MedRobo: A Dedicated Robot for Pharmaceutical Industry

Ismat Hira[1], Intesar Ahmed[1], Muhammad Abubakar[2],
Arfa Rehman[1], Bisma Amjad[1], Hira Akash[1]
[1] Department of Electrical Engineering, Lahore College for Women University, Lahore.
[2] Riphah International University

Abstract

Robotics technology deals with design, construction, operation and application of robots. Robotics has become an extremely large and eclectic discipline. By introducing applications of autonomous robotic, easy repetitive tasks can be accomplished keeping the demands of accuracy and speed in mind. Although many robots are available in market but our MedRobo is designed by fulfilling the needs of pharmaceutical industry. For the use in pharmaceutical industry man power is required however this unique robot separates the expired and other medicine cartons itself by using the IR sensors. MedRobo is designed in such a way that it is fixed on board in front of conveyor belt and it works in collaboration with PC instruction about separating the RED color or GREEN color tagged cartons and places them randomly in the work area. These RED color tagged cartons denote expired medicines and GREEN shows medicines having certain temperature requirement. Instructions for robot are programmed in C++ language that proceeds through PIC microcontroller and interfacing between PC.

I. Introduction

In pharmaceutical industry there is a stumbling block to separate medicines according to their expiry date, and temperature requirement, this is tiresome job for man. It will require more man power and more time consuming. To solve this issue it is the need of hour to introduce such interactive system that will work for human welfare and terminate access of harmful medicines from the users.

We are determined to build an interactive MedRobo that will separate the medicines according to the color tagging on the cartons.

Robotics develop man made mechanical device that can automatically move by themselves, which are must be modeled, planned, sensed activated, supervised and whose motion behavior can be influenced by programming. A Robot can be controlled or supervised by human operator, but mostly robotics are controlled by computer. Robot has two categories: Autonomous robots and Insect robot.

An autonomous robot acts as a separate system, with its own computer (called the controller). Insect robots work in fleets ranging from a few to thousands with all fleet members under the observation of a single controller.

II. Parameters

Kinematics

Cartesian, Parallel, Spherical, Cylindrical, Articulated organization and forms of joints is known as Kinematics of Robot. Our focus is on “Articulated Robot Type”, which uses rotary joints to contact with its work space. Typically the joints are settled in a chain, so that one joint supports another in the chain. Articulated robots have the finest used to grip and lift small parts with abundant accuracy. The articulated robot is composed of trunk, shoulder, arm and wrist. With the capability to rotate all the joints, usually these robots have six degrees of freedom (DoF)[1].

Axis 1 Arm sweeps from side by side

Axis 2 Shoulder moves backward and forward.

Axis 3 Elbow moves in above and below direction.

Axis 4 Middle of forearm pivots up and below.

Axis 5 Wrist moves up and below.

Axis 6 Wrist sweeps from side to side.

Degree of Freedom

Number of points a robot can be directionally controlled. A human arm has 7 degrees. Articulated arms typically have up to 6 DOF as defined above [2][3].

We are working with 4 DOF.

Axis 1 - Arm sweeps from side to side

Axis 2 - Shoulder moves forward and backward.

Axis 3 - Elbow moves up and down.

Axis 4 – A wrist moves up and down

Anatomy of Robot

The industrial robot is similar to the human arm in its bodily structure like the hand devoted with the human body. The robot exploiters of the robotic arm are attached to the base. Chest, upper arm and fore-arm in the human body compare with the links in the robot manipulators [4][5]. The elbow and the shoulder in the human hand are characterized by the joints in the robot arm. As the industrial robot arm compares with the human hand they are also known as anthropomorphic or articulated robot.

Table I. Anatomy of Robot

Anatomy	Representation
Body	Base
Chest	Link
Shoulder	Joint
Upper Arm	Link
Elbow	Joint
Fore Arm	Link
Wrist	Joint

The drives or motion of the link is provided at the joints. The joints motion can be rotational or translatory. The tool known as end-effector is attached to the wrist. The end-effectors are not considered as the part in the robot anatomy [2]. Robot Anatomy is shown in the figure below

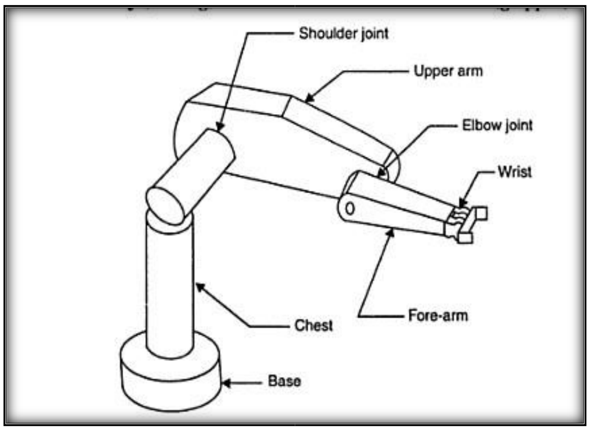


Figure 1. Robot anatomy

Work Space

The reach of the robot is defined as the workspace of the system. All programmed points within the reach of robot are part of the workspace. The workspace shape of the project robot is rectangular.

Robot Motion

The robot has two basic movements:

- The base travel movement.
- The arm rotational movement.

End Effector

The End-Effector is the hand linked to the machine arm. It is different from the humanoid hand. The end-Effector provides the mechanical system the flexibility essential for the process of the robot. The end- Effector of the project is a attractive gripper and is driven by 12V DC source.

Pay Load

Payload is the weight ability of the robot. The project robot has a low load of 130gm.

Actuations

The process of driving the machine axes is called actuation. The actuation system used in the robot is electrical.

Dimensions of Robot

We have designed a MedRobo of length 21 inches and width is 3 inches. The upper arm of our robot is 8.7 inches in length, fore arm has the length of 7 inches while wrist is 4.5 inches long.

Degree of Freedom

Human arm have seven degree of freedom but utmost every robotic arm has four degree of freedom with five servo motors which are organized by the use of only one PIC microcontroller.

Payload Capacity

MedRobo can lift substances up to 130gm but our designed Robotic Arm can lift up to 150 gm.

Maximum Reach

MedRobo could grasp things about 40cm in a hemisphere and it is made by aluminum that make it inexpensive and light weight. On the other hand Robotic arm has the ability to extent 35cm in the hemisphere.

Hardware Interface

Both the Robots having hardware interfacing with PC is done by USB port.

Software Interface

Developing the graphical user interface in NetBeans IDE 7.1.2 software using Java language, while robotic arm's GUI using only the open CV high GUI utilities.

Movement

Keeping the design of MedRobo grip modest as identical to human's hand grip, as well as executing the gripping mechanism with one servo motor only.

III. Hardware Design Detail

Servo Motors: A servomotor is a rotating actuator that permits for accurate control of rawboned location, speed and acceleration. It contains a appropriate motor joined with a device for location feedback. Typical servo motors have three wires, which are for power (4-6 V), ground and control. The dimensions and profile of the servo motors are reliant on the application. RC servo motors are the most used type of servo motors used in robotics due to their affordability, consistency and ease of regulate by microprocessors.

Programmable Interface Controller

PIC is electronic circuit that can be automated to carry out enormous jobs.

1. They can be designed as timers to control a manufacture line.
2. They are found in many electronic devices such as alarm systems, processor based control systems, iPhone etc.

3. There are many types of PIC microcontrollers, although the finest are established in the GENIE variety of programmable controllable micro-controllers.
4. These are designed and simulated by Circuit Wizard software Proteus.
5. PIC Microcontrollers are comparatively inexpensive and can be bought by any user as pre-built circuits kits.
6. A microcontroller has a devoted contribution device and frequently has a small LED or LCD display for production results. A microcontroller also receive input from the device and controls the device by conveying indicator signals to different components in the device.

IV. Methodology

MedRobo is programmed and designed in association with an interfacing PC. The interfacing between MedRobo and PC is accomplish by a USB port. PIC 18F452 microcontroller is used to regulate and control the process flow, to give instructions. MedRobo works with 4 axis of revolution and Servo motors 6V are used that permits accurate control of angular position, speed and acceleration of joints.

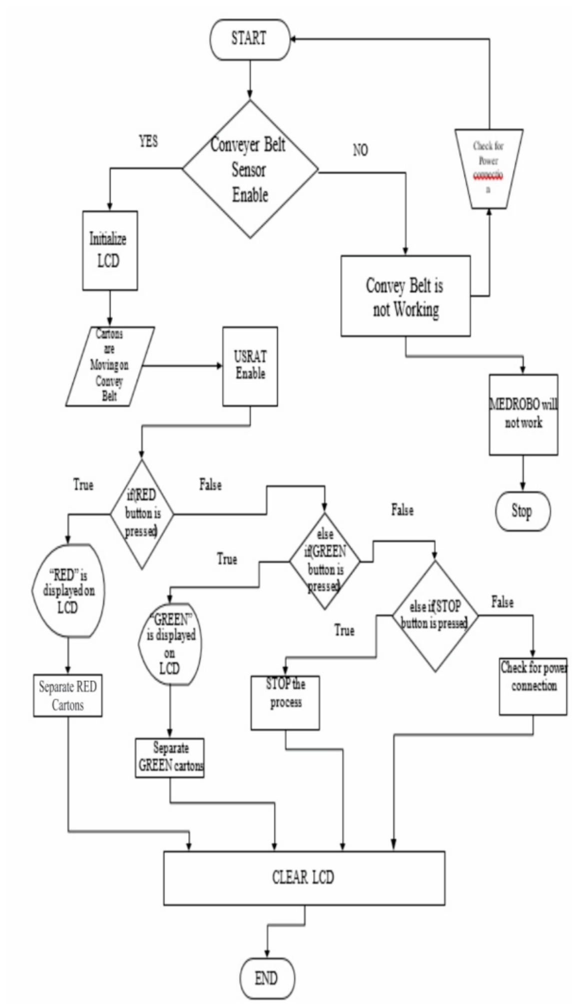
1. Medicine cartons are tagged manually either RED or GREEN. There are three colors in which cartons can be tagged RED, BLUE or GREEN.
2. A joining is made between MedRobo and PC through USB port and MAX232 IC is used with RS232 Communication connector in which the voltage conversion is required that makes TTL devices to be compatible with PC serial port.
3. A permanent magnet DC tackle motor of 12V is used along with this conveyor belt to route it. When input instruction is given, conveyor belt sensor enables and DC gear motor starts the conveyor belt.
4. USART is a chip that enables communication by a computer's serial port using the RS-232C protocol. It is empowered and checks for the instructions. There can be three inputs for conveyor belt.
   - From red button
   - From green button
   - From stop button

Here RED/ GREEN are considered to be “1” and S is considered to be “0” at back end in coding.

5. When cartons move on conveyor belt, IR sensors will dynamic that something is affecting the belt and then color detector turns on for red and green and start detecting color of specific wavelength in infra-red spectrum. If Red button is enable through PC, sensor for Red color enables and MedRobo starts separating Red tagged cartons and when GREEN is enable through PC, sensors for Green colors enable and MedRobo separates only green tagged cartons. MedRobo will place the separate cartons on the permitted location.
6. When Stop button is pressed Conveyor belt stops and the system stop working for cartons separation and LCD is reset.

V. Process Flowchat

Processing for MedRobo starts with manual tagging of the cartons. Cartons are tagged in two colors, Red and Green. Red colored cartons denote expired medicines that are needed to be separate from other medicines to avoid their access from public and Green color cartons show any certain medicine that require to be kept at certain temperature otherwise it may spoil and prove to be harmful. Power is switched on and these cartons are moved on conveyer belt. MedRobo is attached with PC through Serial port. Instruction is given to MedRobo to separate a particular tagged carton either Red of Green. It depends on particular button pressed through PC either RED or GREEN button. MedRobo separates the carton and drops it on allocated place. When we wish to stop the process, STOP button is press through PC and entire work terminates.



VI. Software Unit

MedRobo will separate the cartons according to colors. When we pressed “R”, RED will display on LCD and servo motors starts rotating accordingly as shown in figure 3.

When we pressed “G”, GREEN will display on LCD and servo motors starts rotating accordingly as shown in figure 4.

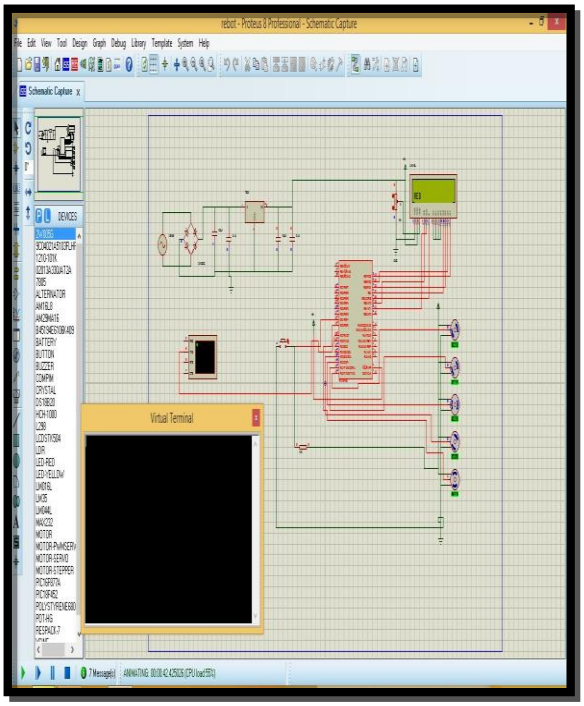


Figure 3. Proteus screenshot while RED displaying

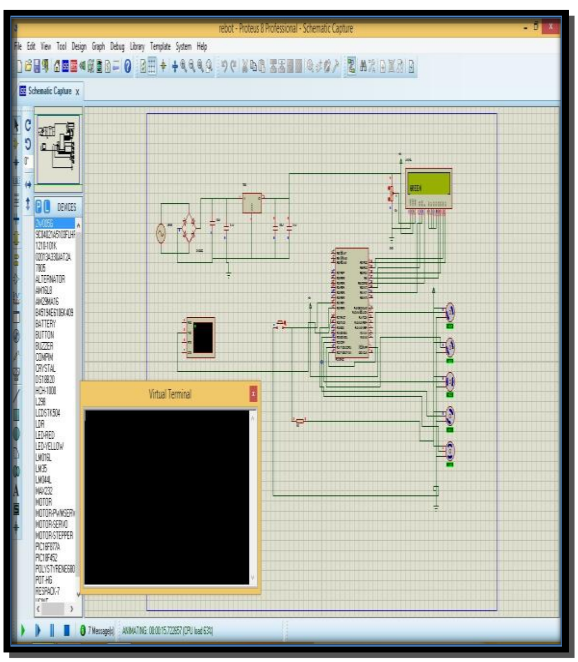


Figure 4. Proteus screenshot while GREEN displaying

VII. Structure

The structure of MedRobo is made up of aluminum. We use aluminum to build our robotic arm because it is cheap and light weight. The arm consists of Upper arm, lower arm and wrist.

Upper Arm

The upper arm of our robot is 8.7 inches in length. Two aluminum sheets of same length are joined together with a clip to fully support the motor attached. The motor is attached to move the upper arm in up and down direction. The upper arm is attached with the forearm.

Fore Arm

The fore arm of our robot is 7 inches long. Same as upper arm the fore arm is also made up of two acrylic sheets joined together with a clip. The motor attached to the fore arm allow it to move in upward and downward direction. The forearm is attached to wrist.

Table II. Structural details

Structure	constraint
Material	Aluminum
Upper Arm	8.7 inches
Fore arm	7 inches
Wrist	4.5 inches
Clip separation	7 inches
Conveyor Belt	Cylindrical path

Wrist

The wrist of our robot is 4.5 inches in length and the separation between the two clips is 7 inches. The motor attached to the wrist is also allowing it to move in upward and downward directions. The gripper is an electromagnet which is attached to the wrist of the robot.

The main structure of our Interactive MedRobo and Medeilo Management System consists of four main parts:

- Conveyor belt
- Robotic arm
- Electrical circuits
- PC

Conveyor Belt

The big box like and the main part of the structure is the conveyor belt on which the main task is performed. The conveyor belt moves in cylindrical path with an angle of 360. Permanent magnet DC gear motor initiates the conveyor belt. Two sensors are placed on the track of conveyor belt. First one is the IR sensor which detects the object and the intensity of the object. Second is the color sensor which detects the color tagging of the object coming on the conveyor belt.

Robotic Arm

Color sensors and IR sensors give information to the microcontroller and in return microcontroller allows passing other colors and places the desired colored cartons besides the conveyor belt.

Electrical Circuits

Three electrical circuits are connected on the main base of the project board that are Microcontroller's circuit, Relay circuit, and LCD circuit. PIC microcontroller controls all the operations of the circuits. It also controls the relay portion and its instructions are displayed on LCD.

PC

All the main tasks of the sensors and color tagging are operated by the help of PC. We can also shuffle the colors of the sensor about which to pass and which to place aside.

Figure 5. Complete Structure of MedRobo

VIII. Results

The designed Medrobo with four degree of freedom and human anatomy parameter listed in section II uses the unique algorithm described in section V and VI. When the defined color tag on the medicine carton is of new medicine stock, the robot will allow passing them, but if the color tag is of the expired medicine the robot will pick it from the conveyor belt and place aside. Robot detects the conveyor belt path which uses IR sensors which detects the belt and sends the information to comparator and then to H bridge which controls the working of the arm. Microcontroller controls the other operations.

IX . PCB LAYOUT

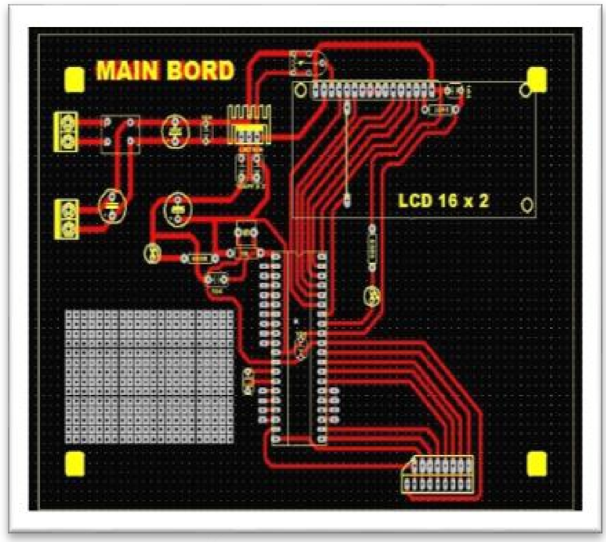


Figure 6. Main PCB Board

X. References

[1] Pelossof, R., Miller, A., Allen, P. and Jebara, T. (2004), "An SVM learning approach to robotic grasping", in proc. IEEEP int. conf. Robotics And Automation 2004, pp.3215-8.

[2] C. C. Kemp, A. Edsinger, and E. Torres-Jara, "Challenges for robot manipulation in human environments [Grand challenges of robotics]," IEEE Robotics and Automation Magazine, vol. 14, no. 1, pp. 20–29, 2007.

[3] Y. Liu, T. Mei, X. Wang, and B. Liang, "Multisensory gripper and local autonomy of extravehicular mobile robot," in proc.IEEEP int conf Robotics and Autmation.

[4] T. D. Thanh, J. Kotlarski, B. Heimann, and T. Ortmaier, "On the inverse dynamics problem of general parallel robots," in proc. IEEEP int conf. Mechatronics (ICM '09), pp. 1–6, Malaga, Spain, April 2009.´

[5] iRobot, "iRobot Create Owner's Guide," iRobot, Inc., 2006, http : / /www.irobot .com /hrd right rail/create rr/create fam / createFam rr manuals.html.