HAZARDOUS ENVIRONMENT ROBOT

By

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DECLARATION

I declare that this university has not previously submitted this work for the awarding of the course marks. To the best of my knowledge and belief, this work contains no material previously published or written by another person except where due reference is made.

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………………………………………….

Date:

………………………………………….

APPROVAL

The project proposal of *Hamid Abdulhakim Salim* was reviewed and approved by the following:

Supervisor Name: Mathew Thiongo

Signature: …………………

Date: ………………….

DEDICATION.

I hereby dedicate this project to my lovely parents who enabled me to pursue this diploma until the end. They have been of great contribution to my education and as a result and an appreciation I dedicate this project to them, they have also been a great source of encouragement, emotional support and they have been my pillar of strength throughout this diploma course.

ACKNOWLEDGMENT

I thank the Almighty Allah for having blessed me the miracle of life and the strength and the ability to study and the mind which understands. Special thanks to my lovely supporting parents Abdulhakim Salim and Faiza Hassan, who have instilled in me the spirit of education by the Will of Allah the Almighty, not forgetting my dear brother, sister, and cousin. A very special thanks to my strong confident father for the sacrifices that he made to see me as I studied and his powerful advice. Last but not least to my supervisor, Mathew Thiongo for tirelessly supporting me through this project. Finally, I appreciate the rest of my classmates who assisted me in any other way and I have not mentioned.

ABSTRACT

Trajectory preparation is one of the most significant focal points made by robotic manipulators in pick-and-place tasks. In today's world robotics is a fast-growing and thought-provoking field. The robot has adequate intelligent cover the maximum area of provided space. Obstacle avoidance is one of the most serious factors in the design of autonomous vehicles such as mobile robots or smart cars which lower the rate of fuel hence leads to low pollution of the environment most smart cars a small in size hence they hence prevent of incidents.

They're not going to do as much damage because of their size. With enough of these little cars on the road, the chance of hurting others is gradually diminishing. Obstacle avoidance may be divided into two parts obstacle detection and avoidance control. Numerous methods for obstacle avoidance have been suggested and research in this area of robotics is done widely obstacle avoidance robots are robots that perform desired tasks in unstructured environments without continuous human guidance. In this project, there will be the use of microcontrollers. A microcontroller is a computer-on - a-chip that can be used as an embedded system, lightweight, low-cost and self-contained. Some microcontrollers can use four-bit expressions and operate at frequencies of the clock. In many consumer electronics, automotive motors, computer peripherals, and test or measurement devices, microcontrollers are used. And these are well suited for battery applications that last for a long time. Certain systems insert the dominant part of the microcontrollers being used now for a few days. Humans came up with the development of this robot so as to minimize and lower the rate of lives lost in bomb disposal and fire extinguishing and to perform a scientific experiment that may involve hazardous chemicals that may cause injuries to humans and may even cause death.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Obstacle avoiding robot is often used to cope with hazardous operations and in an unpleasant setting involving operations. Obstacle avoiding robots can be used in multiple sectors such as aerospace, chemical engineering, construction, production and others.

One instance that requires an obstacle avoiding robot is the high-temperature environment in manufacturing procedures. Obstacle strategy to avoid is a robot action algorithm when an obstacle is detected. The resolution of the obstacle avoidance approach is to avoid the robot from any impact with any object or obstacle which may reason harm to the obstacles and the robot itself. In the aerospace industry, many robots are used in a mysterious place that has no data about the obstacle around the place whereas in manufacturing or chemical industries, raw materials, machinery, parts and merchandises are illustrations of obstacles for the robot. Therefore, preventing any damage to the component is also important.

In obstacle avoidance, obstacle detection is a significant element to choose the motion and path of the robot. For example, a robot will be increasing speed until top speed if an obstacle is far from the robot while the robot will reducing speed if the obstacle is near to it and make a turn. There was a difference in sensor or process that used for obstacle detection such as sonar sensor, image processing and others.

One of the common sensors used to detect the obstacle is the sonar sensor. The sensor detects the range between the sensor and the obstacle by conveying an endless wavelength ultrasound wave that the obstacle will reflect. The transmitter is used to direct the transmitted wave and the receiver is used to get the reflected wave. The sonar sensor does not depend on the color of the object.

Sonar sensor has a few disadvantages. The sensor of the sonar has a range of sensors. Other th an that, the environmental change will affect the sonar sensor's accuracy such as humidity and te mperature.

1.2 PROBLEM STATEMENT

Many industry sectors have been using obstacle avoiding robot or each application, and other industries are beginning to consider obstacle avoiding robot in their applications since technology has been improving recently. The obstacle avoidance system provides security for both the robot and the surrounding obstacles. This would avoid any repair costs and would not increase the cost of the robot maintenance or repair. For both obstacles and the robot, the robot deprived of obstacle avoidance will be unsafe. It can cause accidents in a critical situation that causes major losses.

The problem of moving a robot through an unknown setting over the previous two decades has drawn a lot of attention. Such issues have several difficulties and complexities that are not observed, apart from the ambiguity of how this can be accomplished as a robot may meet barriers of all types that need to be smartly bypassed. The resolution of the robot is to ease access and avoid injuries to us humans. It can be used for recording a video or take images in hazardous places where men cannot access like harsh temperatures either very cold or very hot also it will be used to take live videos in a place where there is a threat of a bomb or a fire. It will also be used in avoid damaging precious stone or minerals by seeing/sensing them as obstacles and avoiding them.it can also be used for shielding soldiers during wars from their enemies

It can also be used in making of vacuum cleaners which works autonomously.

1.3 OBJECTIVES

1. To come up with an efficient robotic system that can avoid obstacles with less or no supervision e.g. (MARS rover)
2. To program the robot to detect objects in its path and consequently turn and realign itself e.g. forthcoming humans, rocks, walls etc.
3. To reduce injuries caused to humans in hazardous experiments.

1.4 JUSTIFICATION

The robot is important it will minimize the chances of injuries and damages to our delicate bodies. This robot will make it easier for investigators to more accurately and safely get good results.

Kenya is increasing tremendously technologically as robots have become essential to human beings in most of the industries in the nation. The main advantage of my robot is that the risks which may harm humans will be avoided. The robot will make it easier for people working in hazardous areas to get and work better without fear of injuries.

Automation of this development will save on a lot of time and will decrease the loss and injuries of humans.

1.5 SCOPE OF THE STUDY

This project will be referred to as ‘HAZARDOUS ENVIRONMENT ROBOT’. It will be mostly used in industries and people who disarm bombs in Kenya, the robot will add to the safety of humans.

CHAPTER 2: LITERATURE REVIEW

2.1.1 DEFINITION OF ROBOTICS

Robotics is an engineering division that involves robots planning, designing, manufacturing and running. Electronics, computer science, artificial intelligence, mechatronics, nanotechnology, and bioengineering overlap this area.

2.1.2 HISTORY OF ROBOTICS

From the very beginning, the concept of "robot" was confusing. The term first appeared in 1921, in the play R.U.R. by Karel Capek, or the Universal Robots by Rossum. "Robot" comes for "forced labor" from the Czech Republic. However, these robots were more religious than shape robots. They looked like humans, and they were made of chemical batter instead of being made of iron. The robots were much more powerful than their human counterparts, as well as much more murdering they ended up on a spree of killing.

The trope of the Not-to-Be-Trusted Computer (e.g., Terminator, The Stepford Wives, Blade Runner, etc.) that persists to this day would be developed by R.U.R. — which does not mean that pop culture has not accepted it.

The real-world "robot" concept is just as slippery as the fictional depictions. Ask 10 robotics and you will receive 10 responses. Yet some basic rules are agreed upon: a robot is a smart, physically embodied machine. A robot can carry out tasks independently. And the world can be sensed and controlled by a computer.

2.1.3 ADVANTAGES OF ROBOTICS

Recent developments in the field of robotics have made robots more user-friendly, smarter, and most of all affordable. It is no wonder with these advantages of robotics that they have found employment in every area. That's right, robots are being used from industrial manufacturing to the medical field.

The robot's advantages have improved their mobility by being able to perform a variety of tasks and applications. They're more accurate and consistent than human workers. Because they can complete tasks faster, robots also allow increased production and profit margin. Robots are able to work around the clock as they don't need holidays, sick days, or breaks. Animals also make fewer mistakes than people, saving time for businesses.

The advantage of robotics is that they can work in any environment, bringing versatility to their work. Robots remove dangerous jobs for people because they can operate in unsafe conditions. Heavy loads, toxic substances, and repetitive activities can be treated by them. It helped businesses avoid a lot of injuries, saving time and money as well.

Robots are used in complex procedures such as prostate cancer surgery in the medical field. Robots can reach and match where human hands are unable to do so, allowing for greater precision. Many robotic advantages are less invasive procedures in the medical field and less discomfort in rehabilitation for the patient.

The benefits of robots have opened the door in many areas for their use. Their versatility ability allows companies the flexibility to use them for a variety of tasks.

2.2 COMPONENTS AND DEVICES REVIEW.

2.2.1 Ultrasonic sensor (HCSR-04)

The module Ultrasonic Sensor (HCSR-04) is a low-cost, high-performance sensor that offers stable and high precision. It ranges from 2 cm to 350 cm with a precision of 3 mm. Ultrasonic transmitter, receiver and control circuit are included in the package. The unit with a microcontroller is relatively inexpensive, reliable and easy to navigate. The versatility of HC-SR04 makes it ideal for the design of object detection and avoidance schemes.

Figure 1

2.2.2 BASIC ULTRASONIC SENSOR OPERATION

Ultrasonic sensors use a vibrating system known as a transducer to emit ultrasonic pulses which are determined by the transducer's frequency by moving on a cone-shaped beam array. As the frequency increases, sound waves transmit for increasingly shorter distances, whereas sound waves transmit for slowly longer distances decreases when frequency decreases.

Ultrasonic transmitter–transducer is used to generate ultrasonic waves before transmitting the ultrasonic wave. A signal is provided to the transducer to produce ultrasonic waves intermittently. The ultrasonic transmitter then sends the waves forward at a fixed frontal range. Depending on the range of ultrasonic sensors used, the maximum range for which obstacle can be detected

Ultrasonic receiver–If the obstacle is detected by the ultrasonic wave, a reflected wave will be formed. To absorb the ultrasonic waves emitted from the barrier, an ultrasonic receiver is used. Using a transducer, the transmitted ultrasonic wave is converted into a receiving signal. An amplifier (operational amplifier) amplifies the signal. Compared to the reference signal, the amplified signal is used to detect components in the amplified signal due to road obstacles.

2.2.3: Microcontroller

A microcontroller is a compressed combined circuit designed in an embedded system to control an exact operation. A typical microcontroller comprises peripherals on a single chip of a processor, memory and input/output (I / O). Often referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are used in cars, robots, office equipment, medical strategies, mobile radio transceivers, vending machines and home appliances among other items.

2.2.3.1: Microcontroller Features

The processor of a microcontroller varies by application. Choices range from simple 4-bit, 8-bit or 16-bit processors to 32-bit or 64-bit processors that are more complex. Microcontrollers are able to use random access memory (RAM), flash memory, EPROM and EEPROM in terms of memory. Microcontrollers are mostly intended to be user-friendly without external computing components since they are equipped with enough onboard memory and provide pins for general I / O operations so that they can communicate directly with sensors and other components.

Microcontroller architecture can be built on architecture from Harvard or architecture from Neumann, each contributing unlike methods of data exchange between processor and memory. The data bus and instruction are isolated from a Harvard architecture, allowing simultaneous transfers. With the architecture of Von Neumann, one bus is used for data as well as for instructions.

Processors for microcontrollers can be established on complex computing instruction set (CISC) or condensed computing instruction set (RISC). CISC typically has approximately 80 instructions, while RISC has approximately 30, as well as more modes of addressing, 12-24 compared to 3-5 RISC. Whereas CISC can be easier to instrument and use memory more efficiently, due to the complex number of clock cycles required to execute instructions, it can have performance deprivation. RISC, which places more stress on software, often delivers better performance than CISC processors, which put more stress on hardware due to its simpler instruction set and thus improved design simplicity, but software can be more complex due to the importance it places on software. Depending on use, which ISC is used differs.

To instrument peripheral functions, MCUs feature input, and output pins. These include analog-to-digital converters, LCD controls, real-time clock (RTC), synchronous/asynchronous receiver (USART), timers, universal asynchronous receiver (UART) and universal serial bus (USB) communication. Microcontrollers are also often connected to sensors that collect data connected to humidity and temperature, amongst others.

Microcontroller types Popular MCUs include the Intel MCS-51 also referred to as the 1985 first produced 8051 microcontrollers; the Atmel AVR microcontroller established in 1996; Microchip Technology programmable interface controller (PIC); and numerous approved ARM microcontrollers.

Several firms, including NXP Semiconductor, Renesas Electronics, Silicon Labs, and Texas Instruments, manufacture and sell microcontrollers.

2.2.3.2: Microcontroller applications

Microcontrollers are used in a variety of industries and applications, including home and business, building automation, engineering, robotics, motorized, lighting, smart power, industrial automation, infrastructures and deployments on the Internet of Things (IoT).

The modest microcontrollers allow the operation of electromechanical systems used in convenience items of daily use, such as ovens, refrigerators, toasters, mobile devices, key fobs, video games, televisions, and lawn watering systems. In-office machines including photocopiers, scanners, fax machines and printers, as well as smart meters, ATMs and security systems, are also popular.

In ships, spacecraft, ocean-going boats, tanks, medical and life-support devices, and robots, more advanced microcontrollers achieve critical functions. The functions of an artificial heart, kidney or other organs can be controlled by microcontrollers in clinical scenarios. In the operation of prosthetic limbs, they can also be instrumental.

2.2.3.3: **Microcontrollers Vs Microprocessor**

The difference between microcontrollers and microprocessors has become less clear as chip density and complexity have become relatively cheap to manufacture and therefore microcontrollers have integrated more "general" functionality types. All in all, however, microcontrollers can be said to operate on their own, with a direct connection to sensors and actuators, where microprocessors are designed to exploit computing power on the chip, with internal bus connections (rather than direct I / O) to support hardware such as RAM and serial ports. Put simply, microcontrollers are used by coffee makers; microprocessors are used by desktop computers.

Microcontrollers are cheaper than microprocessors and use less power. Microprocessors have not built on the chip in RAM, read-only memory (ROM) or other peripherals, but have their pins attached to them. A microprocessor can be considered the core of a computer system, whereas the core of an embedded system can be deliberated as a microcontroller.

2.2.3.4: Choosing a microcontroller

When selecting a microcontroller for a project, there are a number of technology and business thoughts to keep in mind.

In addition to cost, consideration should be given to the extreme speed, amount of RAM or ROM, and number or types of I / O pins on an MCU, as well as power intake and constraints and support for development.

2.2.4: Introduction to Arduino Uno REV3

A microcontroller board based on the ATmega328 is the Arduino Uno. It has 20 digital input/output pins, a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP header and a reset button (of which 6 can be used as PWM outputs and 6 can be used as analog inputs). It contains all the microcontroller needs to support; just connect it to a computer with a USB cable or power it to get started with an AC-to-DC adapter or battery.

This board comes with two voltage regulator i.e. 5V and 3.3V which gives the flexibility to regulate the voltage according to the requirements compared to Arduino Pro Mini which comes through only one voltage regulation. There is no important modification between Arduino Uno and Arduino Mega excluding that additional memory space, larger size and more I / O pins are added later. Arduino code called Arduino IDE is used to program the board that is widely used for all boards that belong to the Arduino community. Atmega16's flexibility on the board makes it unlike from Arduino Pro Mini's programming board using USB to serial converter. There are a reset button and 4 serial hardware port called USART providing a maximum speed for communication set-up.

The Uno differs from all previous boards in that the FTDI USB-to-serial driver chip is not included. Instead an ATmega16U2 programmed as a USB-to-serial converter is featured. This auxiliary microcontroller has its own USB bootloader, allowing it to be reprogrammed by experienced users.

The Arduino has a wide support group and a comprehensive collection of 'shields' support libraries and hardware add-ons (e.g. with our Wixel shield, you can easily render your Arduino wireless), making it a great embedded electronics introductory tool. Notice that we also sell a SparkFun Inventor's Kit, which includes an Arduino Uno along with a variety of components that make it possible to build a number of fun introductory projects e.g. breadboard, sensors, jumper wires, and LEDs).

This is the 3rd Uno (R3) revision, which has a variety of changes:

The USB controller chip was moved to ATmega16U2 (16K flash) from ATmega8U2 (8K flash). The flash or RAM available for sketches is not increased by this.

Three new pins, all of which are duplicates of previous pins, have been added. Also on the side of the board near AREF, the I2C pins (A4, A5) were brought out. Next to the reset pin, which is a copy of the 5V pin, there is an IOREF pin. When a shield is used the reset button is now next to the USB connector, making it more available.

Figure 2

2.2.4.1Pin description

Below is the Arduino Uno R3 pin diagram. It consists of I/O pins with 14 digits. 6-pins such as PWM outputs may be used from these pins. This board consists of 14 optical input/output pins, Analog inputs-6, USB connection, 16 MHz quartz crystal, power jack, USB connection, 16 MHz resonator, power jack, RST button and ICSP header.

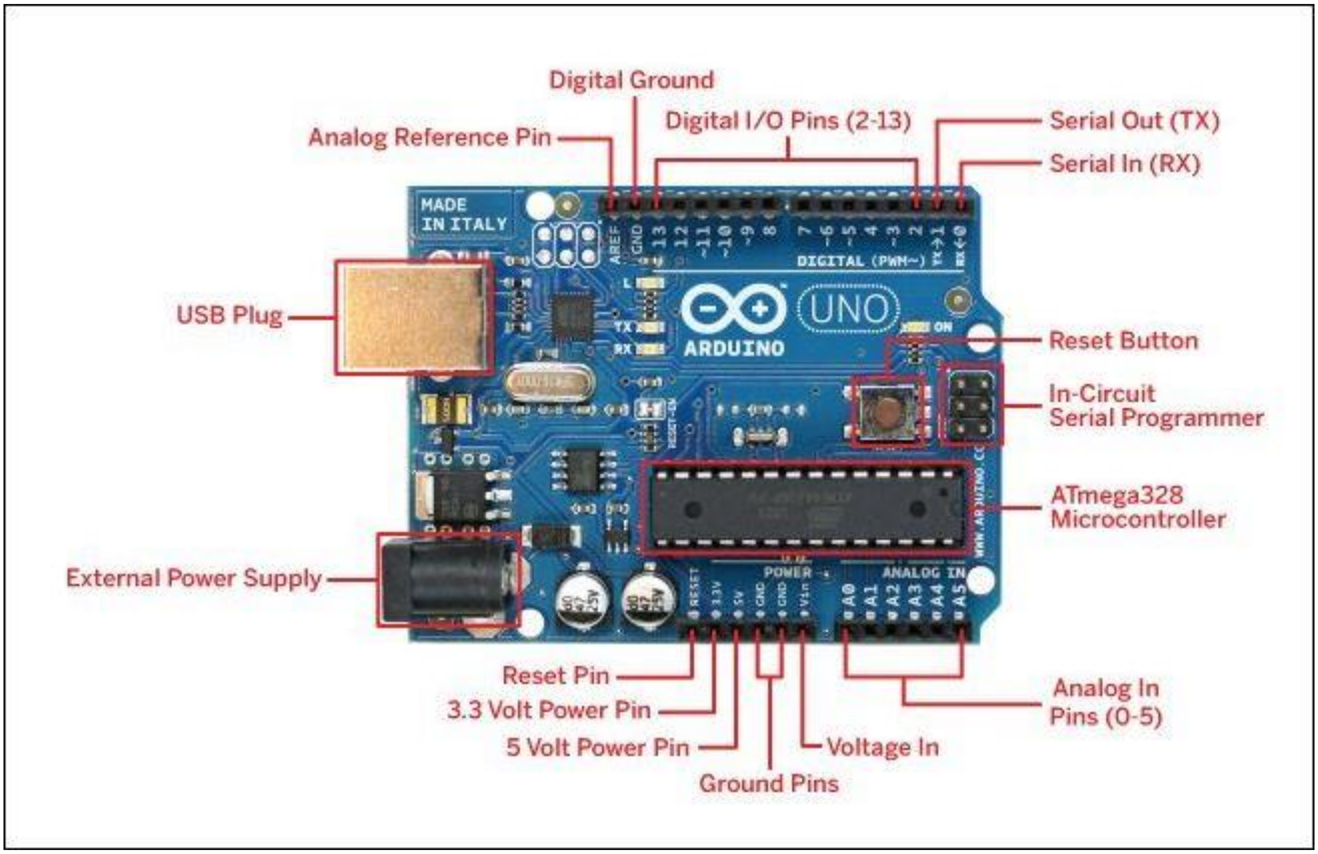

Figure 3

Power supply

Otherwise the power supply of the Arduino can be accomplished with the aid of an external power supply USB link. A battery or an AC to DC converter is primarily used in the external power supply (6 to 20 volts). An adapter can be attached by plugging a center-positive plug (2.1mm) into the board's power jack. The battery terminals can be placed on both the VIN and GND pins. The following include the power pins of an Arduino board.

VIN: Input voltage or VIN to the Arduino by using an external power supply opposite the USB or other RPS (Regulated Power Supply) link volts. One can supply the voltage by the use of this screw.5Volts: The RPS can be used to provide the microcontroller with the power supply as well as the modules that are used on the Arduino board. Via a regulator, this can approach from the input voltage.

3V3: With the onboard regulator, a 3.3 supply voltage can be produced and the highest draw current will be 50 mA.

GND: Pins GND (ground)

Memory

The memory of the ATmega328 microcontroller consists of 32 KB and 0.5 KB of memory used for the boot loader, as well as SRAM-2 KB and EEPROM-1 KB.

Input and Output

We know that an Uno R3 statement contains 14 digital pins that can otherwise be used as an input output using functions such as pin mode (), digital read (), and digital write (). These pins can work with 5V, and each digital pin can give or receive 20 mA, and includes a pull-up resistor of 20k to 50k ohm. The maximum current on any pin is 40mA, which cannot be exceeded to prevent damage to the microcontroller. In addition, particular functions include some of the pins of an Arduino.

Serial Pins

TX (1) and RX (0) pins are the serial pins of an Arduino board and these pins can be used to transfer TTL serial data. The equivalent pins of the ATmega8 U2 USB to TTL chip can be used for connecting these pins.

External Interrupt Pins

The board's external interrupt pins are 2 & 3, and these pins can be arranged to activate an interrupt on an upward falling edge, otherwise a low-value change in value.

PWM Pins

The Arduino's PWM pins are 3, 5, 6, 9, 10, & 11 and offer an 8-bit PWM output with an analog Write () feature.

SPI (Serial Peripheral Interface) Pins

The SPI pins are 10, 11, 12, 13, namely SS, MOSI, MISO, SCK, and with the aid of the SPI library, these will preserve the SPI contact.

LED Pin

With an LED using digital pin-13, an argument board is integrated. The LED will glow if the digital pin is high, otherwise it will not glow.

TWI (2-Wire Interface) Pins

SDA or A4, & SCL or A5 are the TWI pins that can enable TWI communication with the aid of the Wire Library.

AREF (Analog Reference) Pin

The reference voltage to the inputs of an analog i/ps using a feature such as analog reference () is an analog reference pin.

Reset (RST) Pin

This pin provides a low line to reset the microcontroller, and it is very handy to use a RST button for shields that can block the one on the Arduino R3 board.

Communication

The Arduino Uno communication protocols include serial communication with SPI, I2C, and UART.

UART

The Arduino Uno uses all features, such as the digital transmitter pin1 and the digital receiver pin0.0. In UART TTL serial communication, these pins are primarily used.

I2C

An Arduino UNO board uses SDA pin otherwise A4 pin & A5 pin otherwise SCL pin is used for wire library I2C communication. The SCL and SDA are both CLK signal and data signal in this.

SPI Pins

MOSI, MISO, and SCK are part of the SPI interaction.

Pin11 (MOSI)

This is the slave master in the pin, used to transfer the data to the computers.

Pin12 (MISO)

This pin is a serial CLK, and the CLK pulse synchronizes the transmission that the master produces from it.

SCK (Pin13)

The CLK pulse synchronizes the transmission of data that the master produces. Equivalent pins are used for SPI contact with the SPI library. To program the ATmega microcontroller directly with the boot loader, ICSP (in-circuit serial programming) headers can be used.

2.2.4.2:Application of Arduino Uno REV3

Arduino Uno rev 3 is a best choice for projects that involve more memory space to be used on the board with number pins. The Arduino super boards ' core applications follow.

- Mounting 3D printer
- Governing and conduct more than one motors
- Interfacing of number of sensors
- Sensing and detecting temperature
- Water level detection projects

- Home automation and security systems
- IoT applications
- Parallel programming and Multitasking
- Embedded systems

2.2.5: L293D MOTOR SHIELD

Characteristics:

· 2 connections for 5V 'hobby' servos connected to the high-resolution Arduino's

No jitter - dedicated timer!

· Up to 4 bi-directional DC engines with individual 8-bit speed selection (approximately 0.5 percent resolution)

· Up to 2 single-coil, double-coil, interleaved or interleaved stepper motors (unipolar or bipolar) with micro-stepping.

· 4 H-Bridges: The L293D chipset offers thermal strength of 0.6A per bridge (1.2A peak) Shutdown defense, 4.5V to12V • Down resistors hold engines disabled during shutdown. Power-Up.

Wide terminal block connectors for easy connection of cables (10-22AWG) and electricity. Arduino reset button highlighted at the top

2-pin external power link terminal block, for separate logic/motor supplies

· Super, UNO & Duemilanove compatible tested

· Dimensions: 2.7in x 2.1in x 0.6in (69mm x 53mm x 14.3mm)

The L293D is a dedicated module suitable for Arduino UNO R3 and Arduino R3 boards MEGA.
It's basically a motor driver shield that can be used with full Arduino Shield features.

L203D is an integrated monolithic with a feature for high voltage, high current adoption. Four-channel motor driver for the acceptance of loads such as relays, solenoids, DC engines and Stepper Motors and power transistor switching. Simplifying the use of two bridges on each Pair of channels and fitted with inputs available. A separate input to the supply is given for the logic makes operating at a lower voltage and requires internal clamp diodes.

The unit is suitable for use at frequencies of up to 5 kHz in switching applications. THE L293D is assembled in a plastic box of 16 leads with 4 center pins linked together. And used for the sinking of heat. In a 20 lead surface mount that has 8, the L293D is mounted. Center pins are related and used for heat shrinking.

In particular, cheap motors need more energy because chip motors are less powerful. The important thing you need is to figure out what voltage you will need to use. Any tiny ones Engines are only designed to operate at 1.5 volts, but having 6 ~ 12v motors is just a normal one.

The motor controller is designed to operate from 4.5v to 25v on the L294D shield. Maximum 1.5 ~ 3 volts

The motor on this shield won't work. Another thing you need is to find out how much you need to know.

Will the existing engine help it? Up to 600 mA per motor is provided by the L293D chip, with 1.2A

Present of max. Notice that you would probably want to put a heat sink on the heat sink going towards 1A

Chip, otherwise the chip will have thermal failure or burn out.

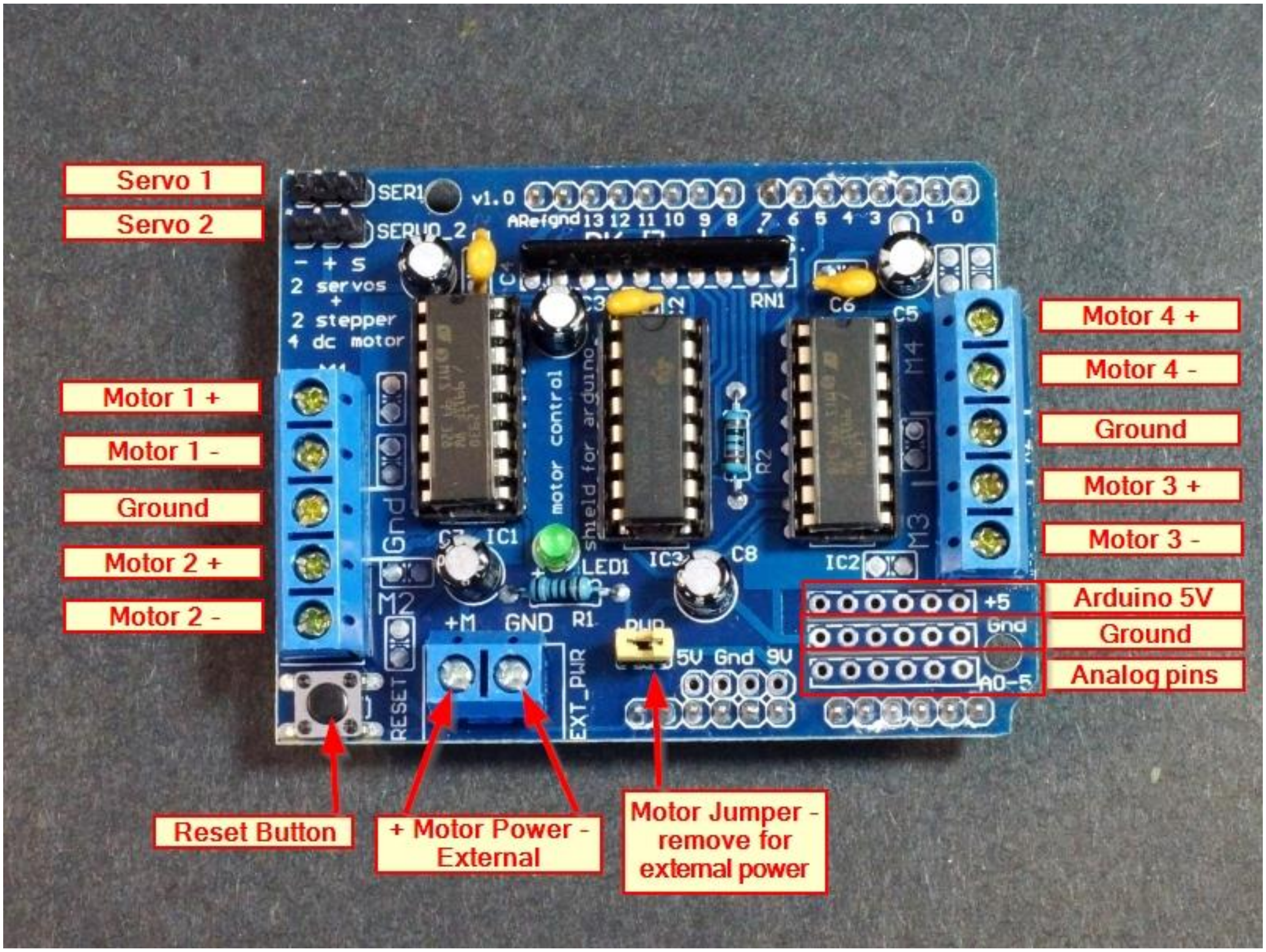
Servo 1
Servo 2
Motor 1 +
Motor 1 -
Ground
Motor 2 +
Motor 2 -
Motor 4 +
Motor 4 -
Ground
Motor 3 +
Motor 3 -
Arduino 5V
Ground
Analog pins
Reset Button
+ Motor Power -
External
Motor Jumper -
remove for
external power

Figure 4

CHAPTER 3: METHODOLOGY

3.1: SYSTEM ANALYSIS

System analysis can be defined as the method of examining a technique or business in order to single out its objectives and motive and produce systems and courses of action that will accomplish them in an organized way. One more view sees system analysis as a problem resolving method that breaks down a system into its component pieces for the determination of studying how well those component parts work and cooperate to achieve their purpose.

3.2: STAGES OF SYSTEM ANALYSIS

System analysis has four stages that are:

1. Investigate and analyze the current system on the market or organization.
   - Currently, most industries and police forces use humans to do hazardous obligations (eg.in industries humans enter highly toxic places and police forces use humans to disarm bombs). However, the use of this robot will help prevent injuries.
2. System requirements determination
   - The system that I am currently working on requires the following components that are:
     - An Arduino UNO (microcontroller)
     - Ultrasonic sensor -HC-SR04
     - Motor shield
     - Geared motor(*2)
     - Robot chassis
     - Battery connector
     - Battery holder
     - Power supply

3. The third step is configuring and structuring the requirements

4. The final step is selecting the best alternative design strategy System analysis includes the following steps

Define the problem In the market

Define the new system's requirements

Prioritize requirements

Conduct a feasibility study

3.3: FEASIBILITY STUDY

A feasibility study or an achievability study is an extensive report that looks at in detail the five casings of examination of a given task. It additionally thinks about its four Ps for example plan, procedure, individuals, and power, its dangers and its limitations are (schedule, expenses, and standards of value). The objective is to decide if the undertaking ought to proceed, be updated, or else relinquished out and out. Project managers use feasibility studies to discern the pros and cons of undertaking a project before they invest a lot of time and money into it.

There are 4 main types of feasibility study that I will be using in my project. They include schedule feasibility, technical feasibility, economic feasibility and organizational feasibility

3.3.1: SCHEDULE FEASIBILITY

Schedule feasibility means judging how extensive the project or system will take to be developed. And to see if it can be finished within a given time, therefore the allocated Time for undertaking this project is three months. Which is enough time to finish the project proposal

Figure 3.1

3.3.2: TECHNICAL FEASIBILITY

A technical feasibility investigation evaluates the details of how you will bring a product or service i.e. technology needed. Technical feasibility is an effort to study the project mostly from a technician's angle. It involves whether the problem can be solved with the help of computers and to what extent.

3.3.3: ECONOMIC FEASIBILITY

Economic feasibility means that the project advantages put forward system prevails over the approximate cost. Usually look at the *total cost of ownership* (TCO), which incorporates ongoing support and keeping cost, as well as purchase cost. To specify the (TCO) the analyst must calculate the cost of license and fees, consulting expenses and software. All the resources I am going to use during the development are free sources.

3.3.4: TIME FEASIBILITY

It address the time it will take to complete the project taking into thought out there resources and extra resources needed if any. Gantt charts are used for planning projects of all sizes and they are a useful way of showing what work is scheduled to be done on a specific week. I have used a Gantt chart to illustrate the time needed to completely develop the system.

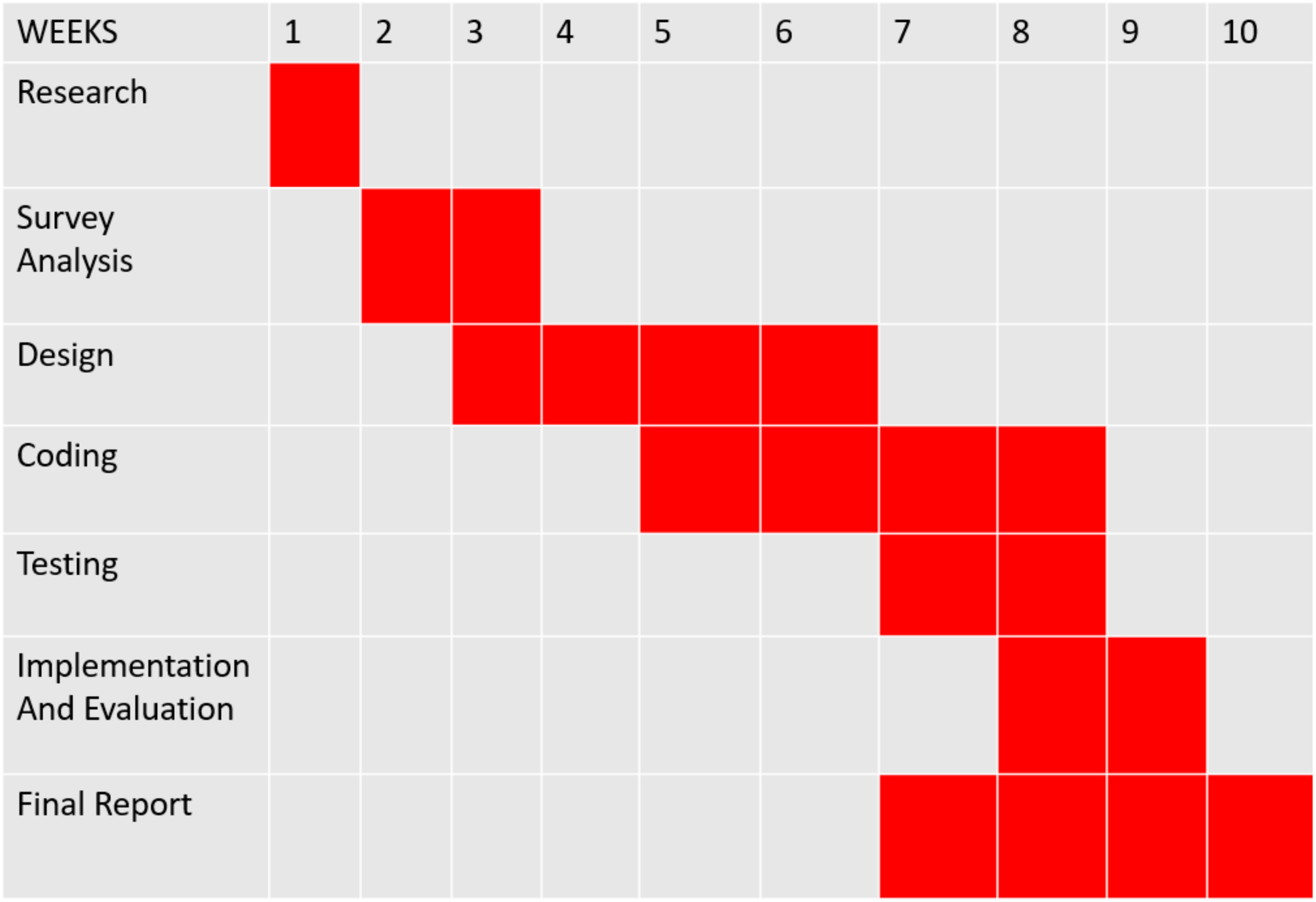

Figure 5

3.4: REQUIREMENT ELECTION

Requirement election is concerned with learning and comprehension of the needs of users and project backers with the fundamental aim of communicating these needs to the system developer. Techniques that can be used are interviews, questionnaires and journals internet. (Morrill, 2013).

3.4.1: SECONDARY DATA

Secondary data is the data that has been collected by others. They are normally in magazines, periodical dailies, research publications and office archives. Secondary data may be accessible in the published or unpublished form.

CHAPTER 4: IMPLEMENTATION AND TESTING

This process illustrates the chronological stages of the hardware product development process in this case being the Robotic system. This development process is used for a typical medium to high volume consumers electronic. Below are the stages of implementation and testing:

4.1: EARLY ARCHITECTURE AND ENGINEERING PROTOTYPING

This stage is characterized by mechanical embedded engineering which majorly involves cable a harness development. Firmware is highly dependent on presence of a custom embedded platform. Industrial design and software engineering also plays a huge to ensure that every aspect works together to form a fully integrated prototype with viable production intent. In this stage matters such as market receptiveness and technical feasibility should be addressed. The Design for Manufacturing (DFM) should also be incorporated at this point as the engineering development work is through at this stage. 1 to 5 prototypes are needed at this phase and since it is a first generation design there are bound to be issues therefore there is need for redefinition of the machine's design among other things. The main of these prototypes is to prove the efficiency of the technology behind the scientific concept. The prototype generated during this phase somewhat work like the final product but they're nothing like the final product. Another work in progress should be the early stage user experience and foam exploration essential for industrial design this helps drive system architecture decisions if and when they move on to the stage. Another key feature in this stage is the primary market research as well as other future stages more precisely discovery research which determines who the customers are and what their wants and needs entail and product research which determines if the proposed solution is effective and efficient to its targeted end users as well as the economic market at large. There should be an integration between the Mechanical Engineering (ME), Electrical Engineering (EE), Firmware (FW), Device Software (DS) and Industrial Design (ID) in a bid to create PCBA sensors firmware software interaction cable and mechanical housing. During this stage suppliers and vendors are to be contacted in order to analyze logistics and sort out the supply of components and various materials. Testability and build ability are also to be into consideration at the plant/factory. Validation and testing at the component level is conducted over and over as well as at an integrated level. This is to determine if the features can be able to be implemented in such a way that it is right for marketing. The methods. This is to determine if the features implemented at this stage are 3-D printing, rapid prototyping, PCB fabrication and the assembly a few boards.

Most importantly, there should be a perspicuous gate review at the end of this stage to decide if there is enough viability to proceed to the next stage. This gate is known as the Basis for development gate. This gate is part of a phase gate process — a project management technique whereby a project is divided into several patent stages or processes. The said gate helps to answer the following, questions:

• Is the proposed idea technically feasible from an engineering point of view?

• Is it economically feasible, taking into account cost, time and quality?

• Is the market research in support of the case to move forward?

• Are compact technical and functional specifications present?

4.2. ENGINEERING VERIFICATION TEST (ENT)

Also known as the pre-production prototype build, this is a design recapitulation of the engineering prototype which aims to address a number of issues during the product assembling, system integration and testing of the first generation engineering prototype. By the end of this phase, a clear gate should be established with the aim of showing the demonstration of the verification build, ability to review findings from various field tests as well as early durability tests, and make the final go/no-go decision to discharge the design to manufacturing. This process is known as the Basis le Production gate. This gate needs careful consideration; this is because it is the cusp point where the program takes a shift from an engineering concentration to a production/manufacturing concentration. During this stage, proprietorship often shifts from the engineering department to operations and manufacturing department, since the prototype is about to be more than just an ideation. At this point, inclusion of the supply chain will be paramount as is the cow Manufacturer. Moreover, limitation of the engineering advancement and prototyping costs is noted. The following questions are to assist in the development of this stage:

- Has the robotic system been steadfastly tested and does it work?
- Is the robotic system set Design for Manufacturing (DFM)?
- By the time this stage is complete will the design will the design by ready to be barred?
- What Beta/User testing mechanisms deployed may have some bearing on the design and features?
- Are there any changes that will be made on the product development and marketing?

During this stage 30-50 units should be made, where the focus is on assembly, testing and its integration. An active thought should be the manufacturing and sourcing for much larger quantities. Design for Manufacturing (DFM) should commence as well and the tooling release for Mechanical engineering also happen by the end of this stage. However, it is to be dully noted that

ME takes place on a different schedule from the development. It is required to be a step ahead because the Lead Times (LT) for tooling are quite long. The Contract Manufacturer ma also get involved to give input on the engineering design, techniques of manufacturing as well as sourcing for the Bill of Materials(BOM). By the end of this phase, the said units should be able to exemplify the final product intended in terms of function, form and surface identification i.e. finish, color and texture.

4.3 MANUFACTURING PHASE 1 - DESIGN VERIFICATION TEST (DVT)

This occurs at the Contract Manufacturer's (CM) site. The parts to be used in the Design Verification (DV) build should ostensibly be physically identical to the Engineering Verification (EV) build. However, the difference comes in when the EV build is archetypally assembled by in house staff and the DV build is assembled by the CM's staff. Some prototyping techniques are still applicable during this stage, because the tooling cycle takes several months. Also, fully tooled parts are not usually ready by the time the DV build is in need of assembling. Therefore some early parts may come in just on time for the said build. The primary intent for the DVT is to edify the contract manufacturer on how to build the robotic system, in turn identifying any DFM delinquencies so that they can be addressed. Minimal differences should be noted between the EV and the DV. The following are some of the activities unique to the DVT stage:

• The CM takes advantage Of this experience to work on process development where the focus is on making identical products but with high output quality- this why the design should remain the same from the stage onwards with minor changes that are tightly controlled and documented

• The DVT stage allows time to manufacture assembly fixtures as well as any other subsequent test fixtures not forgetting the manufacturing test and relevant calibration software needed for the building process.

In conclusion of the DV stage, there is need for a product Verification readiness gate review. At. This Point, the manufacturing test systems, engineering design as well as the manufacturing processes are scrutinized in order to proceed to the next stage, which is the production stage.

4.4 MANUFACTURING PHASE 2 — PROCESS VERIFICATION TEST (PVT)

This also occurs at the Contract Manufacturer's (CM) site where the Manufacturing processes axe tested out by the Fry build. At this point, verification of all the function requirements, cosmetic an appearance requirements is done. This stage tests the manufacturing capability and the development of factory Tine processes created during EVT and PVT. Therefore, no engineering changes should be implemented from EVT to PVT. This PV build involves parts created via the final manufacturing process, since those processes are needed to create high. Quality parts which ate a valuable fit. Depending on the anterior stages, this current stage could be as short as a few weeks or even as long as a few months. Once this stage is comprehensive, a final gate review is conducted where the decision to move into mass production is made. The following are activities that to place during this phase:

• Approximately 200 to 500 units are to be created during the production process.

• Strictly NO engineering changes because this phase is all about process optimization.

• Give serious attention to any issues that come up along the factory line

. • Thoroughly review and refine the QC DOC as well as update the document to synopsis of the quality expected and currently undergoing execution on the line.

•The units created in this stage should be identical to the MP units except maybe the product label.

• By the completion of this stage, regulatory testing should be done so that the right certification marks and numbers can be included in the production labels.

• Ensuring that that logistics are ready for shipment from the factory to the warehouse.

4.5 MANUFACTURING PRASE 3 — MASS PRODUCTION (MP)

This is the final stage of the hardware development process, whereby from here in the next 9 months are spent on sustainability in order to stabilize the product on the manufacturing line, with the aim of achieving high quality of output. A lot of "infant mortality" issues have occurred by now both the early processes well as the design. Besides these minor issues one major issue is likely to be faced is the low incidence effects. Mitigation methods have to be put in place because with such an issue, it will be months before any defect is characterized. However this is a normal occurrence and very much expected. The following are potential issues to be encountered during this last straw:

• The factory may not pay attention to the needed QC requirements, someone is needed on the ground to ensure they are trained to follow the requirements

• There may be a mismatch between the serial numbers on the product and packaging box which maybe be disastrous to inventory tracking.

•Older and new inventory revisions can get mixed up with the newer versions.

• An increase in PCBA production quantities may lead to issues such as soldering crooked parts.

• Mistakes can be made by new operators (OPs) on the factory line and their supervisors may not be paying attention.

4.6 RESULT OF PRODUCT

During the project, the following resulted were generated:

• The prototype was able to avoid obstacles (using the C code).

• It was also able to detect any obstacles within the path range, consequently make a 180° turn and realign itself to a path with no obstacles.

CHAPTER 5. CONCLUSION.

5.1 CONCLUSION AND FURTHER RESEACH

Automated and robotics systems are said to only exist in developed countries and not in non-developing countries. However with the Big 4 agenda created by the current government as a leeway for development in various sectors manufacturing is at the forefront of the agendas. This robotic system will therefore assist in achieving the nation's goals and increase efficiency and sustainability in the manufacturing industry. This project will at its best make the manufacturing industry more organized and safe for the employees. Moreover I will work at my best to solve all the problems stated in chapter 1 and also justify the objectives stated. I believe that this research will be fundamental in the country's vision 2030 matters information technology and it will aid in increasing Kenya's industry market by leaps and bounds.

5.2SHORTCOMINGS

The following are shortcomings that may have prevented the prototype from attaining its optimum potential:

• Lack of sufficient hardware tools e.g. faulty sonar sensor which is meant to detect an object in its path

• Improvisation of wiring which would tend to interfere with the overall working of the system. This in turn led to poor cable management as well as fear of short-circuiting.

• The battery produced too much power for the low power' motors which became a challenge during navigation.

- Errors with the coding which was a setback and discouraging and also a motivation to try harder.

5.3 FUTURE RECOMMENDATIONS

This project will impact the manufacturing sector since it provides streamlined and labor saving services. More research can still be done to make the system much better. Some of them include:

1. Formulate tax laws to govern the use of robotic systems, and to ensure workers of job security.
2. The system can also further be enhanced to enable real-time manufacturing and production.
3. Training of personnel from these factories to handle robotic systems.
4. Using eco-friendly parts and ways to take care of the environment as well as be sustainable.

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LIST OF FIGURES

LIST OF TABLES

Appendix

```
#include <AFMotor.h> //import your motor shield library

#define trigPin 12 // define the pins of your sensor

#define echoPin 13

AF_DCMotor motor1(1,MOTOR12_64KHZ); // set up motors.

AF_DCMotor motor2(2, MOTOR12_8KHZ);


void setup() {

  Serial.begin(9600); // begin serial communitication

  Serial.println("Motor test!");

   pinMode(trigPin, OUTPUT);// set the trig pin to output (Send sound waves)

  pinMode(echoPin, INPUT);// set the echo pin to input (recieve sound waves)

  motor1.setSpeed(105); //set the speed of the motors, between 0-255

motor2.setSpeed (105);

}


void loop() {


   long duration, distance; // start the scan

  digitalWrite(trigPin, LOW);

  delayMicroseconds(2); // delays are required for a succesful sensor operation.

  digitalWrite(trigPin, HIGH);


  delayMicroseconds(10); //this delay is required as well!

  digitalWrite(trigPin, LOW);

  duration = pulseIn(echoPin, HIGH);

  distance = (duration/2) / 29.1;// convert the distance to centimeters.

  if (distance < 25)/*if there's an obstacle 25 centimers, ahead, do the following: */ {
```

```
  Serial.println ("Close Obstacle detected!" );
Serial.println ("Obstacle Details:");
Serial.print ("Distance From Robot is " );
Serial.print ( distance);
Serial.print ( " CM!");// print out the distance in centimeters.

Serial.println (" The obstacle is declared a threat due to close distance. ");
Serial.println (" Turning !");
   motor1.run(FORWARD);  // Turn as long as there's an obstacle ahead.
   motor2.run (BACKWARD);

}
 else {
  Serial.println ("No obstacle detected. going forward");
  delay (15);
  motor1.run(FORWARD); //if there's no obstacle ahead, Go Forward!
   motor2.run(FORWARD);
  }

}
```