Sudan University of science and Technology
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Simulation of Microcontroller Based Industrial Robotic Arm controller

محاكاة متحكم الذراع الروبوتية الصناعية بإستخدام المتحكم الدقيق

A Thesis Submitted as Partial Fulfillment of the Requirements for the Degree of M.Sc. In Mechatronics Engineering

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February 2018

بسم الله الرحمن الرحيم

قَالَ تَعَالَىٰ:

﴿ وَقُل رَّبِّ زِدۡنِي عِلۡمٗا ١١٤ ﴾

صدق الله العظيم

سورة طه

DEDICATION

I want to dedicate this work for my family and friends. It is through their support me that I have been able to focus on my work. My parents taught me that value of learning early on, and have always been supportive me of various decisions to continue my education.

ACKNOWLEDGEMENT

The first thanks and appreciation is for our creator Allah who chooses me for this path, and never abandoned me from his mercy. Allah guided me and enlightened our souls and minds through the last semester getting me bounded together as one person and allowing me to a new definition of the coming life to be which is based on mature thinking and organized group work.

Also each of gratitude and thanksgiving for Dr. **Fath Elrahman Ismael Khalifa Ahmed** as my supervisor, for his continuous guidance and suggestions throughout the preparation of this research. Last but not least thanks are also for my family and friends.

ABSTRACT

Robots are used for the most boring and repetitive jobs in manufacturing. The military and police use robots for dangerous jobs, such as manipulating explosive devices. In this project of simulation of industrial robotic arm to pick and place like in cement factory at rotary packing machine, The conventional packing system is working manually by hand which need more labors to accomplish the packing process and also require a great effort from these labors which will lead to increase human error ratio. Due to that has been simulate industrial robotic arm using microcontroller **ATmega16** in **Proteus** software and **BASCOM-AVR** program to get a good results to be implemented to industrial application in Cement Company of bag applicator. First we used Proteus to draw control circuit of microcontroller, stepper motor and start stop push bottom with BASCOM-AVR program to programming code of microcontroller. Also we do more experiment in circuit and code with corrected more time to achieve good result. This design intends to investigate the design and simulation to control of a 3 DOF industrial robotic arm by using stepper motors and microcontroller, the robotic arm will be controlled via the designed controller and it will be able to grab, pick up and move objects to desire point; we have arm to put empty bag in rotary packing machine and drop the fully bag in another way which like belt conveyer, The simulation results have given the positions of the motors to take and put the cement bag.

المستخلص

يستخدم الانسان الالى فى معظم الوظائف المملة والمتكررة فى التصنيع . الجيش والشرطه يستخدمون الروبوت فى الوظائف الخطرة مثل التعامل مع المتفجرات . في هذا المشروع محاكاه الذراع الروبوتية الصناعية للاخذ والوضع فى مكان اخر، مثل ماكينه التعبيه الدواره فى مصانع الاسمنت . نظام التعبيه يعمل يدويا وهذا يحتاج عدد كبير من العمال لتنفيذ عمليه التعبيه مما يزيد نسبه الاخطاء البشريه ، لهذا قمنا بمحاكاه الزراع الروبوتيه الصناعيه باستخدام المتحكم الدقيق من النوع (ات ميغا 16) فى برنامج بروتوس والباسكوم للحصول على افضل النتائج لتصميم فى التطبيقات الصناعيه فى مصانع الاسمنت .فى الاول استخدم برنامج بروتوس فى رسم دائره التحكم للمتحكم الدقيق وموتور الخطوه بالاضافه الى مفتاحى التشغيل والايقاف مع برنامج الباسكوم لبرمجه المتحكم,كذلك اجريت تجارب فى الدائره والبرنامج وتم تعديلها اكثر من مره للوصول الى النتيجه الافضل.. هذا التصميم يهتم فى محاكاه ذراع صناعيه بها ثلاثه اجزاء حركه حره ويستخدم موتورات الخطوه مع المتحكم الدقيق من النوع (ات ميغا 16) ، الذراع الروبوتيه سوف تتحكم فى المسك وتحريكها الى النقطه المطلوبه كما صممت له ؛ لدينا يد لوضع الكيس الفارغ فى ماكينه التعبيه الدواره واسقاط الكيس الممتلئ فى طريق اخر وهو السير الناقل . وأعطت نتيجة المحاكاة مواقع الموتورات لاخذ ووضع كيس الاسمنت.

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f	The frequency
µC,	Microprocessor/ microcontroller
M1	Motor for pick up empty cement bag
M2	Motor for take bag by gripper from position 1 to 2
M3	Motor for gripper
t	Total time
V	Linear speed
ω	Angular speed
r	radius
Θ	Angle of motor or position

LIST OF ABBREVIATIONS

ADC	Analog to Digital Converter
Bph	Bag per hour
CPU	Central Processing Unit
DC	Direct Current
DOF	Degree Of Freedom
EEPROM	Electrical Erasable Programmable Read Only Memory
EPROM	Erasable Programmable Read Only Memory
GUI	Graphical User Interface
HDPE	High Density Polyethylene
ICs	Integrated Circuit
MCU	Microcontroller Unit
OCR	Output Compare Register
OTP	One Time Programming
PCB	Printed Circuit Board
PIR	Passive Infrared
PWM	Pulse Width Modulation
PIC	Peripheral Interface Controller
PROM	Programmable Read Only Memory
RAM	Random Access Memory
ROM	Read Only Memory

CHAPTER ONE

INTRODUCTION

1.1 Preface

With the growth of technology, the need of new devices grows accordingly. Computer and electronic sciences is mostly premier in raising the new technologies. Of course the new technology could affect different engineering fields. For instance, if the robotics and artificial intelligence are considered, it reveals that the technology with its high potential, affected many different fields of studies. Therefore related fields of study could be combined to generate new technologies that can be used in wide fields.

The robots play important roles in our lives and are able to perform the tasks which cannot be done by humans in terms of speed, accuracy and difficulty. Robots can be employed to imitate human behaviours and then apply these behaviours to the skills that leads the robot to achieve a certain task .They do not get tired or face the commands emotionally, and since they are designed by humans. They can be programmed and expected to obey and perform some specific tasks. In some cases the use of a robotic hand becomes remarkable. Robotic is applied in different forms and fields to simulate human behaviour and motions.

Our daily life is virtually affected by robots .The idea of robotic is to create practical and useful robots that facilitate our daily tasks. Because of the independency of the robots, they have longer life time comparing with the humans and can be helpful in industry, dangerous tasks and nursing homes.

Most of tools, vehicles, electronic devices and cuisine are built and prepared with the help of industrial robots. For instance, there are industrial robot assembly lines which help in many cases that can operate more accurate and faster than humans. Recently, robots operate in almost all human labors mostly in the fields which are unhealthy or impractical for workers. This fact causes the workers to have more free time to spend on skilled professions including the programming, maintenance and operation of the robots which are essential.

There are situations where a robot is a replacement for human because the human does not have the capability to work under the specific conditions, such as working in the space, under the water and etc., unless the person is equipped with some expensive special clothing and equipment. Therefore, while designing a robot, considering the factors such as concept and techniques, artificial intelligence and cognitive science are essential in order to obtain an effective design .The other situation is when the robot is used to ease the actions done by the human or the human is handicapped.

Obviously, building a robotic arm is not a new idea, but still the design and the specifications can differ from other designs. For instance, the circuitry, degree of freedom (DOF), algorithm, program, attachments, equipment, accuracy and speed, completely depend on the designer’s tact.

The challenge is to be able to perform some physical tasks close to a human’s hand actions, such as replacement and grabbing, under the conditions where a human hand is not a particular solution. Therefore, a robotic arm can be designed to perform the required actions which can be controlled by the humans. The robotic arm has a main processor which is using a microcontroller [1].

Most robots are designed to be a helping hand. They help people with tasks that would be difficult, unsafe, or boring for a real person to do alone. At its simplest, a robot is machine that can be programmed to perform a variety of jobs, which usually involve moving or handling objects. Robots can range from simple machines to highly complex, computer controlled devices. Many of today's robots are robotic arms. In this project, the focus topic is on one very "flexible" kind of robot, which looks similar to a certain part of human body. It is called a jointed-arm robot [4].

1.2 Problem Statement

The packing system is working manually by hand which need more labors to accomplish the packing process and also require a great effort from those labors which will lead to increase human error ratio that will cause equipment damage and increase maintenance cost ,it takes a lot of time elapse for packing process and delay the product delivery to customer.

1.3 Proposed Solutions

To design and simulate industrial robotic arm using microcontroller in Proteus software and Bascom-AVR to get a good results to be implemented to industrial application in Cement Company of bag applicator.

1.4 Thesis Aim and Objectives

When make the factory fully automation it will make working easy and do hard job with high speed and best accuracy...

- Design the bag applicator to work instead labors in Cement Company.
- Simulate the bag applicator into Proteus software and give certain position angle of motors.
- To do desire job pick and place empty cement bag simulated the bag applicator.
- To evaluate the bag applicator using stepper and servo motor and compare which one gives good accuracy.

1.5 Methodology

The procedure of design and simulation an articulated arm robot using a microcontroller and stepper motors and the building procedure consists of building the kinematic structure of robot, hardware design and implementation, software design and microcontroller programming.

The motion of the bag applicator is controlled via microcontroller signals which are generated by microcontroller and the effect of these signals on the stepper motors using the software simulation and repeated the experiment more time.

The software was used Proteus to draw control circuit of microcontroller, stepper motor and start stop push bottom and BASCOM-AVR program to programming code of microcontroller. Also we do more experiment in circuit and code with corrected more time to achieve good result.

1.6 Thesis Outlines

The thesis contains five chapters, Chapter one is an introduction that includes preface, problem statement of the project. Chapter two explains a literature review of the robotics and background of the study. Chapter three discusses the system components of the project including the tools and requirements and chapter four explain the simulation and results. Finish of the thesis with solid conclusion and good recommendations for future work are

CHAPTER TWO

LITERATURE REVIEW

2.1Background of the Study

2.1.1The Human Arm

In human anatomy, the term “upper limb” is used for the part of the human body between for the shoulder joint and the wrist (hand) as shown in Figure (2.1). The arm is the part of the upper limb between the shoulder and the elbow joints as shown in Figure (2.2). However it’s common to use the term arm for the whole upper limb, which is going to be the case here. The term arm will be used to refer to the whole upper limb.

Figure (2.1): The upper limb

Figure (2.2): The arm

The arm has 3 joints: the shoulder, elbow and wrist. These three joints allow the different movements of the arm.

2.1.1.1 The Shoulder

The human shoulder is made up of three bones: the clavicle (collarbone), the scapula (shoulder blade), and the humerus (upper arm bone) as well as associated muscles, ligaments and tendons. The articulations between the bones of the shoulder make up the shoulder joints. The muscles and joints of the shoulder allow it to move through a remarkable range of motion, making it one of the most mobile joint in the human body. The shoulder can make left-to-right horizontal movement and up-down vertical movements. The movement of the shoulder causes the whole arm to move with it, i.e. the shoulder carries the arm.

2.1.1.2 The elbow

The elbow joint is the joint between the humerus in the upper arm and the radius and ulna in the forearm which allows the hand to be moved towards and away from the body. The elbow can also make both horizontal and vertical movements.

2.1.1.3 The wrist

The wrist joint is the joint between the radius and the carpus. The wrist can do vertical movements, limited horizontal movements and it can rotate around itself [3].

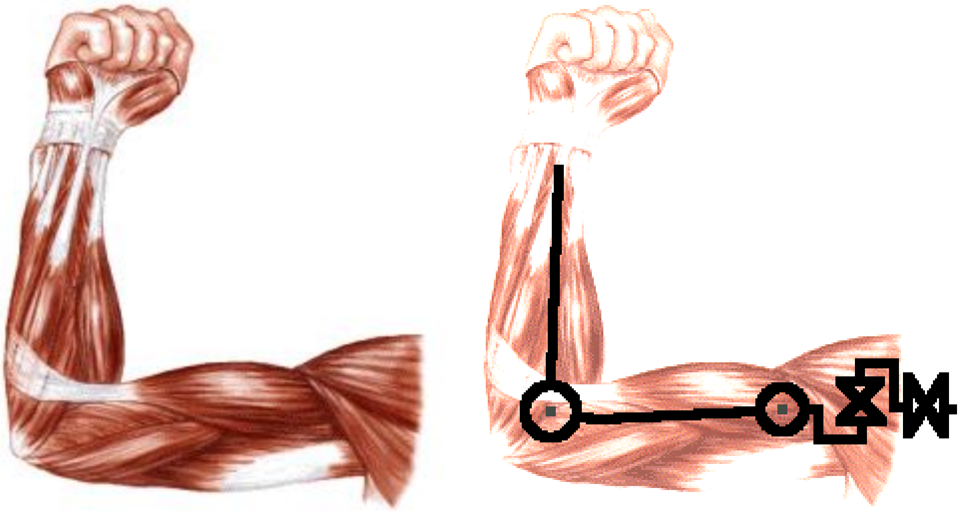


Figure (2.3) Degrees of Freedom of a human arm

In the Figure (2.3) showing Degrees of Freedom in a human arm are used to simulate the robotic arm design, the robotic arm design to be same to human arm must be at least used 6 DOF.

2.1.2 Robots Definition

A robot is a mechanical or virtual agent, usually an electro-mechanical machine that is guided by a computer program or electronic circuitry. It is an automatic apparatus or device that performs functions ascribed to human beings or operates with what appears to be almost human intelligence.

The Robot Institute of America has given a very interesting definition on an Industrial robot. Industrial robots are usually used at industries. "An Industrial robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or special devices through variable programmed motions for the performance of a variety of tasks".

So, a robot is capable of being reprogrammed. This characteristic distinguishes it from a fixed automation. A fixed automation is designed to do one and only one specific task. If the specification of task changes even slightly the fixed automation becomes incapable of performing the task. It is designed to perform according to one fixed specification.

Mainly two types of robots are there, i.e. fixed robot and mobile robot. The fixed type robot is fixed to a particular location while doing his work with his hands. A mobile robot moves from place to place. Mobility is given to robots by providing wheels or legs or other crawling mechanisms.

Basically robot has five major components; the manipulator, the end effectors, the locomotion Device, the controller and, the sensors. Though robots are used widely in industries but they are also popular in other fields like agriculture, nuclear energy, firefighting, mining, undersea exploration, space exploration, medical applications etc.

2.1.3 The Robotic Arm

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot showing in Figure (2.4). The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement.

Figure (2.4): Robotic Arm

The degrees of freedom, or DOF, are a very important term to understand. Each degree of freedom is a joint on the arm, a place where it can bend or rotate or translate. The number of degrees of freedom is typically identified by the number of actuators on the robot arm.

An industrial robotic arm with six joints closely resembles a human arm. It has the equivalent of a shoulder, an elbow and a wrist. Typically, the shoulder is mounted to a stationary base structure rather than to a movable body. This type of robot has six degrees of freedom, meaning it can pivot in six different ways. A human arm, by comparison, has seven degrees of freedom.

2.1.4 ROBOT ARM DESIGN

The chart in Figure (2.5) shows the parallel process of the development in two sides:

- The mechanical side
- The electrical and code (software) side

In the first to design I will make a simulation to electrical circuit and programming code also we can calculate the kinematic analysis to mechanical side. After that electrical circuit will be tested and programming code simulation in software to know mechanical calculation result, also shall be selection the material of robotic arm and electrical circuit to make assembly for all .after finished integration of robotic arm, we will see the result of design if not as desire value we will back to a desired step same as the flow chart.

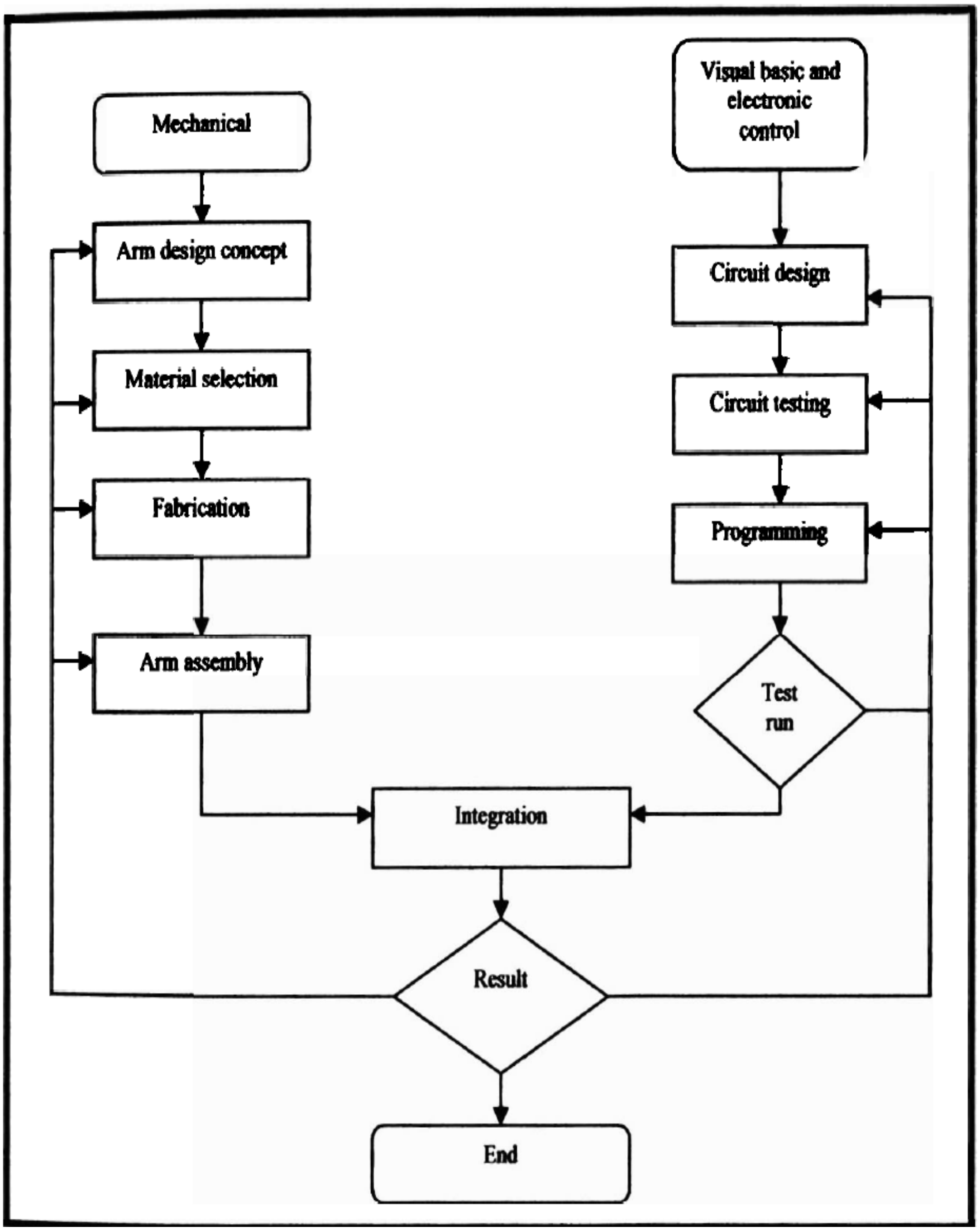


Figure (2.5) implementation robotic flow chart

2.1.5 Techniques of moving a Robotic Arm

Two types of motors are used as actuators to produce motion in robotic arms; stepper motors & servo motors.

2.1.5.1Stepper Motor

A stepper motor (or step motor) is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller), as long as the motor is carefully sized to the application.

Current flowing through a coil produces a magnet field which attracts a permanent magnet rotor which is connected to the shaft of the motor. The basic principle of stepper control is to reverse the direction of current through the 2 coils of a stepper motor, in sequence, in order to influence the rotor. There are two types of stepper motors:

(a) Unipolar Stepper Motor

The Unipolar Stepper motor has 2 coils, simple lengths of wound wire. The coils are identical and are not electrically connected. Each coil has a center tap - a wire coming out from the coil that is midway in length between its two terminals. You can identify the separate coils by touching the terminal wires together-- If the terminals of a coil are connected, the shaft becomes harder to turn. Because of the long length of the wound wire, it has a significant resistance (and inductance) showing in Figure (2.6).

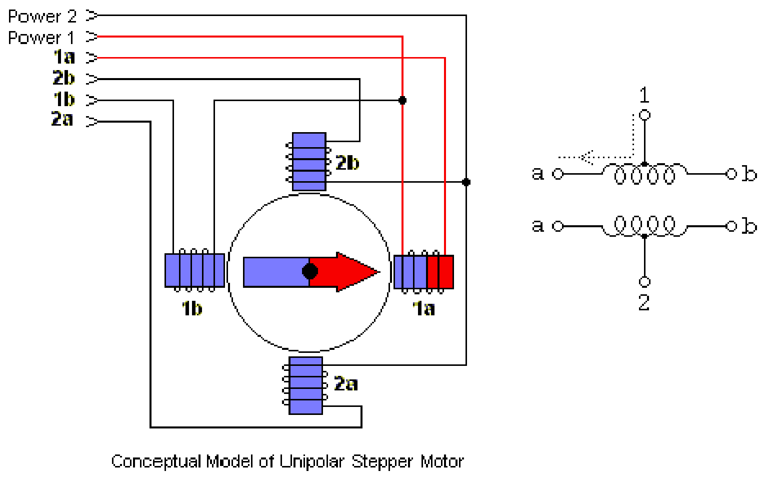


Figure (2.6): Conceptual model of unipolar stepper motor

(b) Bipolar Stepper Motor

The Bipolar Stepper motor is very similar to the Unipolar Stepper motor except that the motor coils lack center taps. Because of this, the bipolar motor requires a different type of controller, one that reverses the current flow through the coils by alternating polarity of the terminals, giving us the name - Bipolar. A Bipolar motor is capable of higher torque since entire coil(s) may be energized, not just half-coils showing in Figure (2.7).

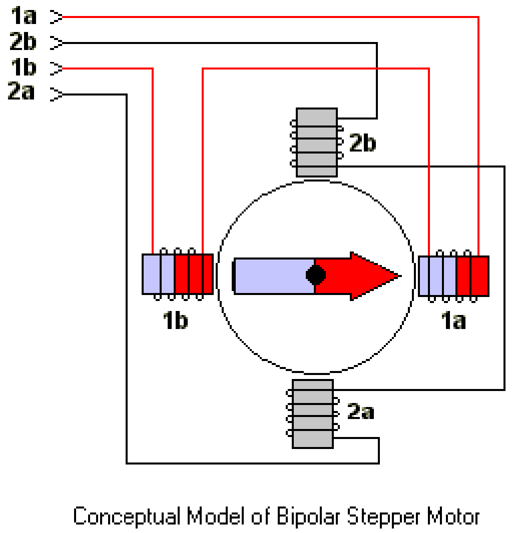


Figure (2.7) Conceptual model of a bipolar stepper motor

2.1.5.2 Servo Motor

A servomotor is a rotary actuator that allows for precise control of angular position. It consists of a motor coupled to a sensor for position feedback, through a reduction gearbox. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

The servo motor can be moved to a desired angular position by sending PWM (pulse width modulated) signals on the control wire. The servo understands the language of PWM. The width of the pulse determines the angular position.

As the name suggests, a servomotor is a servomechanism. More specifically, it is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analogue or digital, representing the position commanded for the output shaft [3].

Each servo has three wires; power, ground and control signal. The servos are controlled by PWM signals generated by the microcontroller. Unfortunately the ATmega’s PWM module can generate only two PWM signals with the appropriate frequency. So an additional microcontroller will be needed to drive the elbow motor. The microcontroller receives the three angles, but forwards the third to the additional microcontroller.

To fully understand how the servo works, you need to take a look under the hood. Inside there is a pretty simple set-up: a small DC motor, potentiometer and a control circuit. The motor is attached by gears to the control wheel .As the motor rotates, the potentiometer's resistance changes, so the control circuit can precisely regulate how much movement there is and in which direction. Servo motor represent in Figure (2.8).

When the shaft of the motor is at the desired position, power supplied to the motor is stopped. If not, the motor is turned in the appropriate direction. The desired position is sent via electrical pulses through the signal wire.

The motor's speed is proportional to the difference between its actual position and desired position. So if the motor is near the desired position, it will turn slowly, otherwise it will turn fast. This is called proportional control. This means the motor will only run as hard as necessary to accomplish the task at hand.

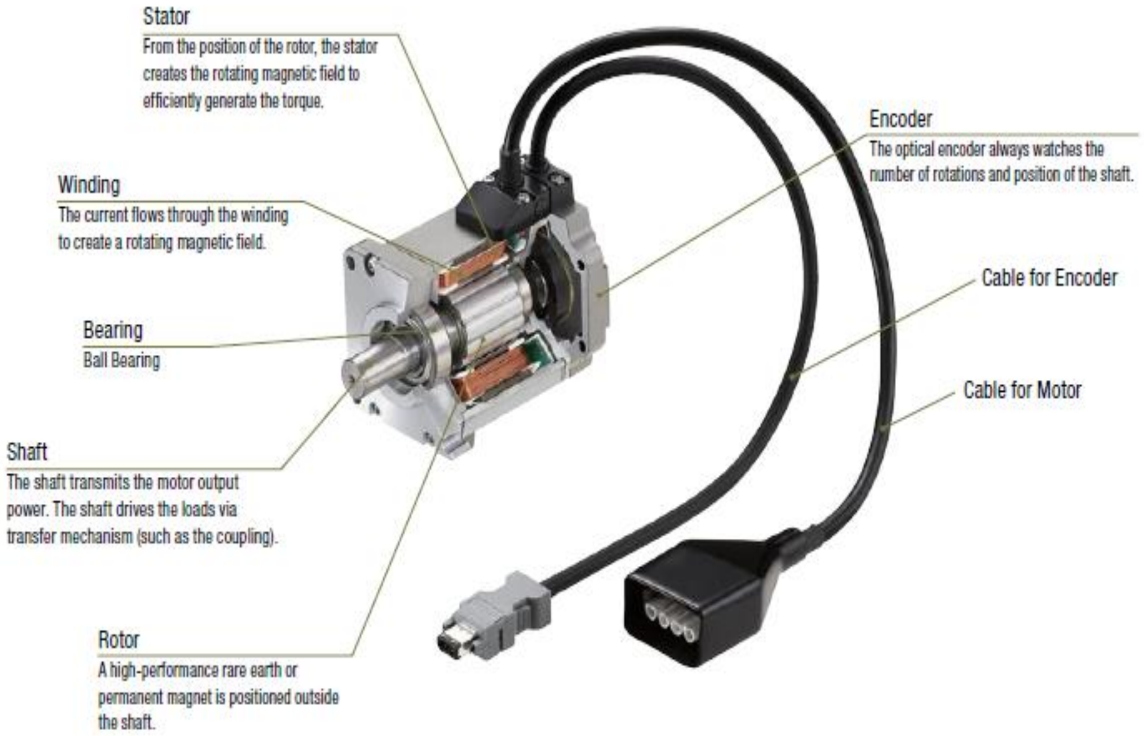

Stator
From the position of the rotor, the stator creates the rotating magnetic field to efficiently generate the torque.
Encoder
The optical encoder always watches the number of rotations and position of the shaft.
Winding
The current flows through the winding to create a rotating magnetic field.
Cable for Encoder
Bearing
Ball Bearing
Cable for Motor
Shaft
The shaft transmits the motor output power. The shaft drives the loads via transfer mechanism (such as the coupling).
Rotor
A high-performance rare earth or permanent magnet is positioned outside the shaft.

Figure (2.8): servo motor

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180°movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it to 0° and any longer than 1.5ms will turn the servo to 180°, as diagrammed belowFigure2.9:

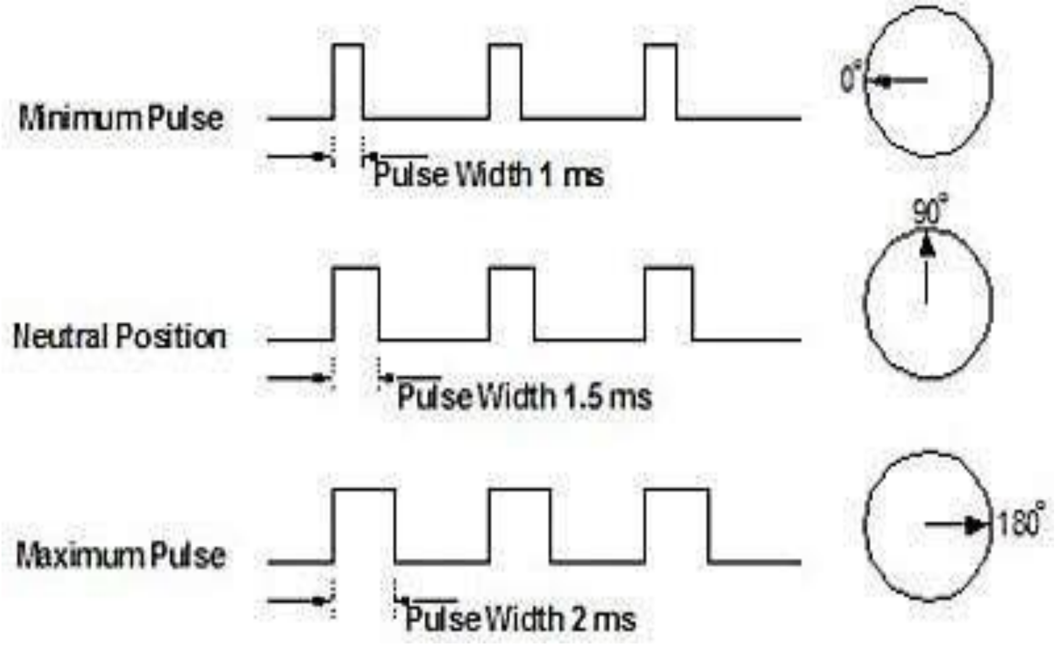


Figure (2.9): Servo controller with (PWM)

When these servos are commanded to move, they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is called the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

Motor driver integrated circuit (L293). The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V showing in Figure (2.10). The L293D is designed to provide bidirectional drive currents of up to600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive supply applications.

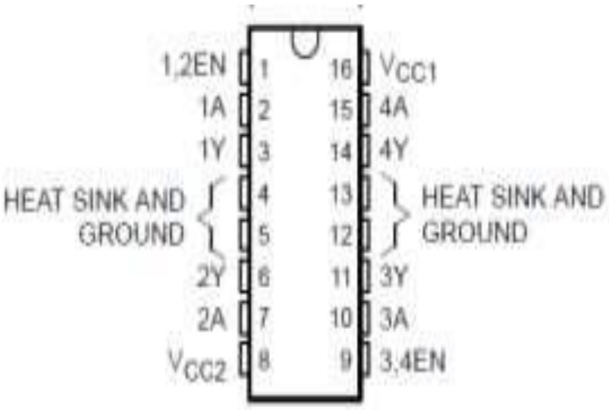


Figure (2.10): DIP L293

All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN.When enable input is high ,the associated drivers are enabled and their outputs are active and in phase with their inputs. When enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. On the L293,external high-speed output clamp diodes should be used for inductive transient suppression. A VCC1 terminal, separate from VCC2, is provided for the logic inputs to minimize device power dissipation.

2.1.6 Sensor which been used in Robotics

Sensors allow the industrial robotic arm to receive feedback about its environment. They can give the robot a limited sense of sight and sound .The sensor collects information and sends it electronically to the robot controlled. One use of these sensors is to keep two robots that work closely together from bumping into each other. Sensors can also assist end effectors by adjusting for part variances. Vision sensors allow a pick and place robot to differentiate between items to choose and items to ignore.

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. For many basic projects or products that need to detect when a person has left or entered the area, or has approached, PIR sensors are great. They are low power and low cost, pretty rugged, have a wide lens range, and are easy to interface with. Note that PIRs won't tell you how many people are around or how close they are to the sensor, the lens is often fixed to a certain sweep and distance (although it can be hacked somewhere) and they are also sometimes set off by housepets .PIR sensor illustrates in Figure (2.11).

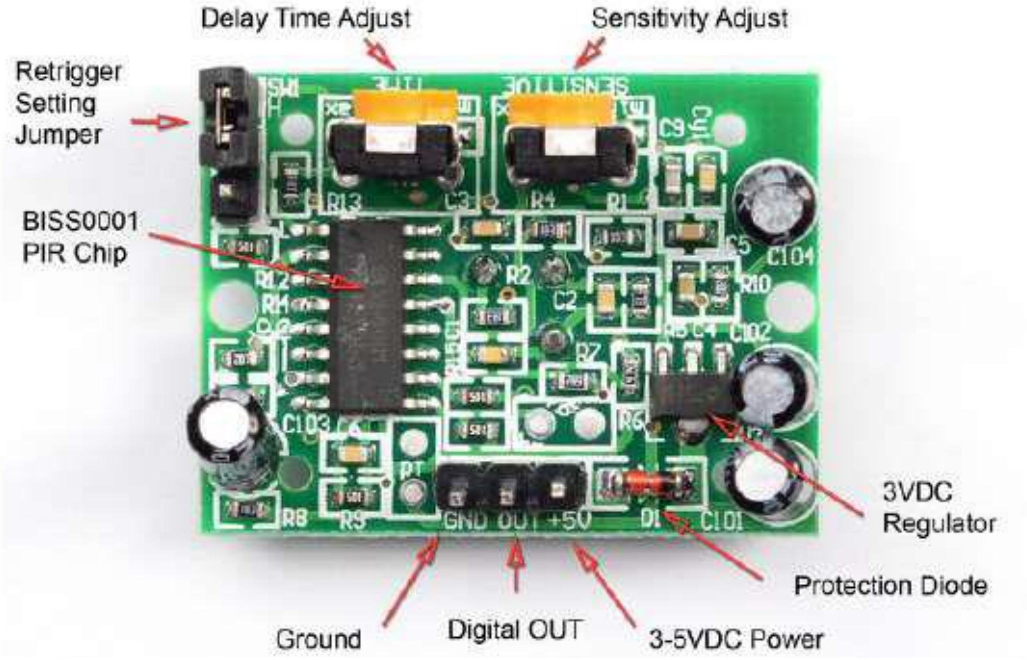


Figure (2.11): PIR sensor

2.2 Related Works

In [8], the author developed mechanism of a robotic arm that serves as a tool to lift an object from one place to another where it is widely used in the factory. The study of the material was analyzed using computer software that can calculate the finite element of linear stress analysis of each mechanical components of robotic arm. The Results of the analysis was used as a reference to select suitable material. The aluminium 6061 was used. In addition, the selection of electrical components used in the robotic arm is also taken into account by calculating the inverse kinematic and forward kinematic of this robotic arm movement. Besides that, the forces exerted on the robotic arm are also calculated to ensure that mechanical components of the robotic arm are not easily broken or 11 damaged. Referring to the result obtained, a robotic arm resistance depends on the motor used. Therefore, the compatibility of motor torque with the robotic arm design is made is important because it affects the stability of the robotic arm.

The author in [8] deals with the aluminium as a hard element to be broken, and the best fabrication notes and consideration. The main problem of the work in [8] is that it doesn’t deal with the joint and the calculations of the robot structure.

In [9], designing a robot arm control using MATLAB is considered. It is designed to be used in the movement either to the left or to the right and is also used to lift an object using MATLAB a robot arm is controlled. The project uses a PIC 16F877A microcontroller circuit as the basic circuit. 3 servo motors were used as an application extension to make movements and lifting an object. In [9], the PIC microcontroller to be programmed instructions to control the servo motor. This project uses MATLAB as a graphical user interface (GUI) for controlling the movement of this robot. The microcontroller software will be standardized to achieve the simulation is not always limited to the convergence between the tools used by the circuit. These types is also designed in such electronics industry and the manufacturing industry in order to achieve the objectives, there are several scope had been outlined. The scope of this project includes using PICBASIC PRO programming to program microcontroller PIC16F877A, build PIC microcontroller circuit and robotic arm for the system, and interface the microcontroller to computer by using RS232 serial port communication. Servo motors are also used for robotic arm and control by MATLAB. MATLAB is used to control PIC microcontroller which is connected to robotic arm. Robotic arm 12 movements can be done by moving to the left or right to take and put things in different places. The author in [9], covers the RS232 connection to the MATLAB and robotic arm, including the procedures and subroutines and the limitations.

In [10], Robotic arms are used in lifting heavy objects and carrying out tasks that require extreme concentration and expert accuracy. This study mainly focuses on the accuracy in control mechanism of the arm while gripping and placing of objects. A design has been proposed to replicate an industrial robot arm with a reach in a three dimensional space which could pick and place objects specified. The three dimensional space access mechanisms operate in cylindrical coordinate system. The operating domain is a cylindrical sector of a fixed radius and height and limited rotation. A four jaw angular gripper will be of use to grip the object firmly with a precise stress. The gripping precision could be defined for objects within the specified dimension of the object. The stress on the object can be controlled. The system facilitates autonomous object detection within its limitations. A user interface is incorporated with the system for human input feed on the desired destination within the working frontiers. The targeted destination is specified in terms of height, radius and angle. In addition the orientation of the object can be provisioned along with the destination. In [10], the design of the circuit is in focus including the microcontroller and sensors with detectors, and the limitations of controlling robotics using microcontroller.

CHAPTER THREE

SYSTEM COMPONENTS

3.1Requirements and Components

The main require components are:

3.1.1 The Robotic Controller

Controller is the "brain" of the industrial robotic arm and allows the parts of the robot to operate together. It works as a computer and allows the robot to also be connected to other systems. The robotic arm Controller runs a set of instructions written in code called a program. The program is inputted with a teach pendant. Many of today's industrial Robot arms use an interface that resembles or is built on the Windows operating system. Moreover the microcontroller considered as one of the best controllers in arm robotic and thus it has been chosen in this design .Microcontroller it was used to control the circuit of the robot and it can be defined as MCU or µC is a functional computer system-on-a-chip. It contains a processor core, memory, and programmable input/output peripherals. Microcontrollers include an integrated CPU, memory (a small amount of RAM, program memory, or both) and peripherals capable of input and output. Microcontroller architecture illustrates in Figure (3.1).

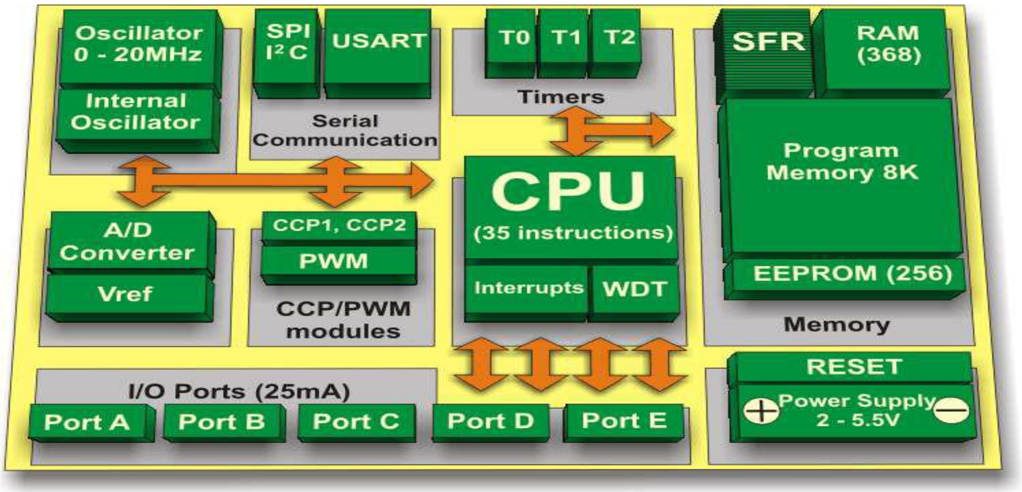


Figure (3.1): shows microcontroller architecture

3.1.1.1 Microcontroller

A microcontroller (sometimes abbreviated µC, uC or MCU) showing in Figure (3.2).is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. A neither program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Figure (3.2): ATmega16 Microcontroller

The microcontroller in this phase has the following jobs:

1) Receive the input signal like potentiometer and sensor

2) Give output signal to stepper motor

3) Program different position for more than one stepper motor

4) Product PWM if we used servo motor

To do these jobs the microcontroller must have a built in analog-to-digital converter (ADC) which can accept several inputs, and the capability of communicating with other microcontrollers. The AVR ATmega16 fits this description perfectly and for this reason –in addition to its availability, low cost and ease of programming- it was chosen to do the job.

3.1.2 The Robotic Arm

Robot arms come in all shapes and sizes. The arm is the part of the robot that positions the end effectors and sensors to do their pre-programmed business. Many (but not all) resemble human arms, and have shoulders, elbows, wrists, even fingers. This gives the robot a lot of ways to position itself in its environment. Each joint is said to give the robot 1 degree of freedom. So, a simple robot arm with 3 degrees of freedom could move in 3 ways: up and down, left and right, forward and backward. Most working robots today have 6 degrees of freedom.

3.1.3 Actuator of the Robot

Actuator of the robot arm is the "engine" that drives the links (the sections between the joints into their desired position. Without a drive, a robot would just sit there, which is not often helpful. Most drives are powered by air, water pressure, or electricity. In this project, the preferred actuator that is chose is electrical drive.

3.1.4 End - Effectors

The end effector is the "hand" connected to the robot's arm. It is often different from a human hand and it could be a tool such as a gripper, a vacuum pump, tweezers, scalpel, and blowtorch or just about anything that helps it do its job. Some robots can change end-effectors, and be reprogrammed for a different set of tasks. If the robot has more than one arm, there can be more than one end effector on the same robot, each suited for a specific task

3.1.5 Sensor of the Robot

Most robots of today are nearly deaf and blind. Sensors can provide some limited feedback to the robot so it can do its job. Compared to the senses and abilities of even the simplest living things, robots have a very long way to go. The sensor sends information, in the form of electronic signals back to the controller. It also gives the robot controller information about its surroundings and lets it know the exact position of the arm, or the state of the world around it. Sight, sound, touch, taste, and smell are the kinds of information we get from our world. Robots can be designed and programmed to get specific information that is beyond what our 5 senses can tell us. For instance, a robot sensor might "see" in the dark, detect tiny amounts of invisible radiation or measure movement that is too small or fast for the human eye to see .sensor for the robot is used such as the limit switch. This type of sensor famously used currently in robotic system as the positioned limit of robot movement. To reduce the high costing on using encoders, this type of sensor is the good solution for the robot positioning sensor.

3.2 ATmega16 Architecture

Our microcontroller, the Atmel ATmega16 integrates memory, clock, a central processing unit, input/output, timers, and an analog to digital converter.

3.2.1 Memory

Memory on a microcontroller can be used to store data and/or the program to be run. There are often several types of memory on a microcontroller:

- Random Access Memory (RAM).
- Read Only Memory (ROM).
  - Programmable Read Only Memory (PROM)
  - Erasable Programmable Read Only Memory (EPROM).
  - Electronically Erasable Programmable Read Only Memory (EEPROM).
  - Flash Memory – a type of EEPROM.

RAM can be either read and write, this usually happens quite fast. Data stored on a microcontroller is often stored in RAM. However, the data stored in RAM is volatile which means that it is lost when power is turned off. ROM is non-volatile and therefore stored between power cycles, but may not be written to.PROM is therefore a compromise between these two types of memory. PROM is non-volatile and also allows a user to program it at least once. Some PROM may be erased by exposure to UV light, but more common today is EEPROM.EEPROM allows read and write access and is also non-volatile, but the sacrifice here is that data transfers take much longer than with RAM.

Flash memory is a type of EEPROM. Program memory (where the program is stored) on the ATmega16 is Flash memory. This is also the same as the memory used in digital cameras and cell phones. Data transfer using flash is much faster than EEPROM because it works in blocks of bytes instead of single bytes. This makes it perfect for program memory in our case.

3.2.2Clock

The ATmega16 we use is run off an 8 MHz crystal oscillator. The rate of instruction execution is fixed and synchronized by this clock. However, this does not mean that each instruction takes 125 nsec. Different instructions require a different number of cycles.

3.2.3 CPU

This is brains of the microcontroller – the CPU executes instructions such as add, move, jump, multiply, etc. To do so, it must first fetch the instruction and any required data over its data bus.

3.2.4Input/output (I/O)

The ATmega16 offers 32 programmable I/O lines with four 8-bit ports. By programming specific registers on the ATmega16, these lines may be set to input, output, or some secondary function. If a pin is set as output, setting the corresponding bit in the output register to 1 will output on that pin and 0 will output ground. If the pin is set to input, it is possible to read either a 1 or 0 on that pin. These pins act just like memory locations so all that is required to output a value is setting a bit in a memory register. To read a pin, all you need to do is read a bit in a register.

3.2.5 Timers

Timers are internal clocks (two 8-bit timers and one16-bit timer is included in the ATmega16). Each timer can be scaled by some factor from the system clock (8 MHz as mentioned previously). These timers can then give us a sense of time and duration– information of great importance in digital control systems. In most cases, you'll just use a timer to count from 0 to 255 (for an 8-bit timer) or 0 to 65536 (for a 16-bit time).In addition, many interrupts can be triggered off of timers. An interrupt is a piece of code triggered by a particular event. That event might be a timer overflowing, or reaching a particular value.

3.3 Pin Description and Configurations

Pin configurations show in Figure (3.3) I will description first the port.

Port A (PA7...PA0) port A serves as the analog inputs to the A/D converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D converter is not used .Port pins can provide internal pull-up resistor (selected for each bit). The port A output buffers have symmetrical drive characteristics with both high sink and source capability .When pins PA0 to PA7are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition become active, even if the clock is not running.

Port B (PB7...PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running .Port B also serves the functions of various special features of the AT mega 16.

Port C (PC7...PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port D (PD7...PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Table (3.1): Pin Configurations& Description.

Pin	The description
VCC	Digital supply voltage.
GND	Ground.
RESET	Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.
XTAL1	Input to the inverting Oscillator amplifier.
XTAL2	Output from the inverting Oscillator amplifier.
AV cc	is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to Vcc, even if the ADC is not used. If the ADC issued, it should be connected to Vcc through a low-pass filter
A_{REF}	is the analog reference pin for the A/D converter.

The Table (3.1) showing the Pin Configurations & description for microcontroller ATmega16 and when it is using.

3.4 Power Supply

Most microcontrollers work off low voltages from 4.5V to 5.5V, so it can be runoff batteries or a DC power pack, voltage in excess of these will destroy the micro .An L in an AVR model number means it can run at an even lower voltage [5].

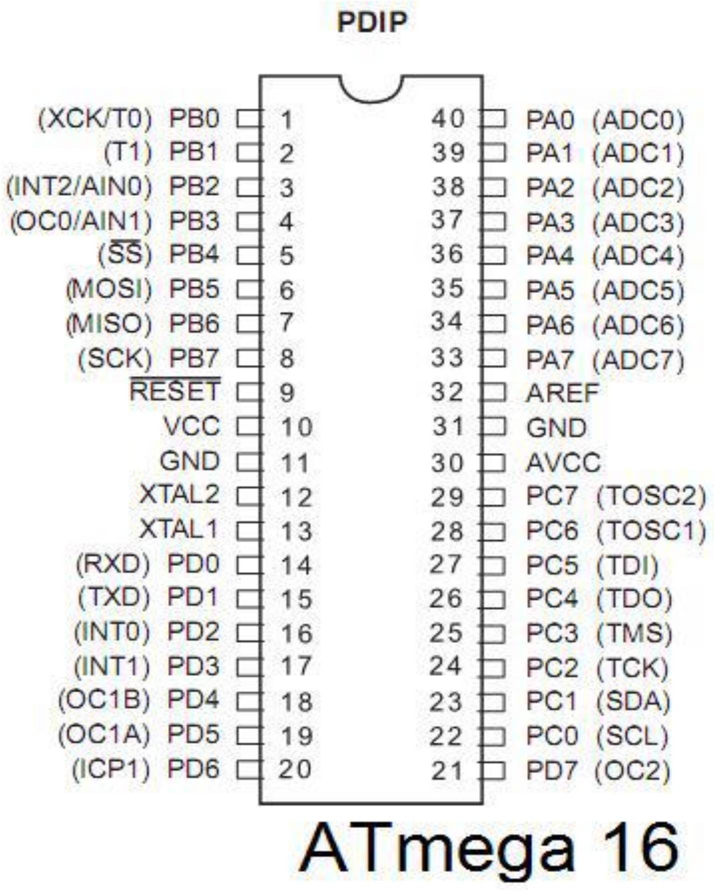


Figure (3.3): Pin Configurations.

3.5 Design of Cement Packing Machine

3.5.1 Cement Dispatch as key Factor

In a modern Cement factory, the efficiency of a cement dispatch unit is a key factor .The term EFFICIENCY is an aggregation of several factors such as:

- Degree of automation and mechanization of the department, leading to a significant reduction of man power and the increasing of safety working conditions ;
- Increasing and optimization of each individual equipment efficiency and performance in terms of actual output, better weigh accuracy, reduced down time for maintenance and amount of spare parts required for maintenance;
- Reduction of dust emission and optimization of the dispatch consumables with particular reference to the bags characteristics;
- Ability to satisfy the market requirements, in terms of sufficient amount of bags to be delivered/loaded on trucks and/or rail wagons;
- Definition of the most rational packing/dispatch and loading plant configuration and layout in terms of characteristics, number and size of equipment, flexibility and logistic.
- The characteristics of carriers available (in India. For example trucks have different shape and dimension, rail wagon dimension and related access doors are fixed and limited) moreover the limits imposed by the Authorities (with particular reference to rail transportation) can’t be neglected.
- In order to reach the above mentioned goal there are some pre-conditions to be provided, one of the most important is the optimization of the cement bag characteristics .See in Figure (3.4) the picture of Cement bag rotary packer

Figure (3.4) Cement bag dispatch/rotary packer

Currently, in India, the most diffused and in use cement bag is the traditional HDPE non laminated stitched bag because two main reasons:

- A very well established industry for the production of this type of bags which is able to satisfy the market requirements in terms of quantity and lead time;
- A competitive price (also considering the huge amount of bags supplied), compared to other type of bags such as paper of PP laminated glued valve , but in this moment it is difficult to understand the realistic gap due to the low request of paper or PP laminated bags versus the HDPE non laminated bags.

The HDPE non laminated stitched bag, in terms of manufacturing sequence, needs a relevant implication of manual operations during the manufacturing process, consequently the manufacturing accuracy (mainly in terms of dimension tolerances) is not stable and not actually controlled.

In case of equipment with high degree of automation the above mentioned factor lead to a very sensitive impact on the performance mainly in terms of efficiency.

The challenge is to find the right compromise and balance between the basic pre-conditions to be provided for a good performance of complete automatic installation and the implementation of the bag quality characteristics with a sustainable price.

When the possible implementation of the bag quality is under Customer evaluation, because requested from the equipment supplier, it is important to make a consideration, quite often underestimated.

With the utilization of a bag with better manufacturing characteristics (either paper or laminated type), there is a very significant reduction of dust emission during the filling process and the handling of full bags, with the following advantages:

- Better weigh accuracy of each individual bag (no cement delivered for free, no illegal underweight bags);
- Less dust in the environment and consequently safer and healthier working conditions;
- Less waste of cement and pollution;
- Less costs for periodic cleaning of equipment and working area ;
- Less wearing of equipment due to the abrasiveness of the cement dust and consequently less maintenance costs;
- Better presentation of the product (bag) when introduced into the market from a realistic calculation currently during filling –handling- loading phases.

A mid-size cement factory easily delivers from 15 to 20 million bags per year which means from 30.000 to 40.000 tons of cement wasted.

In conclusion it must be kept in due consideration that using HDPE non-laminated stitched bags, the operative limit of the bag applicator is limited to max 2400 bph while with bags of different level (paper or PP laminated glued valve) the limit is increased to over 5000 bph. The advantage is the possibility to install very high capacity line (i.e. up to 3000 bph with an automatic truck Loading lines and over 4000 bph with a palletizing line) in other words a packing line with 12/16 spouts or more can be provided with single discharge line with all related positive implications
(Less space, less equipment, less operators, less maintenance etc.).

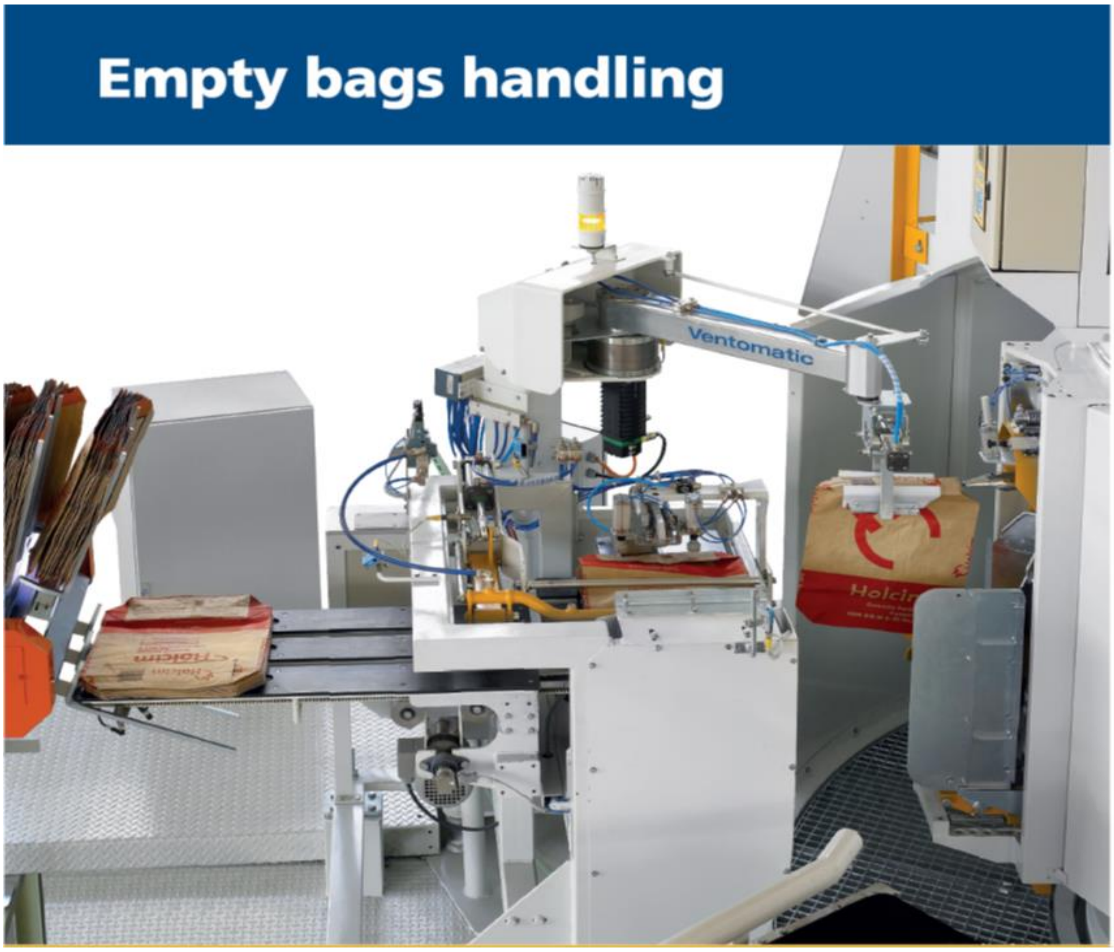
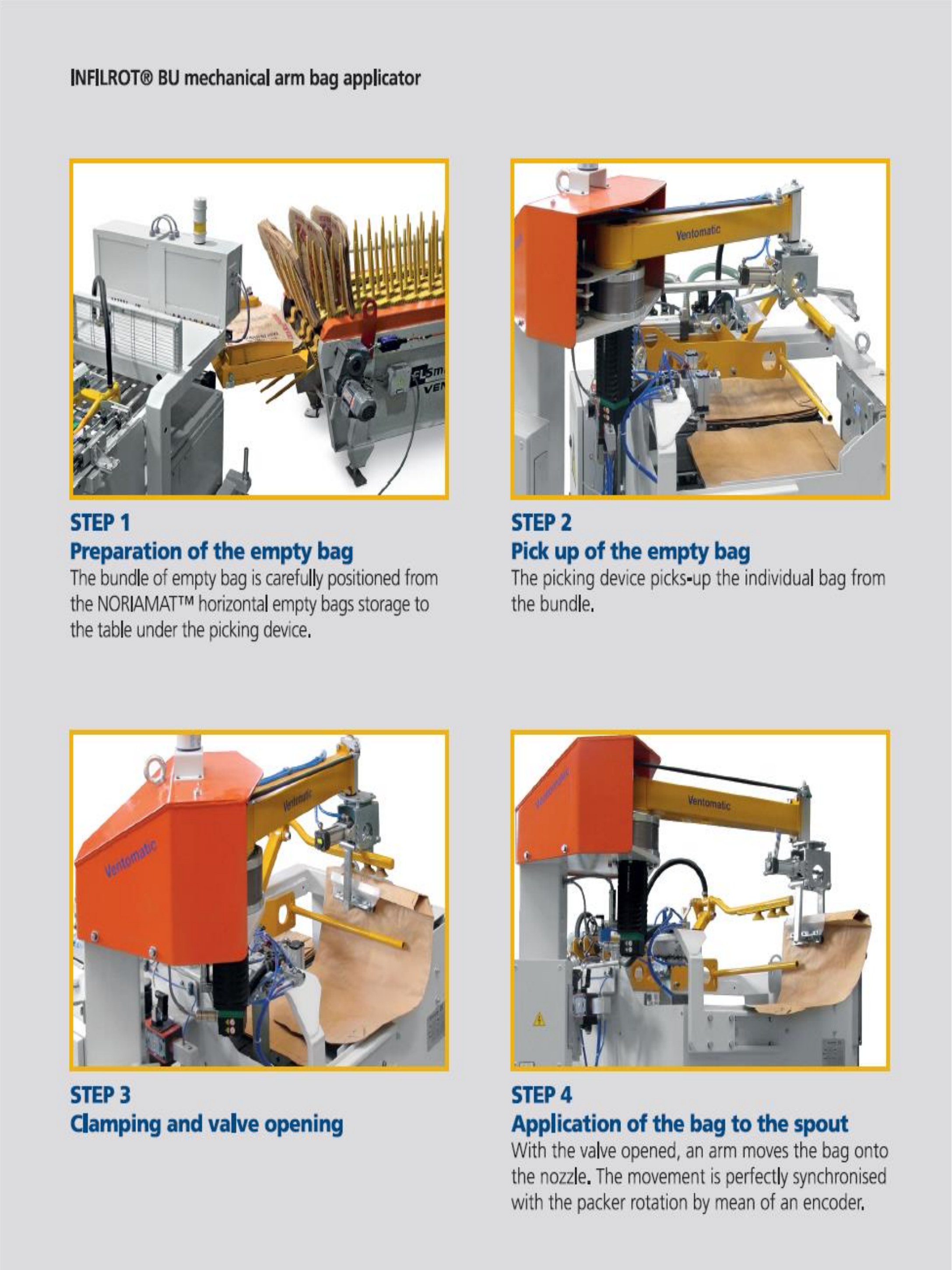


Figure (3.5) Bag applicator arm fixed the bag

In the Figure (3.5) show the Bag applicator arm fixed the bag in the Cement rotary packer machine and doing this job quickly without error and Figure

(3.6)&Figure (3.7) showing two type of Bag applicator arm doing the step of fixed bag in the rotary packer machine



INFILROT® BU mechanical arm bag applicator

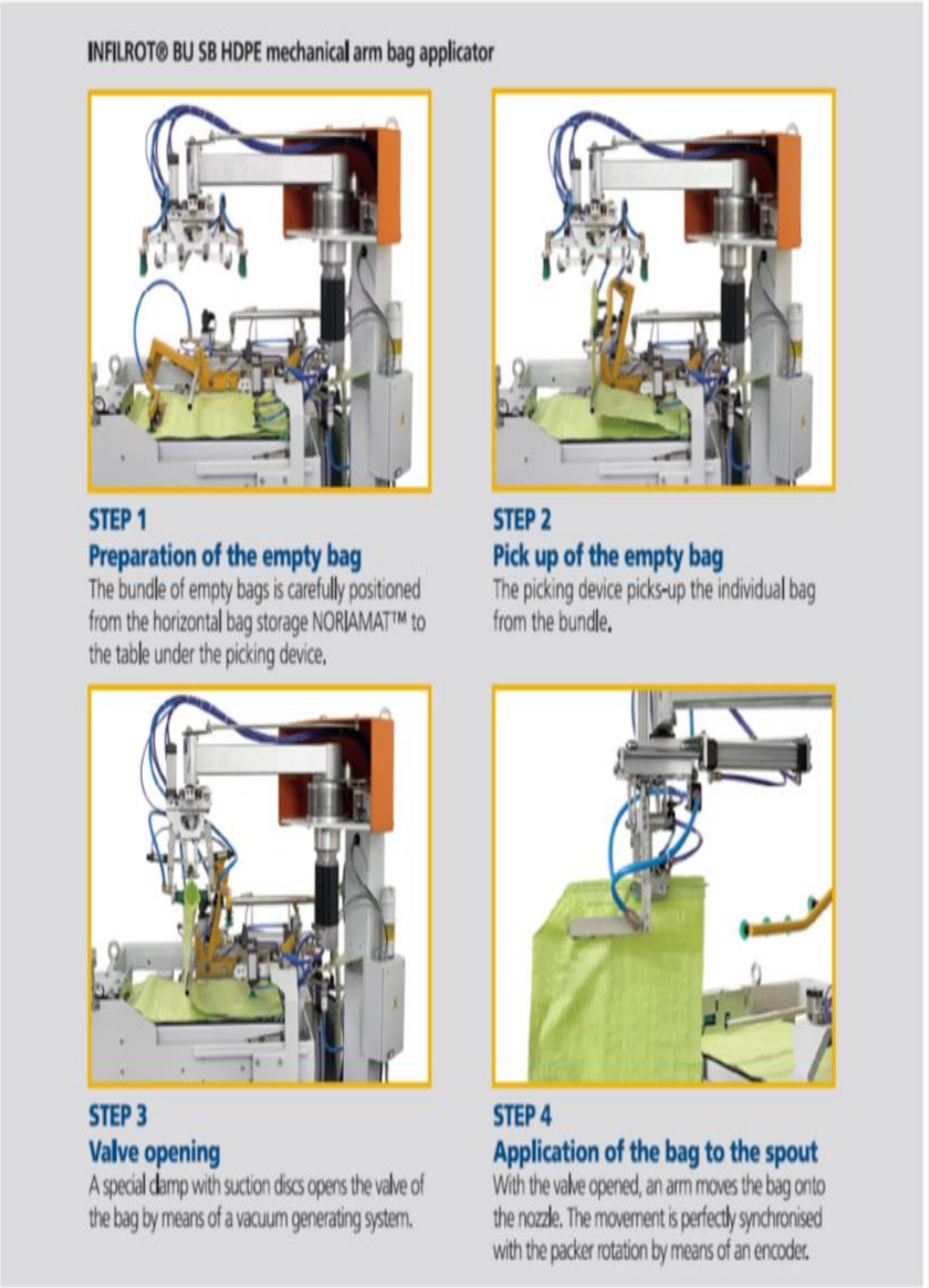
STEP 1
Preparation of the empty bag
The bundle of empty bag is carefully positioned from the NORIAMAT™ horizontal empty bags storage to the table under the picking device.

STEP 2
Pick up of the empty bag
The picking device picks-up the individual bag from the bundle.

STEP 3
Clamping and valve opening

STEP 4
Application of the bag to the spout
With the valve opened, an arm moves the bag onto the nozzle. The movement is perfectly synchronised with the packer rotation by mean of an encoder.

Figure (3.6) Bag applicator type BU mechanical arm



INFILROT® BU SB HDPE mechanical arm bag applicator

STEP 1

Preparation of the empty bag

The bundle of empty bags is carefully positioned from the horizontal bag storage NORIAMAT™ to the table under the picking device.

STEP 2

Pick up of the empty bag

The picking device picks-up the individual bag from the bundle.

STEP 3

Valve opening

A special clamp with suction discs opens the valve of the bag by means of a vacuum generating system.

STEP 4

Application of the bag to the spout

With the valve opened, an arm moves the bag onto the nozzle. The movement is perfectly synchronised with the packer rotation by means of an encoder.

Figure (3.7) Bag applicator type BU SH

3.6 What Is Angular Speed?

We hear about speed in a lot of different contexts, from driving to how fast a ball is pitched. When we talk about angular speed, it simply refers to how quickly an object is rotating. It's defined as the change in angle of the object per unit of time. The formula for angular speed is:

$$\text{Angular speed } (\omega) = \frac{\text{total distance travelled}}{total\ time\ taken} = \frac{\theta}{t} \qquad (3.1)$$

Where omega is angular speed in radians per second, theta is the angle turned through, and t is the duration of the rotation. Notice anything off about that formula? If it looks and sounded Greek to you, you're right. That's how the formula is typically written. To make things a bit easier, we are going to use a slightly modified version for the rest of this lesson

also ,there are motions like motion of car on the carved path ,motion of moon around earth and motion of earth around sun, we don’t see those motion controlled at the center.

How these motions are being controlled? There comes the term centripetal force this centripetal force develops due to the object being continually accelerated, even though moving constant speed. The centripetal force act to ward centre of circular motion and keep the object in circular path, also this type of motion follow the Newton’s first low of motion.

According to first low of motion the unbalance force keeps the body moving in straight line path, hence for body in circular path the presence of unbalanced (centripetal) force is must.

Angular speed (ω) is the scalar measure of rotation rate, in one complete rotation, angular distance travelled is 2π and time is time period (T) then,

$$\text{Angular speed} = \frac{2\pi}{T} \tag{3.2}$$

Hence, angular speed ω =2πf where $\frac{1}{T}$ = f (frequency)

3.6.1 The relation between Angular Speed and Linear Speed

Let the body be moving in circular path of radius r and angular displacement (distance) [s] then we have angle [θ], we know that linear speed [V] see the Figure (3.8).

$$\theta = \frac{\text{arc}}{\text{radius}} = \frac{s}{r} \tag{3.3}$$

Therefore, linear speed

$$V = \frac{s}{t} = \frac{(\theta . r)}{t} = r.\left(\frac{\theta}{t}\right) = r.\ \omega \tag{3.4}$$

Hence angular speed,

$$\omega = \frac{V}{r} \tag{3.5}$$

This is the relation between angular speed, linear speed and radius of circular path. Form this relation we can find angular speed see the Figure (3.8)

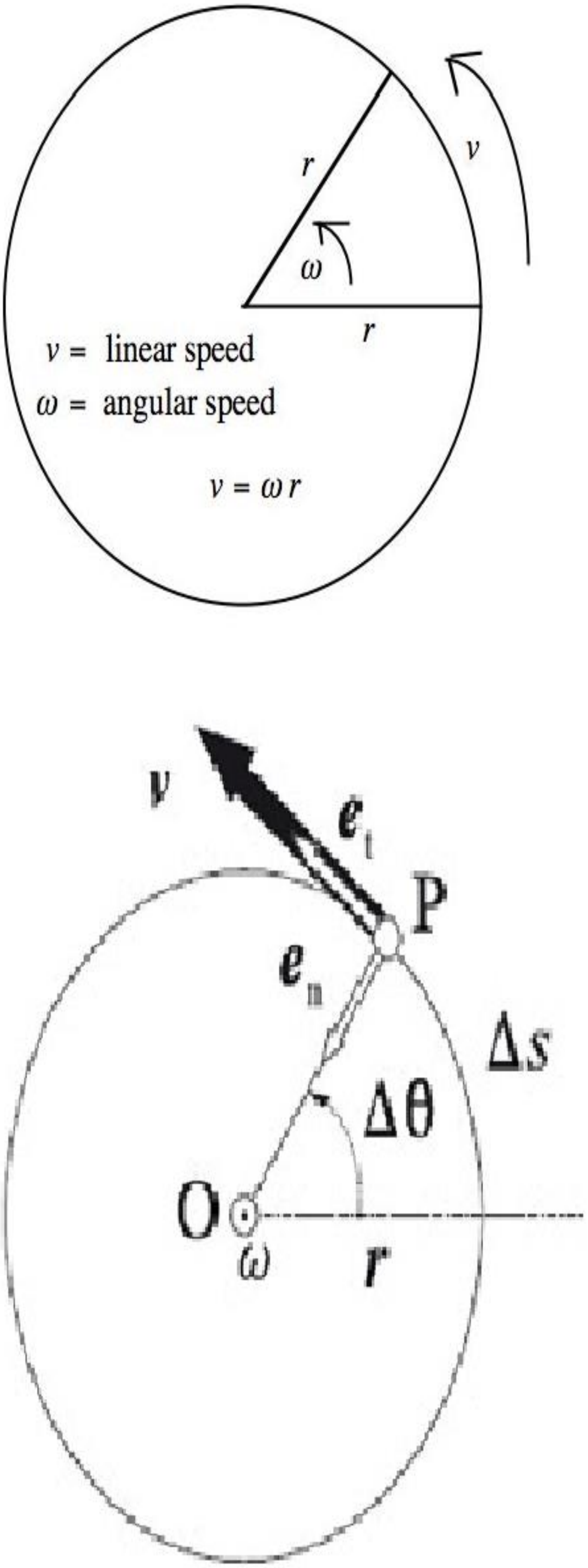


Figure (3.8) the linear& angular speed

CHAPTER FOUR

DESIGN AND SIMULATION

4.1 Introduction

4.1.1 Simulation

The electronic circuit of the robot arm is simulated and tested on Proteus simulation software. Considering the results and behaviour of the system derived from the simulation of the user button control diagram as shown in Figure (4.2), It should be mentioned that since the stepper motor M1 move the cement bag up position and M2 move take bag and put at certain position in packer machine and M3 is gripper to catch bag and drop it at the desired position.

4.1.2 Proteus Simulation Tool

Proteus is software program have a simulation tool that has a good library containing most of the common parts and more importantly it's able to simulate the ATmega16 and that's why it was used. It was used for testing the circuits throughout the design, in the Figure (4.1) showing example for stepper motor in Proteus.

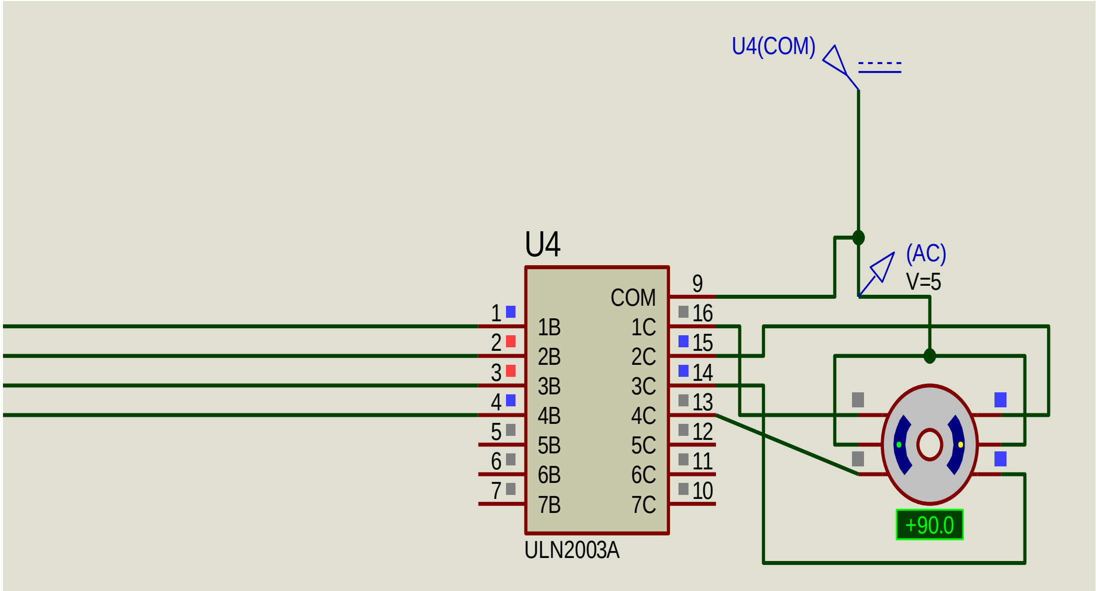


Figure (4.1): stepper motor in Proteus

4.1.3 BASCOM-AVR program

Microcontrollers, such as the AVR, are controlled by software and they do nothing until they have a program inside them.

The AVR programs are written on a PC using the BASCOM-AVR, this software is a type of computer program called a compiler.

The AVR is connected to the PC with a 5 wire cable. Such a development environment supports the whole process from Coding and testing a program to programming the used microcontroller.

Also after write program in Bascom and make compiler and saved we can used hex file in Proteus simulation like in my project.

4.2 The Design and Simulation of Bag Applicator

4.2.1 The Design of Bag Applicator

The bag applicator like industrial robotic arm help us to put empty bag in rotory packing cement machine ,will make automatic cement packing plante with decrease number of labor and decrease cost &time.see Figure(3.4)for cement rotary packing machine will rotated with variable speed induction motor, and take postion by encoder .will put empty bag in certain position after one revolution will be full cement and drop it in another position.

The bag applicator will do job of put empty bag see Figure (3.5) and Figure (3.6)to see step of bag applicator take and put the bag ,first step will pull up the bag by using vaccum airfor fixed bag and other step take and open the hole to put in nozzel(spout) last step will fixed bag in the spout.

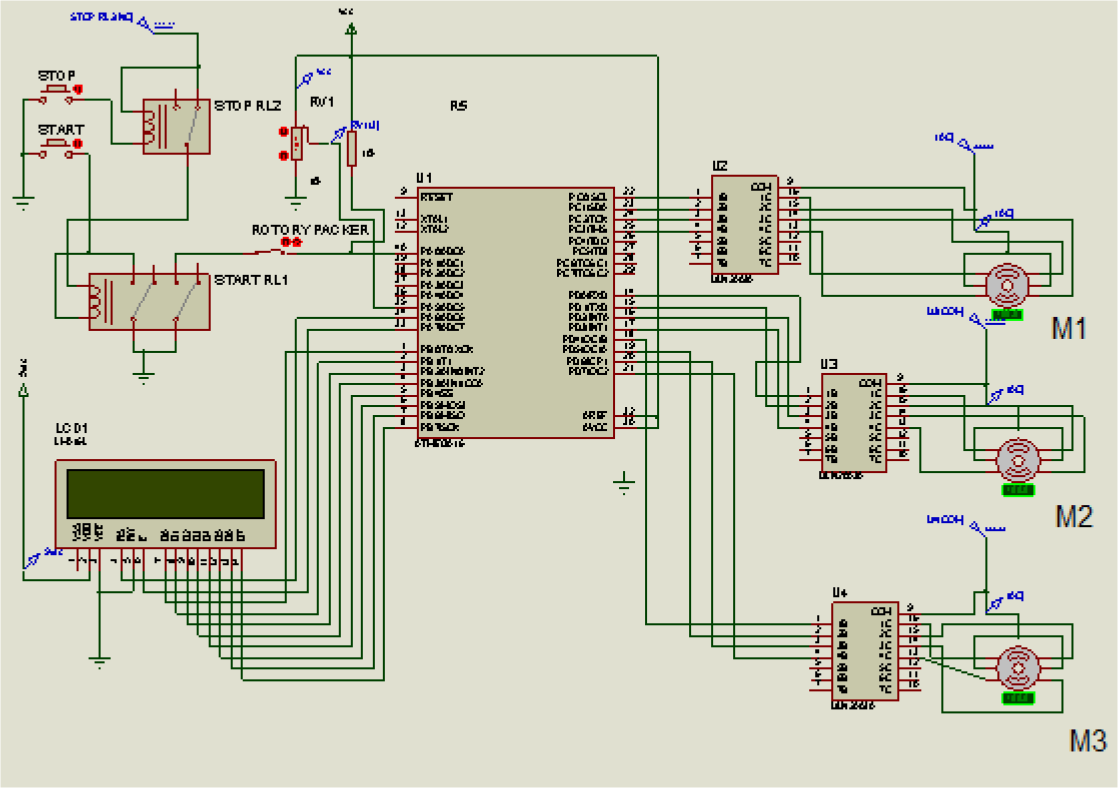


Figure (4.2) simulation of bag applicator

In my design will be simulated the bag applicator in cement company and do same step for bag applicator mention in the up pragraph see Figure (4.2) full simulation using in proteus software and will do same job.

We used stepper motor to do this job of moving part of simulation ,motor one(M1) to pick up bag from angle 90^o to 45^o and come back to angle 90^o to prepair for new bag , motor two (M2) move robotic arm from angle 135^o to 225^o and come back to angle $135^o$to take other bag , motor three (M3) for gripper moving from angle 90^o to 45^o when I need to fixed and open the hole in bag and to 90^o for leave bag.

This moving of motors take signal from microcontroller in different port ,the connection of M1 in port C only four pin and M2 and M3 in port D .

Table (4.1) stepper motor angle position

No	motors	First position	Step 1	Step2
1	M1	90^o	45^o	90^o
2	M2	135^o	225^o	135^o
3	M3	90^o	45^o	90^o

The Table (4.1) describe the first position all motor will beginning in this position and do step 1 like sequense after that step 2 and repeated until give stop command to bag applicator or stop cement packing machine will go to first position.

Table (4.2) motor angle code

No	Angle	Code
1	45^o	0010
2	90^o	0110
3	135^o	0100
4	225^o	1000

The Table (4.2) give which angle and code used in the program of Basscom software and Figure (3.7) describe another type of bag applicator used pynomatic valve instade motor in gripper and make up bag motor.

4.2.2 Simulation of Bag Applicator

In the first I have push button to start and to stop after rotary packing machine running I have feedback from auxiliary contact I can’t making start to bag applicator when stop rotary packer will stop applicator because it is before packer in sequence of operation product line.

After that the microcontroller logic programmed when started signal comes in the input port the microcontroller will give output signal to all motor to moving like mention in the design.

Also we used ADC signal input to microcontroller by variable resistance and give output in LCD to describe the variable production in the packer how much bag per hour (bph) with that must be varying in speed of applicator.

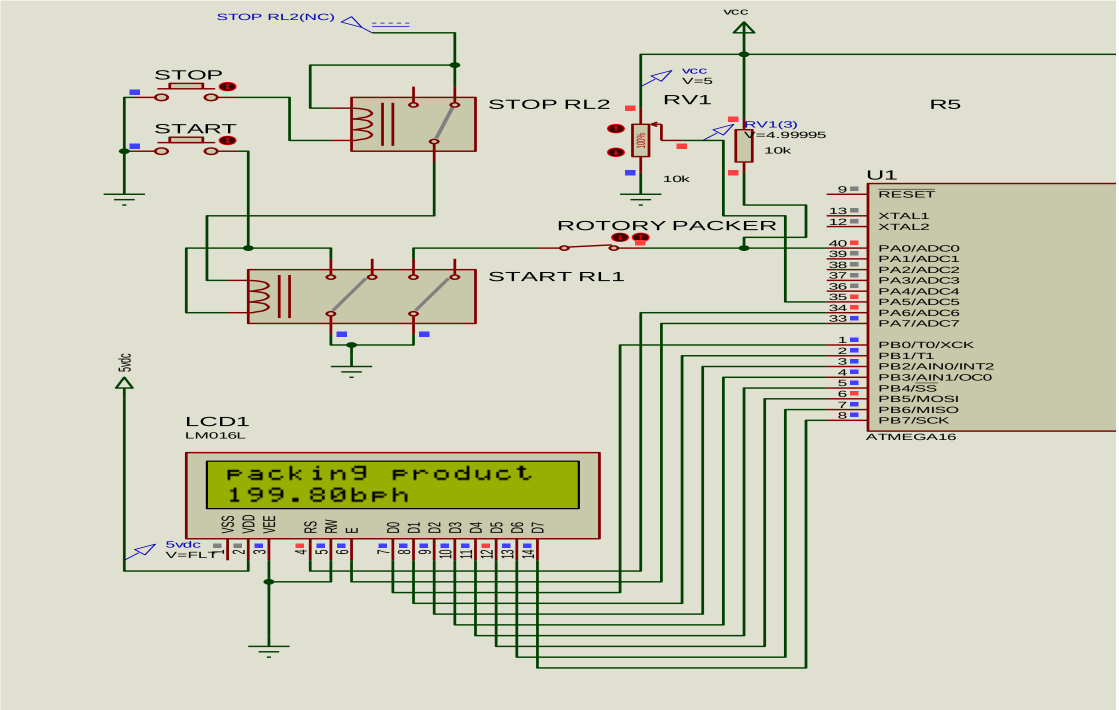


Figure (4.3) simulation of LCD and start /stop

4.3 The Relation between Bag Applicator& Cement Packer

In the first relation of speed in the moving of bag applicator is linear speed but the moving of cement packer is rotating or angular speed, because it is a deferent type of speed the work of bag applicator will be difficult little bit and we will calculate the relation in speed by using standard equation are mention before see in Figure (3.8).

In the second relation of interlock between the bag applicator and the cement packer if the bag applicator is stopped for any fault the cement packer will rotating but versus via must be stopped applicator in the first position (step1) because it will not doing the job, also if the packer nozzle not have bag the applicator come to second position (step2) but if nozzle have bag maybe for two rotation bag not be fully by cement to pull it at belt conveyer the applicator will stop at position one, another interlock between empty bag and applicator if no bag under the applicator must be stop.

4.4The Design of Bag Applicator by Arduino

Arduino is a set of development boards that come with pre-tested hardware and software libraries. It means, you can by an Arduino board and start developing your project instantly. The boards are built around the AVR microcontroller as the base. Software libraries to run on the board are written and made available for free.

In the beginning servo motor is easy to programming in the arduino UNO due to that had been used, in the design is used three servomotor to control in my bag applicator, to programming arduino used arduino C language after compiler the logic will give Hex file to upload in arduino UNO inside the Proteus.

The servo motor can perform high resolution and high response positioning operation by detecting the rotor position and speed with the rotation detector (encoder) on the back shaft side of the motor.

The Figure (4.4) gives the simulate of bag applicator in arduino controller using servo motor instead of stepper motor after take the result give good position, the position angle of servo motor in arduino controller programmed is very easy only write the angle inside the command in logic .

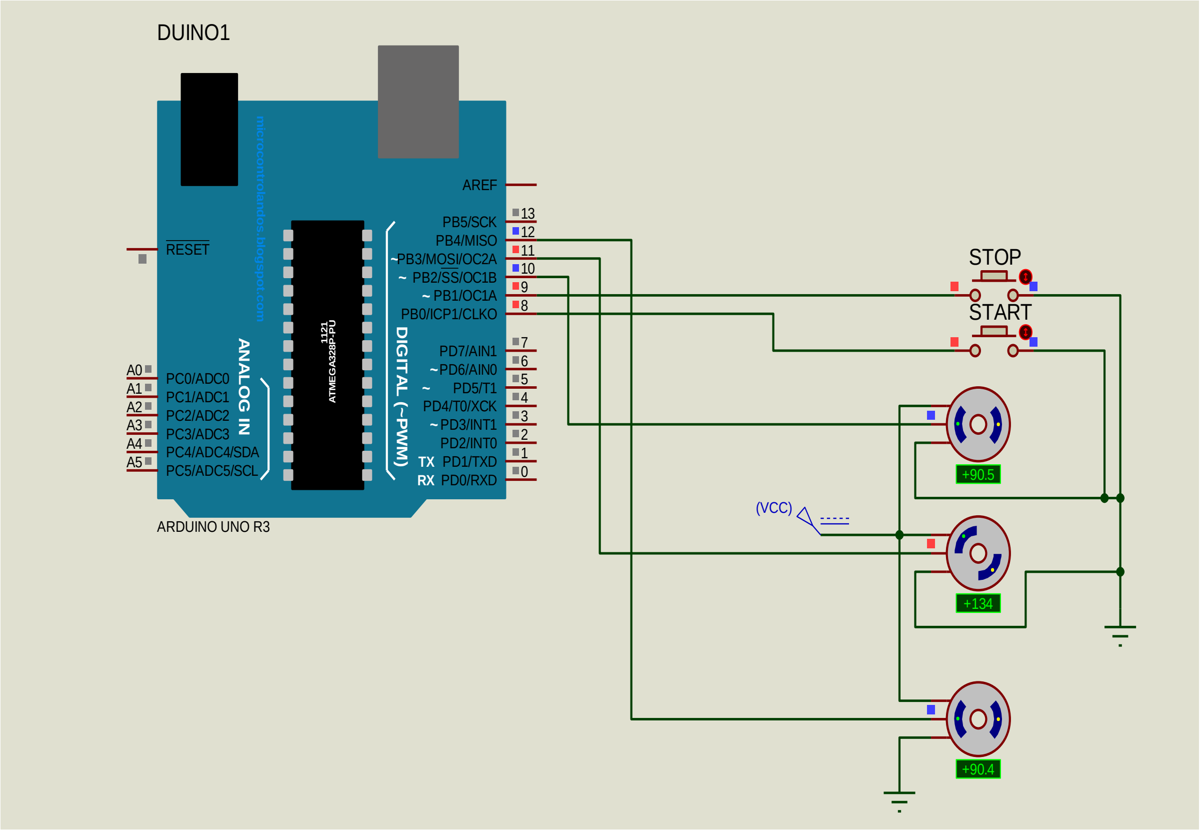


Figure (4.4) arduino bag applicator

The command in arduino C is **[myservo.write(θ)]** ; θis the motor angle but it have small different will mention in the Table below, in the simulation circuit also use Proteus software to moving of servo motor to give bag applicator position , in Proteus software must be adjust the range of angle minimum and maximum value .

Table (4.3) the angle in arduino software

no	The angle	The angle in arduino software
1	0^o	3
2	45^o	68
3	90^o	93
4	135^o	117
5	180^o	180

The Table (4.3) gives value of angle in arduino software in range (0 to 180) if range change will give different position.

4.4.1 The arduino Advantages

Ready to Use; the biggest advantage of Arduino is its ready to use structure. As Arduino comes in a complete package form which includes the 5V regulator, a burner, an oscillator, a micro-controller, serial communication interfaces LED and headers for the connections. You don't have to think about programmer connections for programming or any other interface. Just plug it into USB port of your computer and that's it. Your revolutionary idea is going to change the world after just few words of coding.

In short, Arduino is made to help you use the microcontroller easily.

4.4.2 Basic Differences between Stepper and Servo Motors

Stepper and servo motors differ in two key ways, in their basic construction and how they are controlled

Stepper motors have a large number of poles, magnetic pairs of north and south poles generated either by a permanent magnet or an electric current, typically 50 to 100 poles. In comparison, servo motors have very few poles, often 4 to 12 in total. Each pole offers a natural stopping point for the motor shaft. The greater number of poles allows a stepper motor to move accurately and precisely between each pole and allows a stepper to be operated without any position feedback for many applications. Servo motors often require a position encoder to keep track of the position of the motor shaft, especially if precise movements are required.

Driving a stepper motor to a precise position is much simpler than driving a servo motor. With a stepper motor, a single drive pulse will move the motor shaft one step, from one pole to the next. Since the step size of a given motor is fixed at a certain amount of rotation, moving to a precise position is simply a matter of sending the right number of pulses.

In contrast servo motors read the difference between the current encoder position and the position they were commanded to and just the current required moving to the correct position. With today's digital electronics, stepper motors are much easier to control than servo motors.

4.5 The Simulation Results

At the end of this project, the bag applicator system in cement packing plant has been working automatic without human intervention, and did work quickly in desired time to improve quality of production also decrease operation Cost expenses then have been good efficiency

After finished making simple wire for circuit diagram to bag applicator in Proteus simulation software and make programming logic or (the code of microcontroller) using Bascom software, the experiment result of simulation gave the position of motor to pick and place cement bag.

Also compare step motor and servomotor in this design ,the step motor gave only eight positions but they have modern type give more positions, the servomotor can give any positions like you programming.the arduino has been used due to servo programming in microcontroller is not easy and cannot give any positions because must generate pulse width modulation to any positions .

In the Figure (4.5) showing description of stepper motor position first A&B showing M1 (stepper motor no 1) in two steps 1&2 with angle value to pick up empty cement bag also position C&D showing M2 (stepper motor no 2) in two steps 1&2 to take cement bag by gripper from position of M1 to nozzle of cement packer to make bag full by cement and position E&F showing M3 (stepper motor no 3) in two steps 1&2 of gripper to caught bag in position of M1and leaved in nozzle of cement packer.

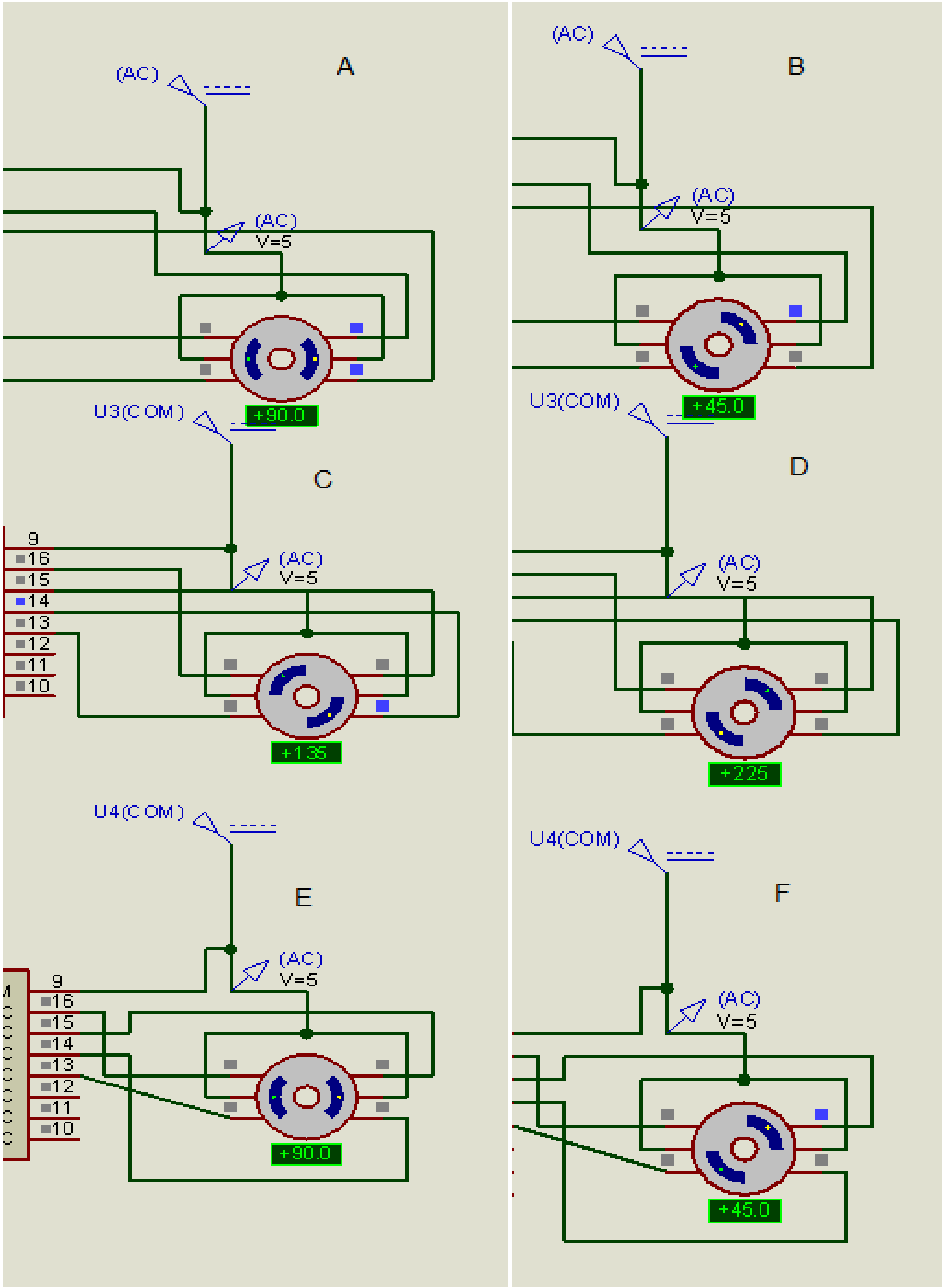


Figure (4.5) stepper motor in step 1&2

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this project the simulation of robotic arm or the bag applicator was done successfully after deep investigation and analysis of the bag applicator, robotic arms design and simulation concepts and theories for put the empty cement bag in the rotary packing machine, Proteus was chosen as a graphical and electronic model creator that deals with the design and application of robots in the presentation. The simulation covers different angle of motor to evaluate the position of the bag applicator design. Moreover simulation environment help to test these application without the cost effectiveness of building robots and selecting optimal materials, component, dimensions and Accuracy.

5.2Recommendations

In the end of this research, some points could be taken as a suggested future works

1. Designs the robotic arm with 6 DOF because are enough to allow the robot to reach all position and orientations in three-dimensional space.
2. If you will design hardware, implementing the inverse kinematics technique in robotic arm.
3. Equipping the robotic arm with sensors (proximity, tactile) will be more sensitive and good accurate.
4. Design and implement electrical circuit board to control the robotic arm.
5. Design and implement the hardware of bag applicator to do desired job.

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APPENDIX A1

```
'------------------------------------------------------------------
' Title Block
' Author: Mohamed A rahman
' Date: February 2017
' File Name: bagapplicator2.bas
'------------------------------------------------------------------
' Program Description:
' send signal to stepper motor and take the position from variable resistane by
' ADC and send to LCD
'------------------------------------------------------------------
' Compiler Directives (these tell Bascom things about our hardware)
$regfile = "m16def.dat"
$crystal = 1000000
ConfigPorta = Input
ConfigPina.6 = Output
Config Pina.7 = Output
ConfigPortb = Output
ConfigPortc = Output
ConfigPortd = Output
ConfigLcdpin = Pin , Port = Portb , E = Porta.7 , Rs = Porta.6
ConfigLcd = 16 * 2                          'configure lcd connections
ConfigAdc = Single ,Prescaler = Auto , Reference = Avcc
'initialise hardware
Cls'clears LCD display
Cursor Off'cursor not displayed
'-----------------------------------------------
'Declare Constants
'Declare Variables
```

```
DimAdc_inAs Word
Dim Voltage As Single
DimDividorAs Single
Dim Volts As String * 5
Dim Message1 As String * 16
'Initialise Variable
Message1 = "my counter"
Dividor = 5.12
'----------------------------------------------
'Program starts here
Ford Alias Pina.0
Rev Alias Pina.1
Do
Adc_in = Getadc(5)
Voltage = Adc_in
Voltage = Voltage / Dividor
Volts = Fusing(voltage , "#.##")
Locate1 , 1
Lcd "packing product"
Locate2 , 1
LcdVolts ; "bph" ; " "
Portc = &B00000110
Waitms 500
Portd = &B00000100
Waitms 500
Portd = &B01100000
If Ford = 0 Then
Wait 3
Portc = &B00000010
Wait 3
Portd = &B00001000
```

```
Wait 3

Portd = &B00100000

Wait 3

Portc = &B00000110

Wait 3

Portd = &B00000100

Wait 3

Portd = &B01100000

Wait 3

Wait 1

End If

Loop
```

APPENDIX A2

```
//  '--------------------------------------------------------------
//' Title Block
//' Author: Mohamed A rahman
//' Date: May 2017
//' File Name: bagapplicator2.bas
//'--------------------------------------------------------------
//' Program Description:
//' send signal to stepper motor and take the position from variable resistane by
//' ADC and send to LCD
//'--------------------------------------------------------------
// Example_bag applicator
#include<Servo.h>
Servo myservo1;
Servo myservo2;
Servo myservo3;
int start=8;
intStop=9;
voidsetup ( )  {
myservo1.attach(10);
myservo2.attach(11);
myservo3.attach(12);
pinMode(start,INPUT_PULLUP);
pinMode(Stop,INPUT_PULLUP);     }
voidloop()  {
myservo1.write(93);
delay(1000);
myservo2.write(68);
delay(1000);
myservo3.write(93);
delay(1000);
if(digitalRead(Stop)==LOW &digitalRead(start)==HIGH)
{  myservo1.write(68);
delay(1000);
myservo2.write(117);
delay(1000);
myservo3.write(68);
delay(1000);
myservo1.write(93);
delay(1000);
myservo2.write(68);
delay(1000);
myservo3.write(93);
delay(1000); }}
```