DESIGN AND IMPLEMENTATION OF A ROBOTIC VACUUM CLEANER SYSTEM

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DESIGN AND IMPLEMENTATION OF A ROBOTIC VACUUM CLEANER SYSTEM

BY

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APPROVAL

This project report has been approved for the acceptance by the Mechatronics Engineering department, Federal University Oye-Ekiti, Ekiti state and meets the regulations governing the award of the Bachelors of Engineering of FUOYE.

By

Supervisor	Head of Department
Name: _____	Name: _____
Signature: _____	Signature: _____
Date: _____	Date: _____

External examiner

Name: _____

Signature: _____

Date: _____

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LIST OF ABBREVIATIONS

RVC	-	Robotic Vacuum Cleaner
DC	-	Direct Current
HMI	-	Human Machine Interface
CPU	-	Central Processing Unit
I/O	-	Input and Output
GUI	-	Graphical User Interface
USB	-	Universal Serial Bus
IR	-	Infrared radiation
IDE	-	Integrated Development Environment
V	-	Voltage
IC	-	Integrated Circuit
AVR	-	Alf and Vegard's
RISC	-	Reduced Instruction Set Computer
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
SRAM	-	Static Random Access Memory
A/D	-	Analog to Digital converter
CFM	-	Cubic Feet per minute
VCC	-	Voltage at the common collector

ACKNOWLEDGEMENT

The satisfaction and euphoria on the successful completion of any task would be incomplete without mentioning the people who made it possible whose constant guidance and encouragement crowned out effort with success.

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This acknowledgement would not be complete without expressing my sincere gratitude to my parents and sister for their love, patience, encouragement, and understanding which are the source of our motivation and inspiration throughout the work.

ABSTRACT

Households of today are becoming smarter and more automated. Home automation delivers convenience and creates more time for people. Domestic robots are entering the homes and people's daily lives, but it is yet a relatively new and immature market. However, a growth is predicted and the adoption of domestic robots is evolving. Several robotic vacuum cleaners are available on the market but only few ones implement cleaning of floors. The purpose of this project is to design and implement a robotic vacuum cleaning device to make cleaning process become easier rather than by using manual vacuum. The main objective of this project is to design and implement a vacuum robot prototype by using ATMEGA 328P, Motor driver L298D, Ultrasonic Sensor and to achieve the goal of this project. Robotic vacuum cleaner will have several criteria that are user-friendly.

DEDICATION

To GOD Almighty and to my beloved parents, Mr. and Mrs Olafare for their love, sacrifices and unconditionally support in my life.

To my siblings and friends who helped me to prepare and complete this report.

And much love to our lecturers who have given much guidance to us without expecting any reward.

DECLARATION

I hereby, declared this report entitled "Robotic Vacuum Cleaner" is the results of my research cited in references.

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(MEE/13/1160)

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CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Nowadays most of the vacuum cleaner machines use human energy to operate as many of the consumers use manual vacuum cleaner in their house. Usually it takes much time to move on the entire area to ensure the room or area can be cleaned sufficiently. This situation may give the user become tired especially if the cleaning process has to be made frequently.

Manual vacuum cleaner usually gives difficulties to human in term of weight, maintenance and limitation in the movement of the vacuum cleaner itself. For persons who are busy, manual vacuum cleaner is not the good choice because it may consume more time and spend more energy to use the manual vacuum.

Every consumer that use manual vacuum cleaner usually does not have enough time to clean their house and it will use more energy when using the manual vacuum cleaner. Furthermore, manual vacuum cleaner also not suitable to be used for older people because the manual vacuum cleaner is heavy hence create trouble to move the vacuum.

Many consumers are using conventional or manual vacuum cleaner that consume electricity. Usually the existing manual vacuum cleaner requires more time and uses more energy to be moved on the manual cleaner. So, this situation is not practical nowadays especially to those who are working or busy person. In this situation, mini Robotic Vacuum Cleaner is more practical in order to replace manual vacuum system.

All this kind of uneasiness situations can be solved if there is a type of vacuum cleaner system that can be operated automatically. In the market actually automatic vacuum cleaner has already been introduced like iRobot's Roomba as Figure 1.1. This automatic vacuum cleaner is the most popular in some country such United State, china, japan and Germany which comes in various ranging.

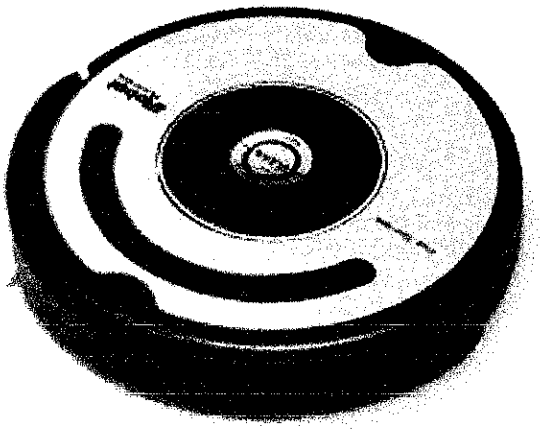

Figure 1: IRobot Roomba 565

Robotic Vacuum Cleaner has intelligent programming and a limited vacuum cleaning capability. Robotic vacuum cleaner is better than manual vacuum cleaner because it helps consumer to save time and energy. By using robotic vacuum cleaner, others things can be done at the same time, for example watching television, reading, cooking or etc. It can save some of the valuable time and energy of human by doing so.

1.2 Problem statement

Automatic vacuum cleaner has been introduced in the market, the product is more expensive and narrow space or wall corner may be a difficult task to be achieved.

Based on that problem, a recommended solution is to come out with a better robotic vacuum cleaner. Perhaps, through this new innovation, it will be able to help consumer to save their time, money and energy to operate the vacuum cleaner, as the proposed mini automatic vacuum cleaner will operate wirelessly and equipped with rechargeable battery. Through this development, the robotic vacuum cleaner is just needed to be put in a room, switch it ON and the sensor will help to detect obstacles when the system is in the operation.

The design of the vacuum cleaner needs to be compact and smaller. Robotic vacuum cleaner will be design and compared to existing automatic vacuum cleaner. This is because existing automatic vacuum cleaner such as Roomba is in large design and gives some limitations during operation.

This design of robotic vacuum cleaner will produce improvement in term of the working operation because it can reach till the small spaces. This design would also help to increase the performance of vacuum cleaner by sucking dust at the area which could not sucked by current existing automatic vacuum cleaner.

Furthermore, the proposed robotic vacuum cleaner will be powered by lipo batteries and able to work autonomously to clean up dust. It is equipped with the ultrasonic sensor to make it intelligent or smart and able to detect obstacles.

1.3 Objectives

The main objective is to develop a robotic vacuum cleaner that is uses to clean up dust automatically. Besides that, other goals that need to be achieved are:

i. design and develop a small size of robotic vacuum cleaner; and

ii. analyze the performance of the small size robotic vacuum cleaner by consistent floor cleaning process

1.4 Scope and limitation

To successfully complete this project, there are some limitations of the project:

i. This project will come out as prototype and not as actual product.

ii. The operation movement area must be flat and no curve.

iii. Test and experiment will be done where the robot is to run in a certain limited area that had been decided at first.

iv. The performance of the vacuum is not analyse in detail.

1.5 Report structure

Chapter one describes briefly about the project introduction and motivation that lead to the implementation of the project. It is also discuss about the problem statement, objectives, scopes and limitation of project.

Chapter two describe about the literature review that consists of the background of the project. It also describes about the similar works that have been done by other person and is a comparison to the similar works, thus discuss the advantages and disadvantages of previous project. Other than that, it also describes about types of the vacuum cleaner that had been existed in the market and the locomotion of the robotic vacuum cleaner.

Chapter three describes about the project planning. The project planning consists of hardware design, software and electrical circuit system. This chapter also discusses about the development method that will be used in the project such as material selection, fabrication process, control system development and programming. Then, the testing method and method to analysis will be discussed.

Chapter four describes about the result and analysis data. The analysis in this chapter is consists of the suction analysis and performance analysis.

Chapter five describes about conclusion and recommendation. This chapter will include about the overall knowledge that comes out from the project and some recommendation for the further study.

1.6 Reason for Use of ATMEGA Chip to Control System

The following reasons were identified for using ATMEGA chips for system control

i. Very High Accuracy

ii. Low Power Consumption (Energy Saving)

iii. High Level human Safety

iv. Less Running cost

v. Small in Size (helps to reduce the size of the system

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discuss the collections of data and information's on related projects to improve our project. This is done to avoid errors, understand the PIC configurations and to make sure the best possible decisions are made to implement this project.

2.2 Manual Vacuums

The vacuum cleaner evolved from the carpet sweeper via manual vacuum cleaners. The first manual models, using bellows, were developed in the 1860s, and the first motorized designs appeared at the turn of the 20th century, with the first decade being the boom decade.

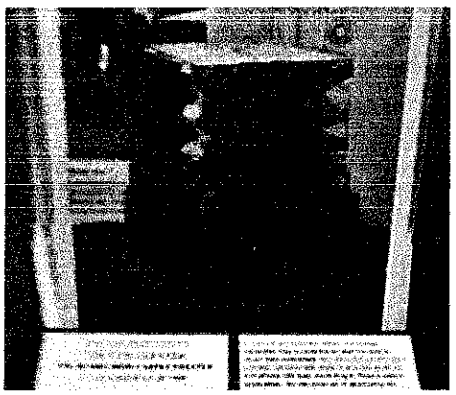

Figure 2: Patent model of Daniel Hess's carpet sweeper

In 1860 a carpet sweeper which is shown in figure 2 above was invented by Daniel Hess of west union Iowa that gathered dust with a rotating brush and a bellows for generating suction. Another early model (1869) was the "Whirlwind", invented in Chicago in 1868 by Ives W. McGuffey. The bulky device worked with a belt driven fan cranked by hand that made it awkward to operate, although it was commercially marketed with mixed success. A similar model was constructed by

Melville R. Bissell of Rapids, Michigan in 1876, who also manufactured carpet sweepers. The company later added portable vacuum cleaners to its line of cleaning tools.

2.3 Powered Vacuum Cleaners

Figure 3: House maid using "dedusting pump", circa 1906.

The end of the 19th century saw the introduction of powered cleaners, although early types used some variation of blowing air to clean instead of suction. One appeared in 1898 when John S. Thurman of Missouri St. Louis. Figure 4 shows a house maid using dedusting pump in 1906.

In 1901 powered vacuum cleaners using suction were invented independently by British engineer Hubert Cecil Booth and American inventor David T. Kenney. Booth also may have coined the word "vacuum cleaner". Booth's horse drawn combustion engine powered "Puffing Billy", maybe derived from Thurman's blown air design," relied upon just suction with air pumped through a cloth filter and was offered as part of his cleaning services. Kenney's was a stationary 4,000 lb. steam engine powered system with pipes and hoses reaching into all parts of the building.

2.4 Domestic Vacuum Cleaner

A hand-powered pneumatic vacuum cleaner, circa 1910. The first vacuum-cleaning device to be portable and marketed at the domestic market was built in 1905 by Walter Griffiths, a manufacturer in Birmingham, England. His *Griffith's Improved Vacuum Apparatus for Removing Dust from Carpets* resembled modern-day cleaners; –

It was portable, easy to store, and powered by "any one person (such as the ordinary domestic servant)", who would have the task of compressing a bellows-like contraption to suck up dust through a removable, flexible pipe, to which a variety of shaped nozzles could be attached. Figure 4 below shows: Early electric vacuum cleaner by Electric Suction Sweeper Company, circa 1908

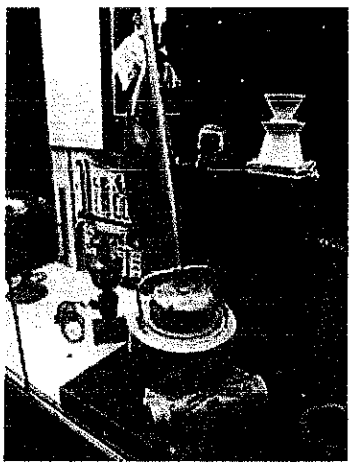

Figure 4: Early electric vacuum cleaner by Electric Suction Sweeper Company, circa 1908

In Continental Europe, the Frisker and Nielsen Company in Denmark was the first to sell vacuum cleaners in 1910. The design weighed just 17.5 kg (39 lb) and could be operated by a single person. The Swedish company Electrolux launched their Model V in 1921 with the innovation of being able to lie on the floor on two thin metal runners.

2.4 Cleaning Robot (Roombai)

Cleaning robot project (RoomBai) is from the Indian Institute of Technology, Bombay Mumbai. The objective of the project is to build a robot, capable of cleaning a floor of the rectangular shape of the given area. The robot moves forward starting from one corner of the cleaning area (simultaneously cleaning also rates) until an Angus is encountered and then move inward by avoiding Angus in rectangular spiral fashion with tackling special cases of missing.

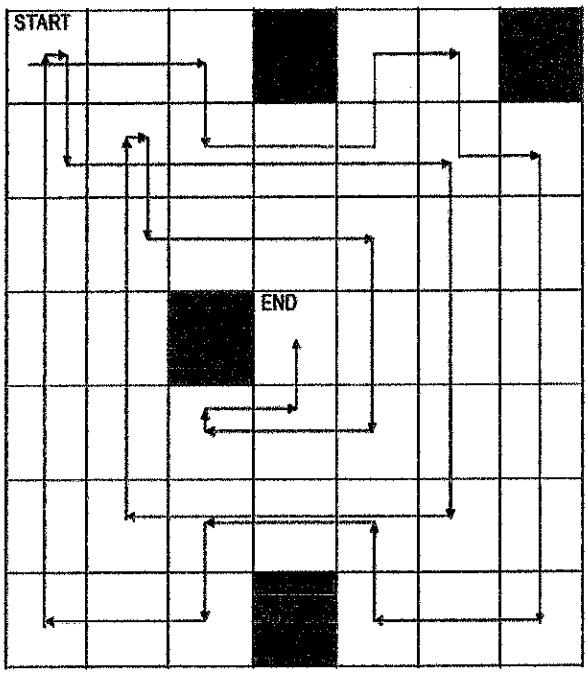

Figure 5: Rectangular algorithm 7

Figure 5 shows the algorithm which was design for Roombai project. The algorithm shape is the rectangular algorithm. Base on the Figure 5 roombai robot begin with around the side of wall and then robot will done the circle change their direction to come inside. The problem that the algorithm face is the roombai robot identifying either the robot is done with the cycle or not. And another problem is the robot cannot differentiate between the wall and obstacle.

In the Roombai, they have several objectives to achieve and the idea of design also clears by their target achievement as follow:-

(a) Project goals: - To implement a robot that cleans a room with no or less unclean place traversed with minimum repetition.

(b) Deliverables: - Efficient cleaning with optimum amount of time with less same area repetition.

(c) Distinct Features: -No white line sensors are used. No mapping of obstacles is done, so dynamic addition of obstacle is possible. Less repetition of previously traversed area.

(d) Assumptions: - The object dimension is assumed to be not more than robot's dimension. The shape of the room is rectangular. The distance between any two obstacles is greater than robot size.

(e) Limitations of 2the application: - There may be cases where same previously cleaned area will be repeated.

2.5 Programming ATMEGA

Programs for use with ATMEGA can be written in a number of formats. First, the **Arduino** compiler/IDE accepts **C** and **C++** as-is. In fact many of the libraries are written in **C++**. Much of the underlying system is not object oriented, but it could be. Thus, "The **Arduino** language" is **C++** or **C**. We used assembly language to program the microcontroller using the Atmel studio 7 and Arduino IDE. Most developers write programs for their systems in C language. However, each tends to develop its own versions and a way to program the chip.

In order to create an Assembly project we need to go to File > New Project > Assembler > AVR Assembler Project, then fill in a name of our choosing and hit ok (I'm using the name AssemblerApplication2). Next we'll be asked to pick the device (For my Arduino Uno that is the Atmega328p). Once all is done, we'll have a new project with a template Assembly file which'll look like this

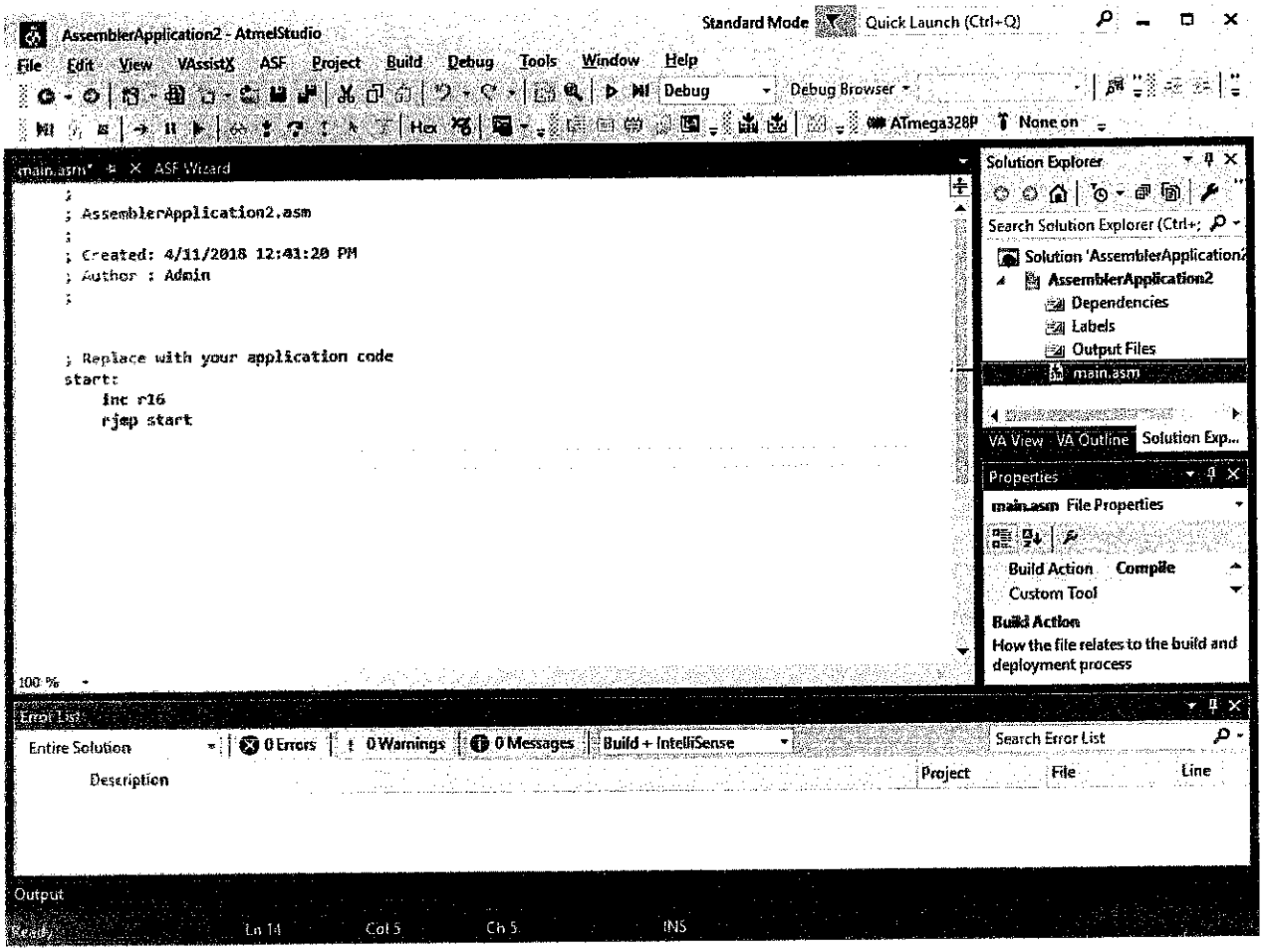

Figure 6: Atmel studio sample template

2.6 Research on Existing Journals

T.B.Asafa, T.M.Afonja, E.A.Olaniyan, and H.O.Alade (2018), developed robot is disk-shaped, equipped with vacuuming and cleaning technology and controlled by Arduino mega microcontroller. It sucks dirt via a retractable dustbin on top of which a cooling fan is mounted, and two sweepers each driven by a 3 V DC motor. The robot navigates via two motor shield controlled rear wheels and a front caster wheel which also governs its turning. Four ultrasonic sensors, placed at 90° apart, detect obstacles and subsequently help the robot navigate. The robot is powered by 3 batteries (28.8 V DC), rechargeable via an embedded AC-DC adapter. It is 12 cm wide and 9 cm tall making it easy for maneuvering its environment. Because of the light weight battery, cardboard based dustbin and small blower used, its weight is about 1.5 kg. The total current

consumed is ~1102 mA. When fully charged, a 2200 mAh-capacity battery works continuously for two hours and cleans floor efficiently. With this capability, the device will be deployed for office and home use thereby making cleaning a fully autonomous duty.

Iwan Ulrich, Francesco mondada, and J.D Nicoud (1997), paper presents the results of the development of an autonomous mobile robot, designed according to some new concepts established in this field during the last decade. These principles can be found in other works based on the constructivist approach, artificial life, subsumption architecture and other bottom-up methodologies. These ideas have been applied to the complete robot design, spanning from the shape of the robot to the sensors, from the electronics to the software control structure. By this way we have developed what we call an "Application Specific Mobile Robot" (ASMR). The target application is a domestic autonomous vacuum cleaner. Despite the actual limitations of the final robot, this work shows how this methodology can bring many interesting result

Vijit Gajbhiye, Naved Ahmad, and M. S. Tufail (2018), Design of D. C. Operated Vacuum Cleaner using Axial Flow Fan, which is capable of Producing a Suction Pressure of 0.17 Bar. And it is more efficient in Cleaning and has less D. C. Power Consumption. This Vacuum Cleaner is wireless leading to better approach in cleaning the floor. As this Vacuum Cleaner is Eco-Friendly, looking forward to use a cleaner source of energy for the betterment of
Mankind, planet earth and environment.

Karthick.T, Ravikumar.A, Selvakumar.L, Viknesh.T, Parthiban.B and Gopinath.A (2015), developed an autonomous robot that can move itself without continuous human guidance. The autonomous cleaner robot consists of low power consuming electronic components and it can operate at very low power. Electronic parts are the controller board Atmega 2560, Ultrasonic sensors, voltage regulator IC and motor driver circuit. Mechanical part is motor with gearbox arrangement. Ultrasonic sensors will detect obstacles according to the program being implemented. A 12V, 4.5Ah lead acid battery is the power source for this proposed cleaning robot. Vacuum cleaning system used in this robot is Cyclonic type filtration system which works under the principle of forced vortex flow same as in case of centrifugal pump. Centrifugal force will be created and all types of debris will be sucked in through pipe. The advantage of using this robot will saves time, it will be very much useful for people with mobility issues to clean the house without any difficulties. It is a simple and low cost robot.

Bram Hendriks, Bernt Meerbeek, Stella Boess, Steffen Pauws and Marieke Sonneveld (2010), presented a paper report on study of the user experience of robot vacuum cleaner behavior. How do people want to experience this new type of cleaning appliance? Interviews were conducted to elicit a desired robot vacuum cleaner personality. With this knowledge in mind, behavior was designed for a future robot vacuum cleaner. A video prototype was used to evaluate how people experienced the behavior of this robot vacuum cleaner. The results indicate that people recognized the intended personality in the robot behavior. They recommend using a personality model as a tool for developing robot behavior.

Sagar B Patel, Ankita Kumari, Vedashruti Sanyal, Ruchi Choudhary, and Anjali Diwan (2016), presented a paper which reviews the importance of Vacuum cleaner robot as a kind of dirt removal system. It is a machine which will automatically clean. A vacuum cleaner robot uses robot system which will make many decisions itself with the help of sensors. System is made up of multiple sensors which will collect data, send to the robot's microcontroller and change directions accordingly. It has an easy to empty reusable dustbin. It uses IR sensors to detect obstacles. It is programmed to accept inputs from sensors to sense obstacles around it and control the robot to avoid any collisions. In case of an obstacle, the microcontroller controls the wheel movement of the robot by a motor driver to avoid collision and prevent the robot from colliding with the object in front. The vacuum cleaner of the robot performs the cleaning operation.

Abhishek Pandey, Anirudh Kaushik, Amit Kumar Jha, and Girish Kapse (2014), proposed a design of an Autonomous Home Cleaning Robots to address household cleaning in this present era, people live a very busy life. People in cities have irregular and long working times in such a situation a person will always find ways of saving time. Household chores are the ones that are most dreaded upon. And cleaning a home tops the list. It is not only time consuming, but also its very tiring. Especially for working women it becomes difficult to handle both home and office work together. She has to do the household chores in the morning, go to work and do the works there and return home in the evening to again start her chores at home. Thus she lives a dual life. In this dual life, they thought of giving her a way of saving some of her precious time.

The requirement of a House Cleaning Robot is born. For saving time they designed an automatic system that cleans on its own without human interventions. Also, they did think about how to aid people with physical disabilities.

Chavan Swaroop Chandrakant,.Parulekar Sharvarish Shashikant,. Gavali Omkar Raju, Gokhale Shantanu Bhalchandra, and Shinde Vaibhav Tanaji (2018), designed a semi-automatic robotic floor cleaner with obstacle avoidance for indoor applications, since domestic robots are entering the homes and people's daily lives, but it is yet a relatively new and immature market. However, a growth is predicted and the adoption of domestic robots is evolving. Several robotic floor cleaners are available on the market but only few ones implement wet cleaning of floors. The purpose of this project is to design and develop robotic floor cleaner. Vacuum cleaner robot is designed to make cleaning process become easier rather than by using manual vacuum. The project is to design and implement of semi-automatic robotic floor cleaner with obstacle avoidance and wet cleaning attachment.

CHAPTER 3

METHODOLOGY

3.1 Design Description

A number of software and hardware implementation techniques were used to design and develop the system.

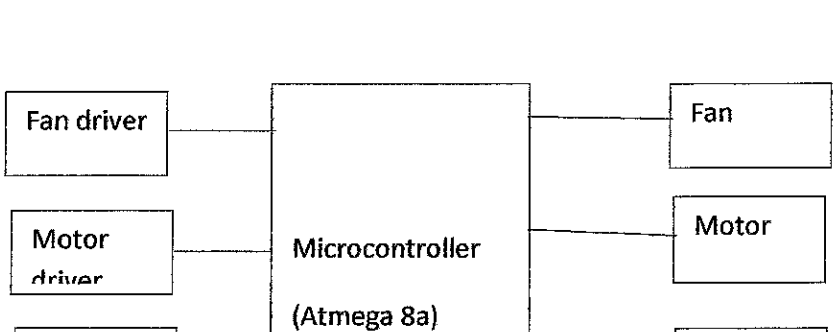

Figure 7: The Initial Block Diagram for the Robotic Vacuum Cleaner

Figure 7 shows the block diagram of the system. We used a 12V DC motor, L298 IC, two Different ultrasonic Sensor, fan as a Vacuum mechanism and ATMEGA 328p to develop our system. The operation of the robotic vacuum is going to be based on retrieving data from the ultrasonic sensors that will tell the condition of the environment around the vacuum. Each of these parts will be described in further detail further on later in the documentation. The data from these inputs will be fed into the microcontroller which is then translated through its software program. It will decide which direction the vacuum should move by sending the control signals out to the drive motors.

3.2 Components

3.2.1 Hardware Components of the System

Hardware components of the system and description

Table 1: System Components of the Robotic Vacuum Cleaner

S/N	SYSTEM COMPONENT	QUANTITY	MODEL /VERSION	USAGE
1.	Microcontroller (Atmega 328P)	1	Arduino uno	To control the whole system
2.	Zippy 1300mah battery pack	1	li-po	To power the system
3.	H bridge dual motor driver	1	L298	To control the two wheel drive motors
4.	Robot chassis	1	Acrylic	The body of the system
5.	Ultrasonic sensor	1	HC-SR04	To detect obstacles
6	Bumper sensor	2	Plastic	To detect when the side of the system hits an obstacle
7.	Switch	1	Plastic	To turn on/off the system
8.	Irf 520 MOS FET Driver Module	1	IC	To switch heavy DC loads

9	Fan Blower AVC BA10033B12G 12V	1	38 CFM	To suck the dusts and dirts
10	1k ohms resistor	1	Metallic	As a voltage divider to regulate voltage
11	2k ohms potentiometer	1	Variable	As a voltage divider to regulate voltage

3.2.2 Software Specifications of the System

- Assembly language
- Atmel studio
- Arduino IDE

3.3 Components Overview

3.3.1 Microcontroller: ATMEGA 328P

Microcontroller board based on ATMEGA 328P (datasheet). The high-performance, low-power Microchip 8-bit AVR RISC-based microcontroller combines 8KB ISP flash memory with read-while-write capabilities, 512B EEPROM, 1KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte oriented two-wire serial interface, 6-channel 10-bit A/D converter (8-channel in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, SPI serial port, and five software selectable power saving modes. The device operates between 2.7-5.5 volts.

Microcontrollers are used to automatically control the system, such as the motors used in the systems. It reduces the size and cost of the robotic vacuum cleaner compared to a design that uses a separate microprocessor, memory, and input/output devices, ATMEGA makes it economical to digitally control even more devices and processes.

3.3.2 H Bridge L298 dual motor driver

This is an electronic circuit that switches the polarity of a voltage applied to a load. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards.

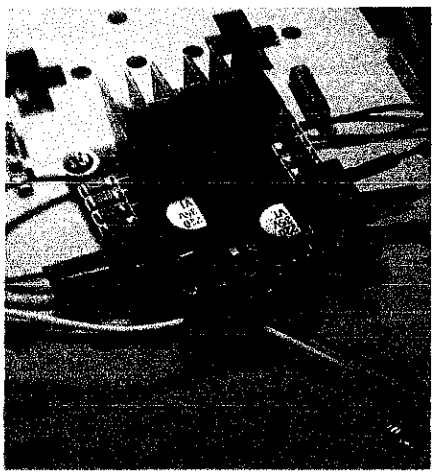

Figure 8: H Bridge L298 dual motor driver

3.3.3 Robot chassis

This serves as the body for the system, it carries all the components that sum up to make the automatic vacuum cleaner system. It has two motors connected to it at the rear side, and a ball caster at front side.

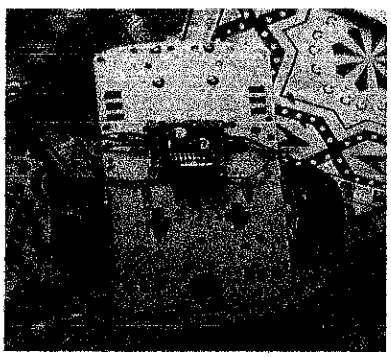

Figure 9: Robot chassis

3.3.4 Ultrasonic sensor

HC-SR04 distance sensor is commonly used with both microcontroller and microprocessor platforms like Arduino, ARM, PIC, Raspberry Pie etc. Power the Sensor using a regulated +5V through the Vcc ad Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins. The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor.

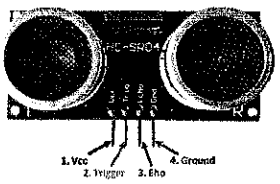

Figure 10: HC-SR04

The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information the distance is measured as explained in the above heading.

HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required.

3.3.5 Irf 520 MOS FET Driver Module

This is a breakout board for the IFR520 MOSFET transistor. The module is designed to switch heavy DC loads from a single digital pin of your microcontroller. Its main purpose is to provide a low cost way to drive a DC motor for robotics applications, but the module can be used to control most high current DC loads. Screw terminals are provided to interface to your load and external power source.

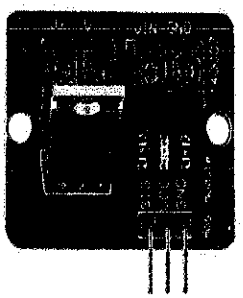

Figure 11: IRF 520 MOSFET

3.3.6 Fan Blower AVC BA10033B12G 12V

The most important thing of a vacuum is to choose the appropriate fan with a decent CFM (Airflow cubic feet per minute), it is the force of this airflow across a surface that picks up the dirt and moves it to the dust bag or container. Therefore, the more airflow, the better the cleaning ability of the vacuum cleaner. Most of the big vacuums use more than 60 CFM but since we are using a small battery, we are ok with at least 35 CFM. The AVC fan that will be used has 38 CFM and it actually has a lot of power.

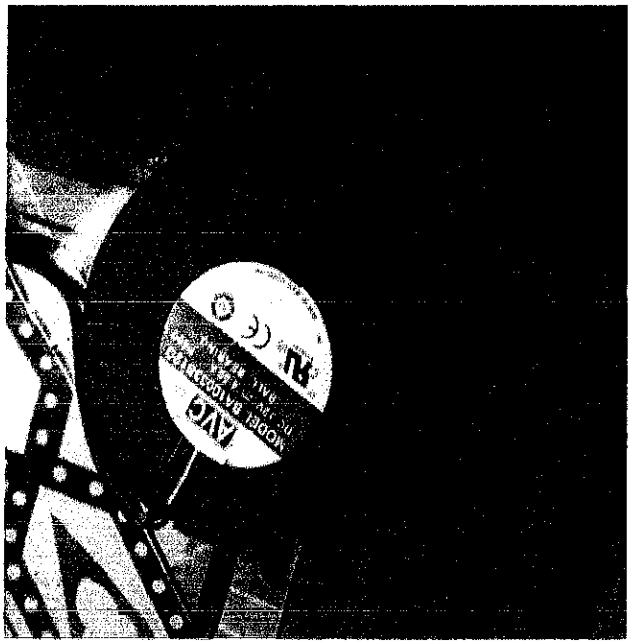

Figure 12: AVC BA10033B12G 12V

3.3.7 Resistor

Resistors for this we will need two Resistors R1 and R2. We use one fixed and the other one as a potentiometer so that we can manipulate the circuit to calibrate it carefully. Use a R1 of 1k Ohms and set the Potentiometer to 1536 ohms. Setting our desired output to be Vout = 5V and the battery voltage when it was fully charged = 12.68 V.

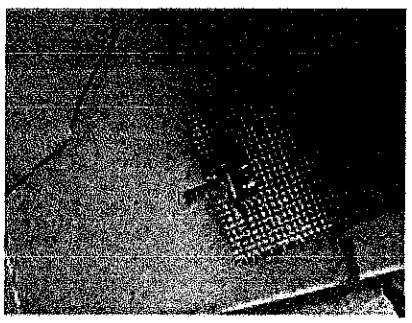

Figure 13:1 Resistor

3.4. Circuit Development

The circuit was designed using Proteus Design suite. **Proteus Design Suite** is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. There was some issue with the design because some of the components was not saved in the database of the software but we replaced it with something similar

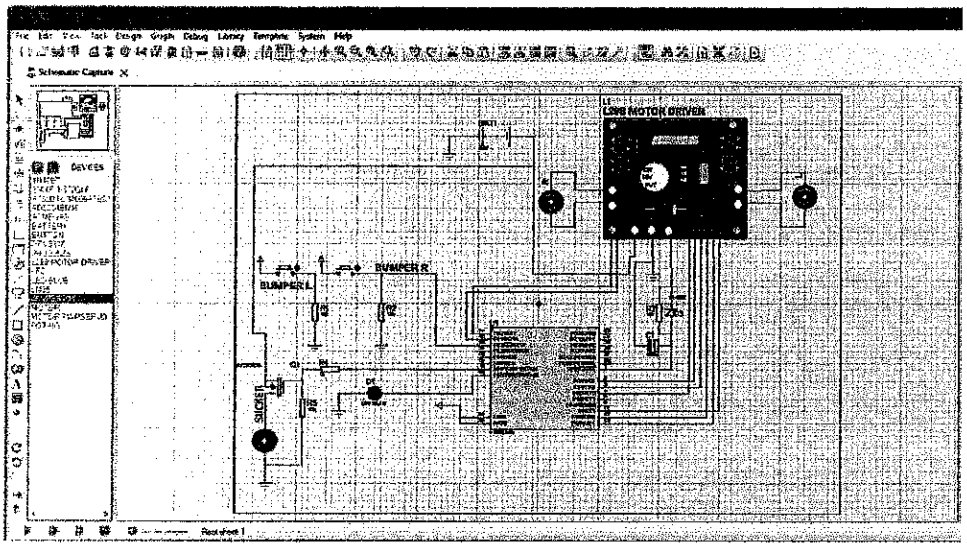

Figure 14: RVC circuit

3.5 Operating Principle

On Opening the package which contains two DC motors, two wheels and one acrylic car chassis. There is also a small plastic bag that comes with a battery holder, a small wheel for the front, some bolts and screws, four wires and other required components to assemble the robot. The kit which comes with the needed wires, which is two red wires and two black wires. We need one red wire and one black wire for each motor. We use a wire cutter to cut the wires to desired length. After preparing all four wires, we solder them to the DC motors.

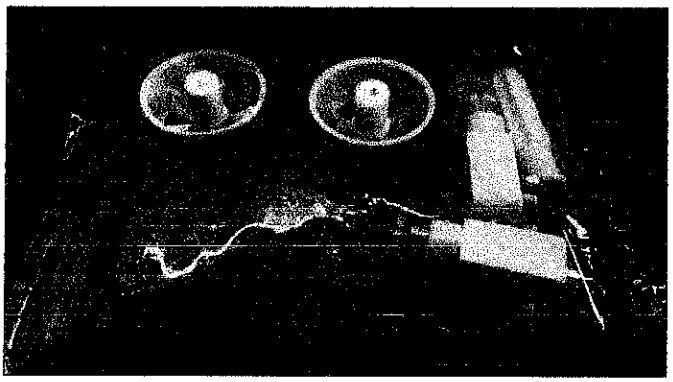

Figure 15: Robot Package

For the connection we need the screwdriver, bolts and screws, and those metal pieces. Start by attaching the metal pieces to the DC motors. Connecting the small wheel and attaching it to the front part of the chassis. Finally we attach the DC motors to the chassis and connect the wheels to the DC motors.

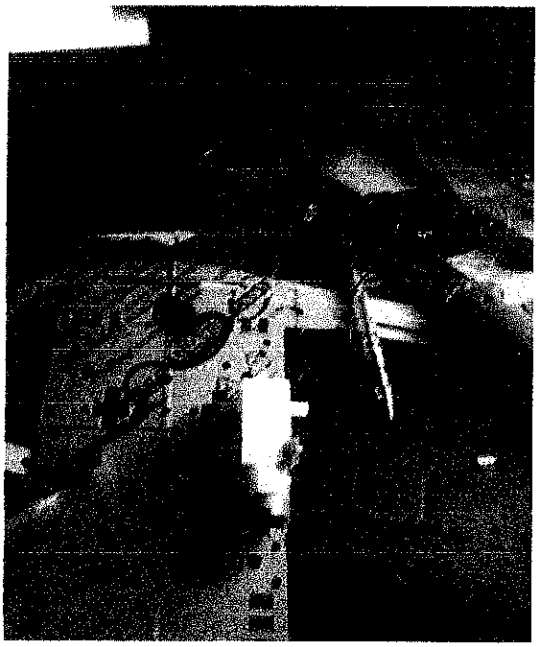

Figure 16.1: Setting up the motors for the robot chassis

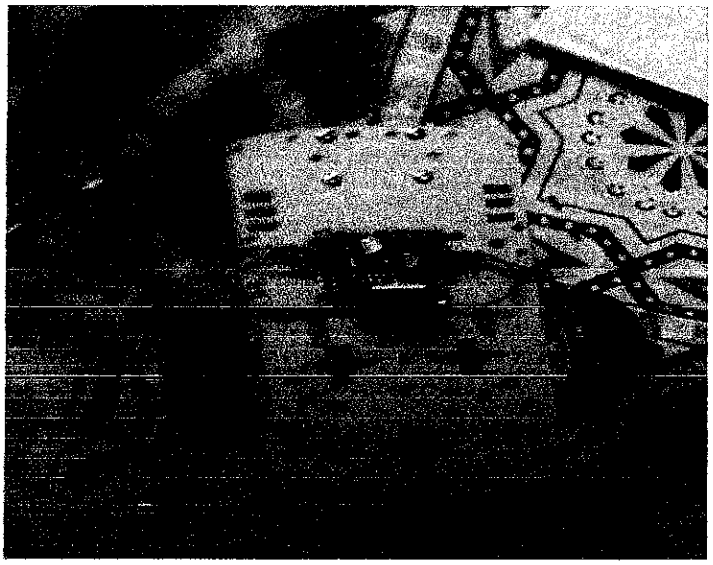

Figure 16.2: After assembling the robot chassis

3.6 Power Consumption of the Robot

Since the robot is designed to work for longer hours. The required power needed to sustain the robot can be determined as follows;

Recall; Power = I × V

Output voltage required = 5V

Hence, total current required to flow through the circuit will be $I_T = I_{MOTOR-D} + I_{ARDU} + I_{UT-SENS} + I_{LED}$

$$I_T = (0.5 + 0.045 + 0.015 + 0.010) = 0.57 = 570mA$$

$$I_T = 570mA$$

$$P = 0.57 \times 5 = 2.85W$$

Available battery capacity is 1,300mAh.

(Operating voltage 5V)

$$P_{batt} = 1.3A \times 5V = 6.5Wh$$

Thus, for longer operation of the robot, the battery can sustain the robot to work for;

$$\frac{6.5Wh}{2.85W} = 2.3\ hours\ \approx (2\ hours)\ considering\ losses$$

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Results and Analysis

The result of the testing process carried out on the Robotic vacuum cleaner when it is tested include

4.1.1 Obstacle Detection

It measures the distance from the sensors to an object and when it is close it turns to the opposite side. It senses when it is on a corner and turn 180 degrees. When the bumper touches it turn right.

4.1.2 Battery Monitor

It is constantly measuring the voltage and if the battery voltage is below the threshold it will turn off all the motors and the LED will start blinking. When starting it tries to turn on the Fan and if the battery voltage is below the threshold it won't start.

4.1.3 Fan Control

The IRF 520 MOSFET turns on and off the fan

4.1.4 Motor Control

With PWM it moves the motors in both directions.

Table 2: Test when battery is fully charged or low

Test	Battery full	Battery low
Obstacle detection	LED blinks and RVC turns 180degrees	Stops working
Distance of obstacle	4cm	Stops working
Bumper sensor	Detects obstacles	Stops working

Fan control	Keeps Working with full speed	Stops working

4.2 Discussion

This project is absolutely a microcontroller board based on ATMEGA 328P (datasheet). The high-performance, low-power Microchip 8-bit AVR RISC-based microcontroller combines 8KB ISP flash memory with read-while-write capabilities, 512B EEPROM, 1KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte oriented two-wire serial interface, 6-channel 10-bit A/D converter (8-channel in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, SPI serial port, and five software selectable power saving modes. The device operates between 2.7-5.5 volts.

This system provides efficient means of cleaning the floor in a room without supervision. Now, with the advent of this system, problems associated with the manual process of cleaning the floor will be alleviated to the minimum level. Hence, cleaning of floors is aimed at using a robot to make floor cleaning process easy, fast and accurate. This project looks at the existing manual vacuum cleaners and other previous automatic vacuum cleaners and attempt to introduce more sensors to increase the obstacles detection in order to reduce the time spent on floor cleaning manual operations to eradicate errors and time consumptions.

This project is an electronic device that uses ATMEGA and assembly programming language for interpreting signals from the sensors and the bumper which is used to detect if the side of the system hits an obstacle. We connect the fan to the pins of the ATMEGA chip as it is shown in the circuit diagram. A filter and dust bag is designed to stop large particles from entering the fan so that it won't spoil the fan or reduce the fan efficiency while it is under use, a dust bag is there to hold dirt particles till the system is done with cleaning. The dust bag is designed based on the size of the system so that the motor can carry the load presented to it (the bigger the system the bigger the dust bag). After the whole design had been completed, the system was tested in a room with cemented floor and carpet floor.

4.4 Implemented Prototype

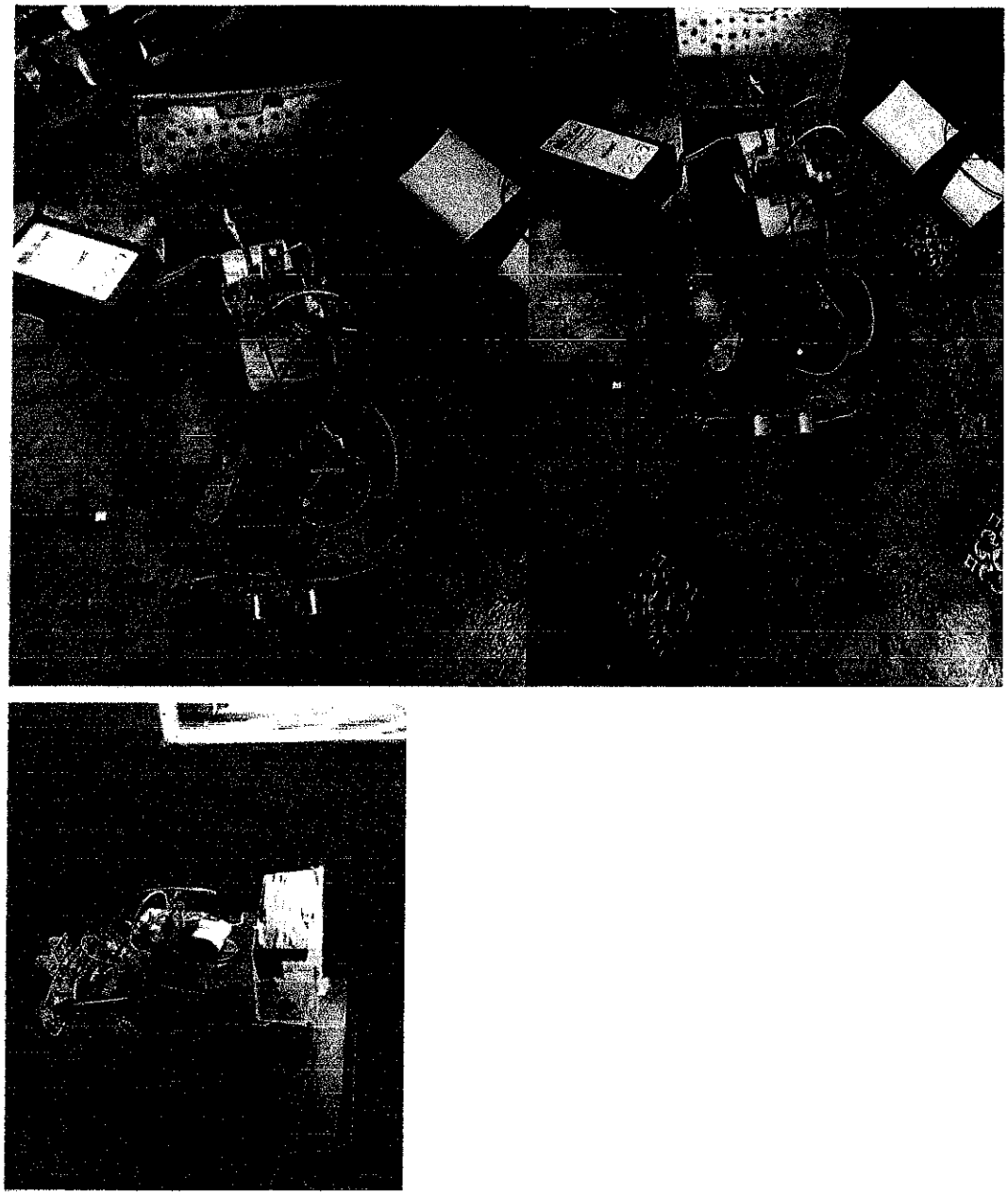

Figure 17: Implemented Prototype

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The Design of Robotic vacuum robot for cleaning floors is developed using a robot chassis and ATMEGA chip. It fully meets the objectives for which the system has been designed and developed.

i. To design and develop a small size of robotic vacuum cleaner

ii. To analyze the performance of the small size robotic vacuum cleaner.

iii. To make consistent floor cleaning process by using robotic vacuum cleaner

Based on that problem above, we come up out with an robotic vacuum cleaner, which answers the questions in our objectives

i. We designed a small size robotic vacuum cleaner

ii. Testing to analyse the performance of the small size robotic vacuum cleaner

iii. Improvements was made to make consistent the floor cleaning process of the robotic vacuum cleaner

5.2 Conclusion

This project has been developed in using ATMEGA 328P and assembly programming using, and it has also help me to understand programs writing in assembly which the ATMEGA chipset recognize. And with the knowledge gain from executing this project, I can say am able to run ASM programs when designing the system without problem. The system reached a steady state where all bugs have been eliminated with the use of effective programming and fixing the bugs that was encountered during testing. The system is operated at a high level of efficiency and beta testers and possible users associated with the system understand its advantage. From the tests performed on the new system and design it will improve the overall performance of manual vacuum cleaners in cleaning homes and offices respectively.

Thus the system solves the problem that it was intended to solve. Furthermore, robotic vacuum cleaners is not just a normal technological innovation, it is more of automation and how a machine

can respond to its environment and development; It usage is not limited to homes and offices, it can also be used in shops, hotels, malls etc. The robotic vacuum cleaner system has brought about faster and easier method of cleaning.

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Chavan Swaroop Chandrakant,.Parulekar Sharvarish Shashikant,. Gavali Omkar Raju, Gokhale Shantanu Bhalchandra, and Shinde Vaibhav Tanaji (2018), designed a Semi-Automatic Robotic Floor Cleaner with Obstacle Avoidance for Indoor Applications, Volume: 05 Issue: 02 | Feb-2018.

Appendix A

COST ANALYSIS

No.	Components	Quality	Initial Cost	Total Cost (N)
1.	Arduino uno(ATMEGA)	1	3,000	3,000
2.	2WD motor chassis	1	2,500	2,500
3.	Medium soldering LED 60/40	1	700	700
4.	IRF 520 MOS Driver Module	1	1,500	1,500
5.	LIPO battery charger	1	4,000	4,000
6.	Fan Blower AVC BA10033B12G	1	6,500	6,500
7.	H-bridge L298 Dual Motor Driver	1	800	800
8.	Ultrasonic sensor	2	600	600
9.	1k resistor	2	50	100
10.	Indicator LED	2	20	40
11.	Vero board	1	100	100
12.	Screwdrivers	Set	700	700
13.	Multimeter	1	2,000	2,000
14.	Male-female jumper wire (set)	Multiple	350	350
15.	Miscellaneous	-	15,000	15,000
16.	TOTAL			**N37,890**

TOTAL AMOUNT IN WORD – Thirty Seven Thousand Eight hundred and Ninety Naira Only

Appendix B

Project source code

```
;
; SNEH MOTOR.asm
;
; Created: 11/20/2018 9:24:42 PM
; Author : HAYONE
;


.EQU  ADRES1      = 0X60
.EQU  ADRES2      = 0X61
.EQU  ADRES3 = 0X62
.EQU  ADCCOUNT = 0X63
.EQU  ADRES1B     = 0X64
.EQU  ADRES2B     = 0X65
.EQU  ADRES3B = 0X66
.EQU  ADCCOUNT2 = 0X67


.ORG  0X00
```

```
INITIALIZE:

        LDI     R17,0X5F
        OUT     SPL,R17

        LDI     R17,0X04
        OUT     SPH,R17

        LDI     R17, 0X04       ;PULLUP ON D2
        OUT     PORTD,R17

        LDI     R17,0XF3
        OUT     DDRD,R17

        LDI     R17,0X00
        OUT     PORTC, R17
        OUT     DDRC, R17

        LDI     R17,0X00
        OUT     PORTB,R17

        LDI     R17,0XFD
        OUT     DDRB,R17
```

```
        LDI         R17, 0X41    ;MOVE FOREWARD
        OUT         PORTD, R17

        CBI         PORTB, 4     ;Trigger
        SBI         PORTB, 4
        RCALL       DELAY10US
        CBI         PORTB, 4

READ:
        SBIS   PINB, 1           ;read echo
        RJMP  READ

STARTCOUNT:
        RCALL DELAY10US                ;distance set
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US
        RCALL DELAY10US

  INC  R19
```

```
        SBIC  PINB, 1
        RJMP  STARTCOUNT

    CPI   R19, 0X07
        BRLO   AVOID

        ;CPI     R19, 0X96
    ;BREQ  ROTATE

    RJMP  START



AVOID:
    LDI R17, 0XB9          ;pwm control  B4,  AF
        OUT OCR2, R17

    SBI    PORTB,0
    RCALL      STOP
        RCALL  DELAY1SEC
        RCALL  REV
        RCALL  DELAYM4
        RCALL          STOP
        RCALL  DELAYM4
        RCALL  STR
```

```
    RCALL  DELAYM3
    RCALL  DELAYM3
    RCALL  DELAYM3

    LDI R17, 0XAF        ;pwm control  B4,  AF
    OUT OCR2, R17
    RET

    AVOID1:
SBI   PORTB,0
RCALL     STOP
    RCALL  DELAY1SEC
    RCALL  REV
    RCALL  DELAYM4
    RCALL        STOP
    RCALL  DELAYM4
    RCALL  STL
    RCALL  DELAYM3
    RCALL  DELAYM3
    RCALL  DELAYM3


    RET
```