort robot, Intelligent oil fume hood, air conditioning and so on. DC motor is used in **industry equipment**, such as Mobile Phone Base Station, Circuit breaker, Video Conference, Intelligent Electric Pan-Tilt and so on. DC motor is used in **automobile**, such as Electric Positioning System (EPB),Automotive panoramic sliding skylight, Automotive Seat Headrest, Automobile Power Lift gate Cables, Throttle Actuator and so on. DC motor is used in **Medical devices**, such as Intelligent eye massage, Intelligent insulin pump, Smart Medical Injection System, Minimally invasive linear cutting stapler and so on. DC motor is used in **Electronic products**, such as Full Screen Mobile Phone Camera, Smart phone photo printer, Intelligent Electric Toothbrush and so on. Figure 2.5 shows the DC motors.

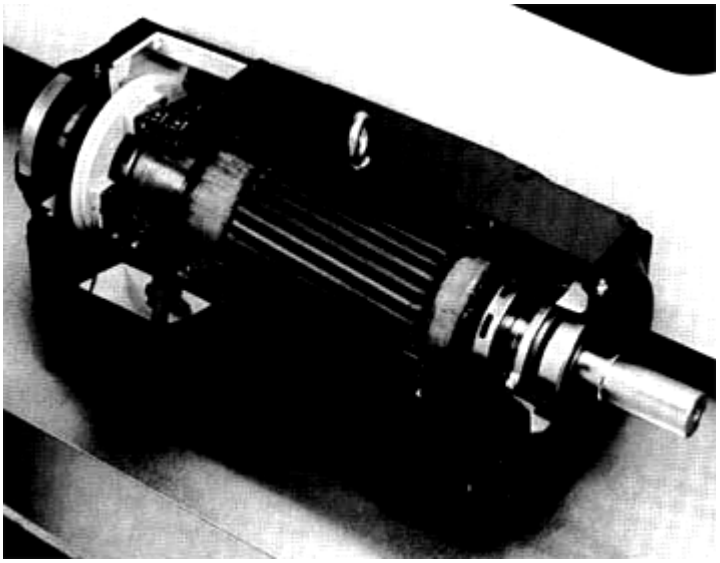


Figure 2.5: DC motor.

2.5 Bluetooth

Bluetooth is a wireless technology standard for exchanging data over short distances (using short wave length UHF radio waves in the ISM band from 2.4 to 2.485 (GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by Dutch electrical engineer JaapHaartsen, working for telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative toRS-232 data cables.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 30,000member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as , but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A Network of patent supply technology, are licensed to individual qualifying devices.

2.5.1 Ranges of Bluetooth

Officially Class 3 radios have a range of up to 1 meter (3 ft), Class 2, most commonly found in mobile devices, 10 meters (33 ft), and Class 1, primarily for industrial use cases,100 meters (300 ft). Bluetooth Marketing qualifies that Class 1 range is in most cases 20–30 meters (66–98 ft), and Class2 range 5–10 meters (16–33 ft).[1] The actual range achieved by a given link will depend on the qualities of the devices at both ends of the link, as well as the air conditions in between, and other factors.

The effective range varies depending on propagation conditions, material coverage, production sample variations, antenna configurations and battery conditions. Most Bluetooth applications are for indoor conditions, where attenuation of walls and signal fading due to signal reflections make the range far lower than specified line-of-sight ranges of the Bluetooth products.

Most Bluetooth applications are battery-powered Class 2 devices, with little difference in range whether the other end of the link is a Class 1 or Class 2 device as the lower-powered device tends to set the range limit. In some cases the effective range of the data link can be extended when a Class 2 device is connecting to a Class 1 transceiver with both higher sensitivity and transmission power than a typical Class 2 device. Mostly, however, the Class 1 devices have a similar sensitivity to Class 2devices. Connecting two Class 1 devices with both high sensitivity and high power can allow ranges far in excess of the typical 100m, depending on the throughput required by the application. Some such devices allow open field ranges of up to 1 km and beyond between two similar devices without exceeding legal emission limits. The Bluetooth Core Specification mandates a range of not less than 10 meters (33ft), but there is no upper limit on actual range.

Manufacturers' implementations can be tuned to provide the range needed for each case..

2.5.2 Applications of Bluetooth

A typical Bluetooth mobile phone headset, Wireless control and communication between a mobile phone and a hands free headset. This was one of the earliest applications to become popular. Wireless control of and communication between a mobile phone and a Bluetooth compatible car stereo system. Wireless control of and communication with IOS and Android device phones, tablets and portable wireless speakers. Wireless Bluetooth headset and Intercom. Idiomatically, a headset is sometimes called "a Bluetooth". Wireless streaming of audio to head phone switch or without communication capabilities. Wireless streaming of data collected by Bluetooth-enabled fitness devices to phone or PC Wireless networking between PCs in a confined space and where little bandwidth is required. Wireless communication with PC input and output devices, the most common being the mouse, keyboard and printer transfer of files, contact details, calendar appointments, and reminders between devices with OBEX replacement of previous wired RS-232serial communications in test equipment, GPS receivers, medical equipment, bar codes canners, and traffic control devices. For controls where infrared was often used. For low bandwidth applications where higher USB bandwidth is not required and cable-free connection desired. Sending small advertisements from Bluetooth-enabled advertising hoardings to other, discoverable, Bluetooth devices. Wireless bridge between two Industrial Ethernet (e.g., PROFINET Seventh and eighth generation game consoles such as Nintendo's Wii, and Sony's PlayStation 3 use Bluetooth for their respective wireless controllers. Dial-up internet access on personal computers or PDAs using a data capable mobile phone as a wireless modem. Short-range transmission of health sensor data from medical devices to mobile phone, set-top box or dedicated

telehealth devices. Allowing a DECT phone to ring and answer calls on behalf of a nearby mobile phone. (RTLS) are used to track and identify the location of objects in real time using "Nodes" or "tags" attached to, or embedded in, the objects tracked, and "Readers" that receive and process the wireless signals from these tags to determine their locations. Personal security application on mobile phones for prevention of theft or loss of items.The protected item has a Bluetooth marker (e.g., a tag) that is in constant communication with the phone. If the connection is broken (the marker is out of range of the phone) then an alarm is raised.

Figure 2.6: Bluetooth module (HC-05)

2.6Weather vane

A weather vane, wind vane, or weathercock is an instrument for showing the direction of the wind. It is typically used as an architectural ornament to the highest point of a building. The word vane comes from the Old English word fana meaning "flag". Although partly functional, weather vanes are generally decorative, often featuring the traditional cockerel design with letters indicating the points of the

compass. Other common motifs include ships, arrows and horses. Not all weather vanes have pointers. When the wind is sufficiently strong, the head of the arrow or cockerel (or equivalent depending on the chosen design) will indicate the direction from which the wind is blowing. The weather vane was independently invented in ancient China and Greece around the same time during the 2nd century BCE. The earliest written reference to a weather vane appears in the Huainanzi, and a weather vane was fitted on top of the Tower of the Winds in Athens.

2.7 Compass

A compass is an instrument used for navigation and orientation that shows direction relative to the geographic cardinal directions (or points). Usually, a diagram called a compass rose shows the directions north, south, east, and west on the compass face as abbreviated initials. When the compass is used, the rose can be aligned with the corresponding geographic directions; for example, the "N" mark on the rose points northward. Compasses often display markings for angles in degrees in addition to (or sometimes instead of) the rose. North corresponds to 0°, and the angles increase clockwise, so east is a 90° degree, south is 180°, and west is 270°. These numbers allow the compass to show azimuths or bearings, which are commonly stated in this notation.

The main types of compasses are:

- ✓ The magnetic compass.
- ✓ Non magnetic compass.
- ✓ Gyrocompasses.
- ✓ GPS receivers used as compasses.

Figure 2.7 shows the compass.

Figure 2.7: Compass

CHAPTER THREE

MODEL DESIGN

3.1 Introduction

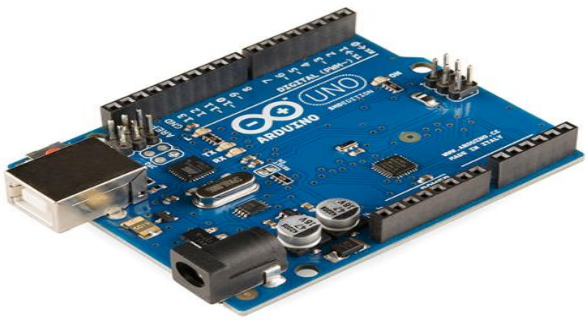
A multitude of hardware design challenges faced working on this Project. When designing the weathervane Assembly. We faced challenges of choosing the proper sensors to detected wind speed, designing physical device that could mount the desired sensors while maintaining the functionality of a weathervane, and hiding all the electronics for the user interface. When designing the haptic feedback belt and designing the circuit to drive eight vibration motors given the limited amount of pins on the small board.

3.2 Model Components

In this project used a number of components as below:

3.2.1 Arduino Uno

Arduino is an open source hardware and software company, project and user community that designs and manufactures single board microcontrollers and microcontroller kits for building digital devices and interactive objects in the physical and digital world, Arduino Uno shown in figure 3.1.



.Figure 3.1: Arduino Uno

The build of Arduino Uno are represent as follow:

USB Port: The USB Port is used to connect the Arduino to a specialized computer or to supply it with electrical power.

DC Power : Using it as an external battery power source is plugged in if we don't use USB.

Power Pins: Contains power supply pins 5v-3.3v as well as ground pins GND and VIN port.

Analog Pins Inputs pins used to insert analog signal, and it has 6 pins.

Digital Pins: Used to insert digital signal sand the value of the signal are 0/ 1.

Reset Button: Used to restart the loaded program on microcontrollers.

LED: It lights up when the Arduino works.

Crystals Oscillator: Its frequency is 16MHz and it is responsible for anything related to time in the Arduino, such as determining the time it takes the Arduino to perform a particular order and its presence is necessary for the Arduino.

Voltage Regulator: Used to convert the large voltage into a convenient voltage for running the Atmega chip, and running the accessories.

Pin 1: Responsible of restarting Arduino.

Pins 2-3: (T-X, R-X) send and receive data.

Pins7-8: Supply the Atmega chip with the power needed to operate it and they connected in Arduino panel with voltage regulator output.

Pins 5-19: The terminals are the normal input and output in the Arduino panel with pins (2-13).

Pins 9. 10: they are connected to the oscillator

Pins 20-22: they are responsible for the supply of analog (ADC) terminals and they are connected to the Arduino with a fully integrated output voltage.
Pin 21:It's responsible for determining the maximum voltage tolerated by the analogs terminals (ADC) and it's connected in the Arduino board on the edges of the AREF and is rarely used.

Pins 23-28: its analog terminals (ADC), the responsible for reading the voltage (0-5) and connecting the board to the Arduino the sides.

The signals come to Arduino from HMC compass and wind transmitter to send it to the master Bluetooth.

Arduino function in the receiver circuit:

The signals come from the slave Bluetooth to control the vibration motors

This figure below shows the structure of Arduino Uno:

3.2.2 HMC5883L2 Compass

The HMC5883L is a surface amount multi- chip designed for Low- filed magnetic sensing with a digital interface for application such as low-cost compassing and magnetometers. The HMC5883L2 include our state-g- the art high resolution HMC118 X series magneto restive sensor plus an ASIC containing implications. Automatic Degaussing strap drivers offset cancellation and a 12-bit ADC the enable to 2 compass heading accuracy. The IIC Serial bus allows for east interface. The HMC5883L 3-0X3.0X9 mm surface mount.16-pin leadless chip carrier (LCC). Application for the HMC5883L Include Mobile phone net books, consumer electronics, Auto Navigation Systems, and personal navigation device.

Anisotropic Magneto-Resistive Sensors .The HMC5883L magneto resistive sensor circuit is a trio of sensors and application specific support circuits to measure magnetic fields. With power supply applied, the sensor converts any incident

magnetic field in the sensitive axis directions to a differential voltage output. The magneto resistive sensors are made of a nickel-iron (Perm alloy) thin-film and patterned as a resistive strip element. In the presence of a magnetic field, a change in the bridge resistive elements causes a corresponding change in voltage across the bridge outputs. These resistive elements are aligned together to have a common sensitive axis (indicated by arrows in the pin out diagram) that will provide positive voltage change with magnetic fields increasing in the sensitive direction. Because the output is only proportional to the magnetic field component along its axis, additional sensor bridges are placed at orthogonal directions to permit accurate measurement of magnetic field in any orientation, structure of HMC5883L compass shown in Figure 3.2.

Figure 3.2: Structure of HMC5883L compass

(a) Features

3 Axis magneto resistive sensor and ASIC in a 3.0*3.0*9 mm LCC surface mount package.12-bit ADC coupled with low noise AMR sensors achieves 5 milli-gauss

resolution in negative or positive fields. Build in self-test of Low voltage operation (2-16to 3-6v) and low power conduction (100MA) .Build sterndrivecircuits.I2c digital interface. Lead free package construction.

Wide magnetic field range (+/8 Oe). Software and algorithm support. Fast 160 HZ Maximum output Rate.

(b) Specifications

The specifications of HMC5883L shown in the Table 3.1.

Table 3.1: Specifications of HMC5883L .

Characteristics	**Conditions***	**Min**	**Typ**	**Max**	**Units**
Power Supply					
Supply Voltage	VDD Referenced to AGND VDDIO Referenced to DGND	2.16 1.71	1.8	3.6 VDD+0.1	Volts Volts
Average Current Draw	Idle Mode Measurement Mode (7.5 Hz ODR; No measurement average, MA1:MA0 = 00) VDD = 2.5V, VDDIO = 1.8V	- -	2 100	- -	µA µA

(C)Pins configuration

The pin configuration shown in the Table 3.2

Table 3.2: Pins configuration of the HMC5883L

Pin	**Name**	**Description**
1	SCL	Serial Clock – I2C Master/Slave Clock
2	VDD	Power Supply (2.16V to 3.6V)
3	NC	Not to be Connected
4	S1	Tie to VDDIO
5	NC	Not to be Connected
6	NC	Not to be Connected
7	NC	Not to be Connected
8	SETP	Set/Reset Strap Positive – S/R Capacitor (C2) Connection
9	GND	Supply Ground
10	C1	Reservoir Capacitor (C1) Connection
11	GND	Supply Ground
12	SETC	S/R Capacitor (C2) Connection – Driver Side
13	VDDIO	IO Power Supply (1.71V to VDD)
14	NC	Not to be Connected
15	DRDY	Data Ready, Interrupt Pin. Internally pulled high. Optional connection. Low for 250 μsec when data is placed in the data output registers.
16	SDA	Serial Data – I2C Master/Slave Data

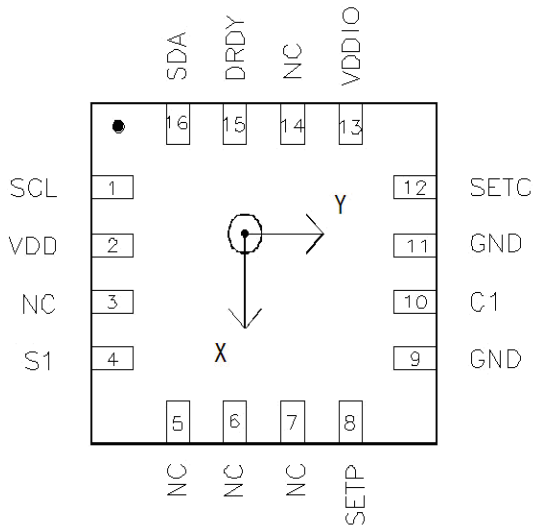


Figure 3.3: Top view of HMC5883L.

3.2.3 Vibration motor

Vibration motor is a compact DC motor used to inform the users of receiving the signal by vibrating. Vibration motors are widely used in variety of applications including cell phones, handsets and so on, vibration motor (coin tybe) shon in Figure 3.4.

Figure 3.4: vibration motor (coin tybe)

(a) Features of vibration motors

The main features of vibration motors are the magnets coreless DC motor are permanent, which mean sit will always have its magnetic properties. Another main feature is the size of the motor is small, and the power consumption that the motor produce while using are low. The vibration motors are configured in two basic varieties: coin type and bar type. In this project we used the coin type of vibration motor. The need for smaller, thinner designs led to the adapt at ion of brush motor technology into the coin type the coin type vibration.

Coin type vibration is comprised of a weight, a ring magnet, rotor with commutation points attached in the front and coils assembled on the back, and power supplied brushes attached to the ring magnet. The commutation points are in contact with the end of the brushes. The commutation points will energize the electrical coils in the rotor. Energizing the coils produce a magnetic field and it is strong enough to interact with the ring magnet integrated into the stator, causing rotation. A force is generated due to the magnetic field. This force causes the

weight to displace. The displacement of the weight produces a varying force which is felt as vibration.

(b) Functions of the vibration motors

The function of these motors in our project is vibration as a signal to determine the direction of the wind after receiving a signal via Bluetooth from the weathervane that beaded in the transmission circuit .and we divided the motors according to the eight direction each motor sets a certain direction. These motors are in the receiving circuit(R-X) and they are connected to the drivers (L293D) to operate.

3.2.4 LCD display

In 16x2 LCD there are 16 pins over all if there is a back light, if there is no back light there will be 14 pins. One can power or leave the back light pins. Now in the 14 pins there are 8 data pins (7-14 or D0-D7), 2 power supply pins (1&2 or VSS&VDD or GND&+5v), 3rd pin for contrast control (VEE-controls how thick the characters should be shown), and 3 control pins (RS&RW&E), LCD 16*2 shown in Figure 3.5.

Figure 3.5: LCD 16*2

(a) Components required

To operate the LCD we need hardware: Arduino Uno, power supply (+5V) and software: Arduino IDE (Arduino nightly)

(b) LCD connections

The connections which are done for LCD are given below:

- PIN1 or VSS to ground
- PIN2 or VDD or VCC to +5v power
- PIN3 or VEE to ground (gives maximum contrast best for a beginner)
- PIN4 or RS (Register Selection) to PIN0 of ARDUINO UNO
- PIN5 or RW (Read/Write) to ground (puts LCD in read mode eases the communication for user)
- PIN6 or E (Enable) to PIN1 of ARDUINO UNO
- UNO PIN11 or D4 to PIN8 of ARDUINO
- PIN12 or D5 to PIN9 of ARDUINO UNO
- PIN13 or D6 to PIN10 of ARDUINO UNO
- PIN14 or D7 to PIN11 of ARDUINO UNO

In this project the LCD display connected in the (R-X) circuit to display wind speed.

3.2.5 Bluetooth HC-05

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

Blue core 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, the HC-05 shown in Figure 3.6.

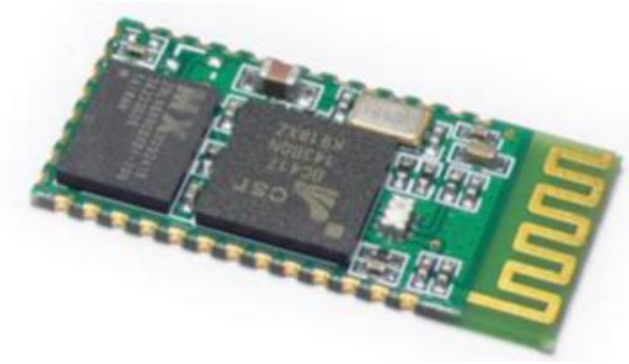


Figure 3.6: Bluetooth HC-05

(a)Features of Bluetooth HC-05

The hardware specifications is: Typical -80dBm sensitivity, Up to +4dBm RF transmit power, Low Power 1.8V Operation, 1.8 to 3.6V I/O PIO control, UART interface with programmable baud rate , With integrated antenna , With edge connector. The software specifications are:

Default Baud rate: 38400, Data bits:8, Stop bit:1, Parity: No parity, Data control: has supported baud rate: 9600,19200,38400,57600,115200,230400,460800. Given a rising pulse in PIO0, device will be disconnected. Status instruction port PIO1: low-disconnected, high-connected, PIO10 and PIO11 can be connected to red and blue led separately. When master and slave are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s, Auto-connect to the last device on power as default, Permit pairing device to connect as default, Auto-pairing PINCODE:"0000" as default, Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.

(b)Pins configurations

The pins configurations of HC-05 shown in Table 3.6 .

Table 3.3: Pins configurations of HC-05.

PIN Name	PIN #	Pad type	Description	Note
GND	13 21 22	VSS	Ground pot	
3.3 VCC	12	3.3V	Integrated 3.3V (+) supply with On-chip linear regulator output within 3.15-3.3V	
AIO0	9	Bi-Directional	Programmable input/output line	
AIO1	10	Bi-Directional	Programmable input/output line	
PIO0	23	Bi-Directional RX EN	Programmable input/output line, control output for LNA(if fitted)	
PIO1	24	Bi-Directional TX EN	Programmable input/output line, control output for PA(if fitted)	

The work of Bluetooth technology begins by generating wireless waves and the value of the frequency id 2.45GHZ which is the value agreed globally in the, scientific and medical devices.

(c)Connection diagram

The connection diagram of HC-05 is shown in the Figure 3.7.

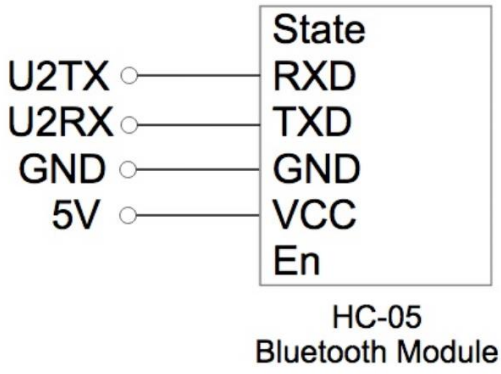


Figure 3.7: Connection diagram of HC-05.

(d)Transmitting over Bluetooth

To using wind readings from the weathervane to the belt. We weird up the Bluetooth module over UART on both the belt and the weathervane. Once connected and paired up, the microcontroller where are able to communicate as if there was direct serial connection between them. Using the Bluetooth module for the data transmission, it was also easy for us to test or code to the module on their side of connection and view what was being send back and forth in our serial monitor. HC-05 Bluetooth Slave Works as a Bluetooth slave in the RX circuit and connected on serial with the RX Arduino as an input. It receives the signals that contains the information's from the master Bluetooth and sends it to the RX.

3.2.6 Wind transmitter

Component of the wind speed in the field of meteorology and environmental measuring technology, evaluation of location and measurement of capacity characteristics The wind transmitter is designed for the acquisition of the horizontal of wind power systems. Special characters are defined and optimized, dynamic

behavior also at high turbulence intensity, minimal over-speeding and a low starting values.

The measuring value is available as digital signal at the output. It can be transmitted to display instruments, recording instruments, data loggers as well as to process control systems. For winter operation the instrument is optional equipped with an electronically regulated heating, which guarantees a smooth running of the ball bearings, and prevents the shaft and slot from icing-up.

(a) Construction and mode of operation

A low-inertia cup star with 3 cups, made of carbon-fibre-reinforced plastic, is set into rotation by the wind. The rotation is scanned opto- electronically, and is converted into a square wave signal. The frequency of this signal is proportional to the number or rotations. Depending on the supply voltage, the output signal ranges between maximal output voltage and ground or a potential (life-zero), lifted by approx. 1.2 V. The supply of the electronics can be done by DC-voltage of 3.3 V up to 48 V at a very low current consumption. An AC- or DC-voltage of 24 V is intended for the separate supply of the optional heating. In all probability, the heating guarantees a trouble-free function of the Wind Transmitter First Class even under extreme meteorological icing-conditions. The outer parts of the instrument are made of corrosion-resistant anodized aluminum. Highly effective labyrinth gaskets and O-rings protect the sensitive parts inside the instrument against humidity and dust. The instrument is mounted onto a mast tube; the electrical plug-connection is located in the transmitter shaft, Wind Transmitter shown in Figure 3.8.

Figure 3.8: Wind Transmitter

(b) Applications of wind transmitter

The wind transmitter is designed for the acquisition of the horizontal component of the wind speed in the field of meteorology and environmental measuring technology, evaluation of location, and measurement of capacity characteristics of wind power systems. Special characters are defined and optimized, dynamic behavior also at high turbulence intensity, minimal over-speeding, and a low starting value. The measuring value is available as digital signal at the output. It can be transmitted to display instruments, recording instruments, data loggers as well as to process control systems. For winter operation the instrument is optional equipped with an electronically regulated heating, which guarantees a smooth running of the ball bearings, and prevents the shaft and slot from icing-up.

(c)Connection diagram

This diagram shows the connection of wind transmitter in Figure 3.9.

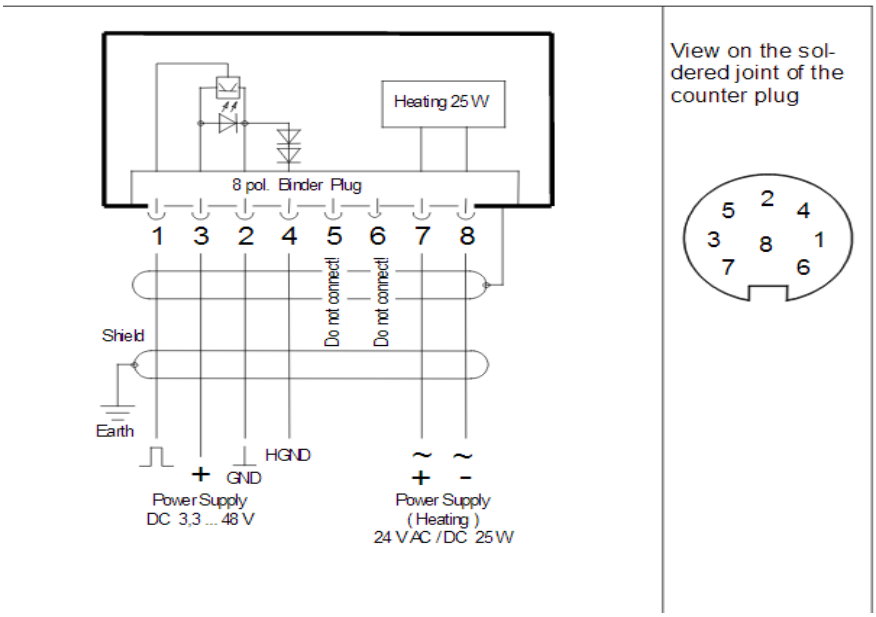


Figure 3.9: Connection diagram of wind transmitter.

(d) Pin configuration

The Pins configuration of wind transmitter shown in Table 6.3

Table 3.4: Pins configuration of wind transmitter.

Pin	Name	Function
1	SIG	Signal (rectangle)
2	GND	Ground
3	+US	Supply 3.3 V...48 V DC
4	HGND	Ground at life-zero signal
5	NC	Do not connect!
6	NC	Do not connect!

3.2.7 Driver (L293D)

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz. The L293D is assembled in a 16-lead plastic package which has 4 center pins connected together and used for heat sinking The L293DD is assembled in a 20-lead surface mount which has 8 center pins connected together and used for heat sinking , the driver L294D shown in Figure 3.10.

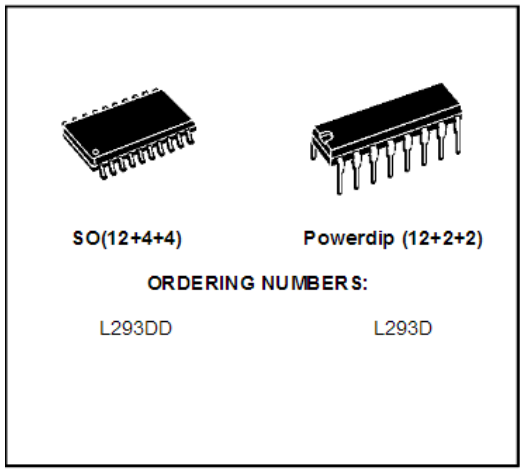


Figure 3.10: The driver L294D

(a) Block diagram of the driver L293D

This block diagram shows the top view of L293D shown in Figure 3.11.

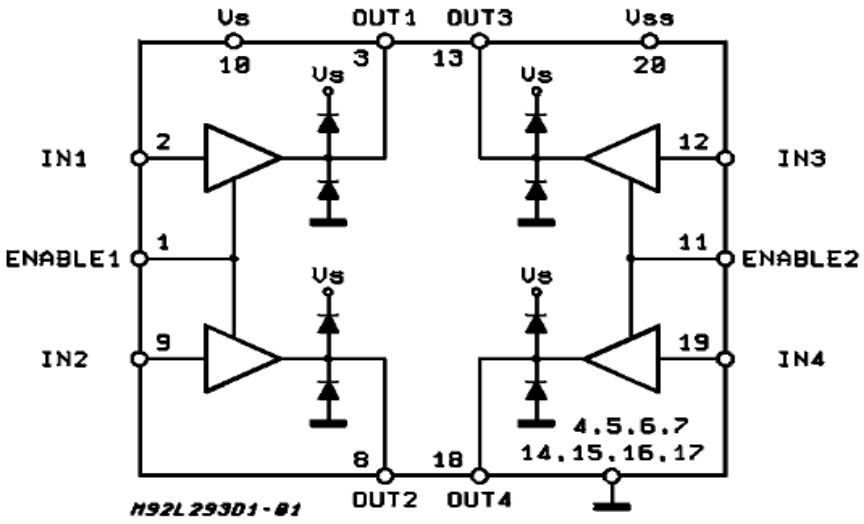


Figure 3.11: Block diagram of driver L293D.

(b) Pins configuration of driver L293D

The pin configurations of driver L293D are shown in the Figure 3.12.

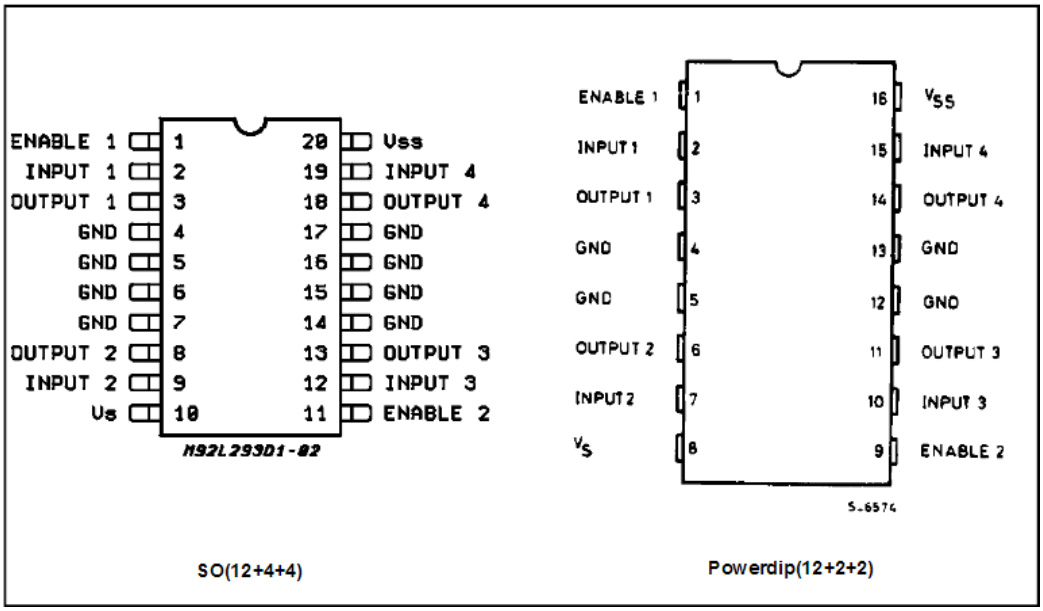


Figure 3.12: Pins configuration of driver L293D.

3.3 Block diagram of transmission and receiving circuits

Figure 3.13 shows the block diagram of the transmission circuit (T-X)

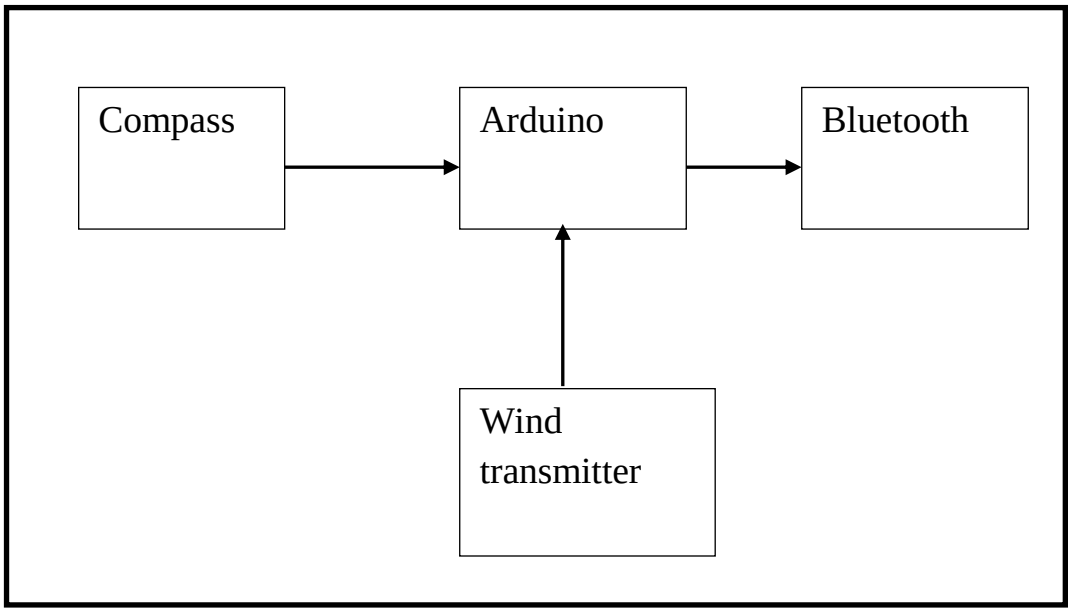


Figure 3.13; Block diagram of transmission circuit.

Figure 3.14 shows the block diagram of the receiving circuit.

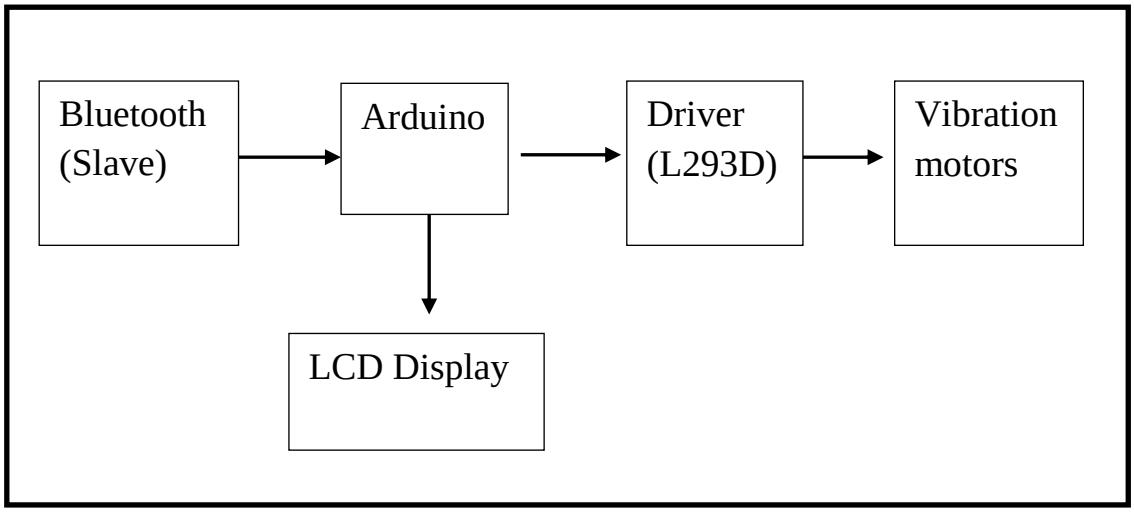


Figure 3.14: Block diagram of receiving circuit.

CHAPTER FOUR

PRACTICAL AND SOFTWARE

4.1 Introduction

In this project we have two circuits, the transmission circuit (TX) and the receiving circuit (RX). Each circuit has components collected together.

4.2 Practical

In the practical part we connected the two circuits as follow:

4.2.1 Transmission circuit (TX)

This circuit contains:

- ✓ Compass.
- ✓ The wind transmitter (The fan).
- ✓ Arduino.
- ✓ Bluetooth (HC-05) master.

To connect the compass with the Arduino, the compass terminals are connected to the ADC part of the Arduino. We connected the SCL (serial clock) pin in the compass with the A5 pin in the Arduino in the ADC part. The SDA (serial data) pin is also connected with the A4 pin in the Arduino in the ADC part. And then the ground and VCC of the compass were connected with the Arduino by the board. The compass is connected to the Arduino to send a signal to determine the direction. To determine the directions, we installed the compass on a board containing the eight angles of the directions, and the compass was moved on the board from the east direction towards the north-east direction and then to the north direction and so, until all the degrees of directions were determined. Figure 4.1 shows a drawing of the directions board on which the compass is installed.

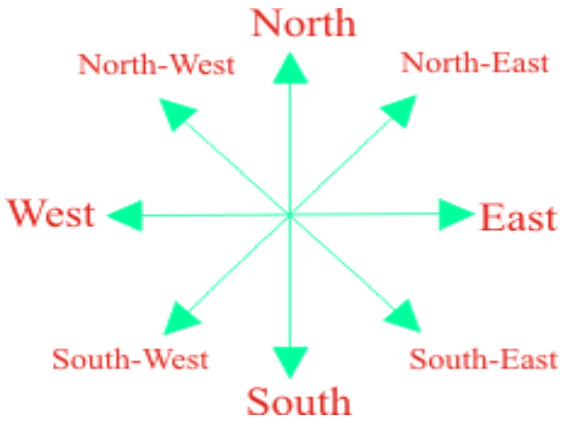


Figure 4.1**:** The eight directions.

(a)Connecting the wind transmitter (the fan) with the Arduino

To connect the fan with the Arduino, the fan pins are connected to the PWM part of the Arduino. The SIG (signal) pin is connected in the fan with PIN8 in the Arduino in the PWM part. The ground and VCC were then connected with the Arduino through the board. The fan is connected to the Arduino to send a signal to determine the wind speed. When the wind movement causes fan rotation, the fan generates frequencies according to the speed of its rotation between (0-1082 Hz) to measure a speed of (3-80 m/s). We divided the speed into eight parts, to be displayed via the LCD screen as we will explain later.

(b)Connecting Bluetooth HC-05(master)with the Arduino

To connect the Bluetooth HC-05 (master) with the Arduino, Bluetooth HC-05 (master) terminals are connected with the Arduino in the PWM section. We connected the TX pin of the Bluetooth HC-05 (master) with the RX (PIN0) pin in the Arduino, and we connected the RX pin of the Bluetooth HC- 05 (master) with

the TX pin (PIN1) in the Arduino. The ground and VCC were then connected with the Arduino through the board.The Bluetooth HC-05 (master) is connected to the Arduino to receive the compass and fan readings, and then sends it to the Bluetooth HC-05 (slave) in the receiving circuit.

(c)Connecting Bluetooth HC-05(slave) with Bluetooth HC-05(slave)

In order to connect the master with the slave, we entered orders in the Arduino software (IDE) to determine which master and slave, after installing the commands and connecting the slave with the master, then the Bluetooth were separated from the source. When the two Bluetooth connections are reconnected, they are automatically connected.

4.2.2 Receiving circuit (RX)

This circuit contains:

- ✓ Bluetooth HC-05 slave.
- ✓ Arduino.
- ✓ Drivers (L293D).
- ✓ Vibration Motors.
- ✓ LCD screen.

(a)Connecting Bluetooth HC-05 (slave) with Arduino

To connect the Bluetooth HC-05 (slave) with the Arduino, Bluetooth HC-05 (slave) terminals are connected with the Arduino in the PWM section. We connected the TX pin of the Bluetooth HC-05 (slave) with the RX (PIN0) party in the Arduino, and we connected the RX pin of to the Bluetooth HC-05 (slave) with the TX pin (PIN1) in the Arduino. The ground and VCC were then connected with the Arduino through the board.The Bluetooth HC-05 (slave) is connected to the

Arduino to receive thesignals from the Bluetooth HC-05 (master), and then sends it to the receiving circuit Arduino.

(b)Connecting the motors with the arduino

The Arduino has a current of up to 700mA, and the motors require a higher current. Therefore, we used the driver (L293D) as a power amplifier to increase its value to 1.2A. The driver (L293D) operates only four motors so we used two drivers.

Connecting driver (1) with Arduino

Table 4.1:The connection between the Arduino and the first driver.

Driver 1 pins	Arduino pins
PIN2_IN1	A2
PIN7_IN2	A3
PIN10_IN3	A0
PIN15_IN4	A1

Connecting driver (2) with Arduino

Table 4.2: connection between the Arduino and the second driver.

Driver 2 pins	Arduino pins
PIN2_IN1	A4
PIN7_IN2	A5
PIN10_IN3	PIN3
PIN15_IN4	PIN2

Connecting driver (1) with motors

Table 4.3: pins connection between the first driver and four of the motors.

Driver 1 pins	Motors
PIN3_OUT1	V1
PIN6_OUT2	V2
PIN11_OUT3	V7
PIN14_OUT4	V8

Connecting driver (2) with motors

Table 4.5: pins connection between the second driver and the other four motors.

Driver 1 pins	Motors
PIN3_OUT1	V5
PIN6_OUT2	V6
PIN11_OUT3	V3
PIN14_OUT4	V4

(c)Connecting LCD screen with Arduino

Table 4.5: the connection between the Arduino and the LCD

LCD pins	Arduino pins
PIN4	PIN8
PIN6	PIN9
PIN11	PIN10
PIN12	PIN11
PIN13	PIN12
PIN14	PIN13

Figure 4.2 shows the connection between the Arduino and the LCD.

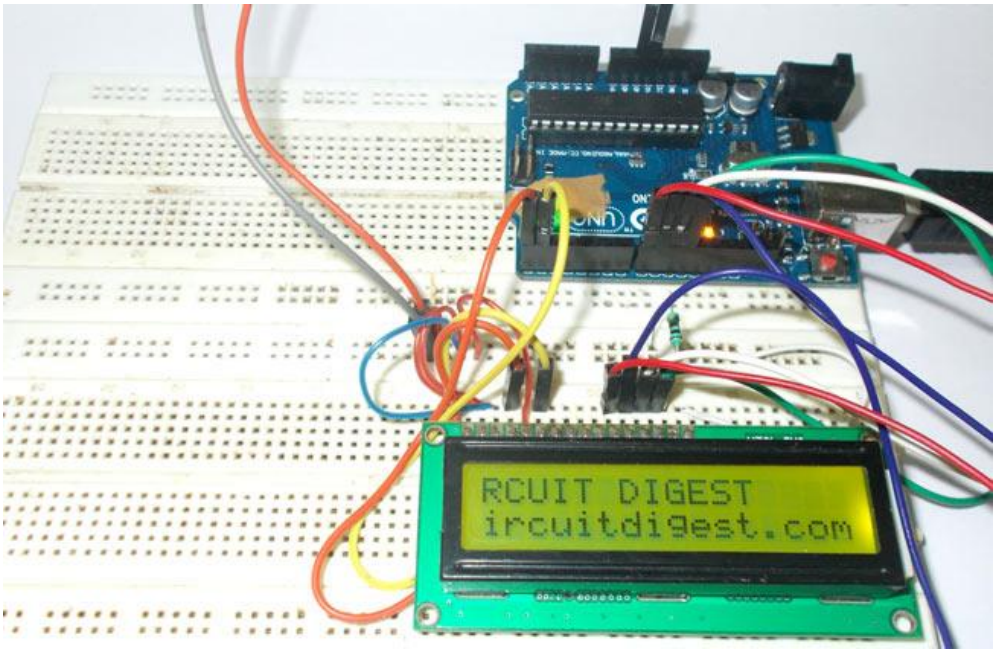


Figure 4.2: the connection between the arduino and the LCD.

4.3 Arduino Software (IDE)

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board. Arduino software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to

verify and upload programs, create, open, and save sketches, and open the serial monitor. Libraries are a collection of code that makes it easy to connect to a sensor, display, module, etc. There are hundreds of additional libraries available on the Internet for download. The built-in libraries and some of these additional libraries are listed in the reference. To use the additional libraries, they must be installed.

4.4 Model circuit

The model circuit is containing RX and TX circuits.

RX Circuit

Figure 4.3 shows the connection of the receiving circuit

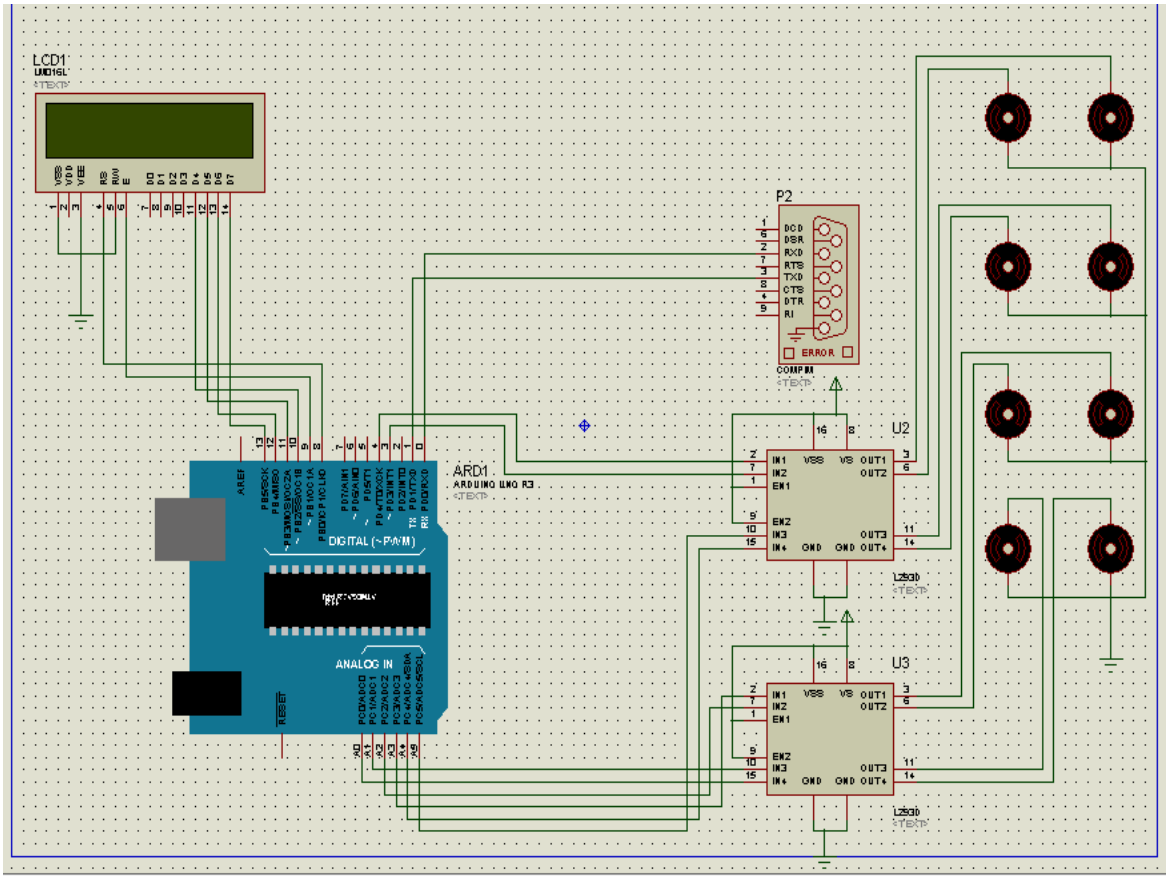


Figure 4.3: Receiving circuit.

We could not find a device that represents the wind transmitter and the compass in the simulation program, so we could not make a model circuit for the transmission circuit.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The project was implemented in stages, initially we collected basic information about the project and then we studied general concepts related to the project such as control, microcontroller, motors and some other concepts. After that, we learned about all the components of this project in terms of the way it definitions, functions and how it works. And then connected these components with each other to build the project circuit of the project which was divided into the transmission circuit receiving circuit and connected between the two circuits Via Bluetooth which received signals from the weathervane and compass and sent to the Bluetooth in the receiving circuit, which in turn sent signals to the motors and the LCD screen until the direction of the wind and the value of the speed was determined.

5.2 Recommendations

- We recommend installing the motors on the belt to be the shape of the project that was supposed to be, because of the problems we encountered in the installation of the belt.
- We recommend using a wide range of transmitter and receiver devices because the range of Bluetooth is somewhat limited.
- When designing the weathervane, we recommend that you make sensors to measure the temperature and humidity so that the project becomes more comprehensive and better.
- We recommend the use of more stable, better quality, and larger size vibration motors than the type we used.

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