International Journal on Applications in Electrical and Electronics Engineering
Volume 2: Issue 4: April 2016, pp 26-30. www.aetsjournal.com ISSN (Online) : 2395 -3527

Technology Transferred Modeling Approach of Multipurpose Industrial Robot Design

Mr.C.Manivel, Ms.Malarvizhi, Mr.N.Gopalsamy

Abstract— *In the world of technology, there is a vital role for robotics to make human life better in many ways. The proposed Multi-Purpose Mobile Robot is a creative innovation which brings both complex technology and aesthetic design all together. This robot consists of a robot arm with 4 degrees of freedom. We are introducing the easiest form of control with a pendant that consists of a joystick and motion control with inbuilt inertial measurement sensors. In pendant mode, the robot calculates all of Its joint parameters using forward kinematics. The robot can also be controlled using simulation software. In simulation mode, user can either provide the desired angle of each joint, or coordinates of the end effector. If coordinates are provided, the robot calculates each joint parameters using Inverse kinematics. The software also creates the 3D simulation of the arm even before uploading the instructions to the robot so as to prevent most of the accidents and errors. To eliminate the main limitation of robot arms, locomotion ability is given to this multi-purpose mobile robot which makes it very helpful in various applications. The inbuilt Proximity sensors helps avoid any collisions ahead and finds the optimum route to maneuver. This makes this robot really multi-purpose, with the addition of an end effector which can be a universal gripper the robot can be used as a pick and place robot as well as a personal assistant for a physically challenged person also.*

Keywords— *Robot Arm, Robotics, Simulation, locomotion of robot arm, Multi-purpose*

I. Introduction

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing.

A 'mobile robot' is a robot that is capable of moving in the surrounding. Mobile robotics is usually considered to be a subfield of robotics and information engineering. Mobile robots have the capability to move around in their environment and are not fixed to one physical location. Mobile robots can be "autonomous" which means they are capable of navigating an uncontrolled environment without the need for physical or electro- mechanical guidance devices. Alternatively, mobile robots can rely on guidance devices that allow them to travel a pre-defined navigation route in relatively controlled space. By contrast, industrial robots are usually more- or-less stationary, consisting of a jointed arm and gripper assembly, attached to a fixed surface. Mobile robots have become more commonplace in commercial and industrial settings. Hospitals have been using autonomous mobile robots to move materials for many years. Warehouses have installed mobile robotic systems to efficiently move materials from stocking shelves to order fulfillment zones. Mobile robots are also a major focus of current research and almost every major university has one or more labs that focus on mobile robot research. Mobile robots are also found in industrial, military and security settings. The components of a mobile robot are a controller, sensors, actuators and power system. The controller is generally a microprocessor, embedded microcontroller or a personal computer. The sensors used are dependent upon the requirements of the robot. The requirements could be dead reckoning, tactile and proximity sensing, triangulation ranging, collision avoidance, position location and other specific applications. Actuators usually refer to the motors that move the robot can be wheeled or legged. To power a mobile robot usually we use DC power supply instead of AC.

Robotics have emerged and advanced at an exponential rate since the initiation of the 20th century. These robots function in potentially hazardous settings in proximity to biological dangers. It enables the betterment of physically challenged people’s lives. Due to assistive technology people with disabilities have an opportunity of a more positive and easygoing lifestyle, with an increase in social participation, security and control, and a greater chance to reduce institutional costs without significantly increasing household expenses. The proposed multi-purpose mobile robot arm can be used as a device that replaces a missing body part or it can be used to replace a person in some cases too. The mobile robot allows the user to control it using a joystick or by other adaptive methods. A robot arm with 5 degrees of freedom is mounted on a base which can be moved around the workspace as the users needs. The multi-purpose mobile robot is made in a compact design which makes it human friendly more than ever.

II. Literature Review

Vaibhav Kharat [4] studied about system presents the wireless bomb disposal robot which will help to improve defense of our nation from terrorist, suicide bombers and other such activities. The bomb detectors and disposal system works

Mr.C.Manivel, Assistant Professor, Nehru Institute of Engineering & Technology, Coimbatore, Tamilnadu, India
Ms.Malarvizhi, Assistant Professor, Mount Zion College of Engineering and Technology, Pudukkottai.Tamilnadu, India
Mr.N.Gopalsamy, Assistant Professor, Nehru Institute of Engineering & Technology, Coimbatore, Tamilnadu, India

only with the presence of experts. But this way of analyzing takes more time and make risk to life of experts. The Wireless Bomb Disposal Robot uses a control application, at the user end to control the robot remotely using Wireless technology. The bomb technician controls the robot using this application at control site. The Robot consists of a Base, a robotic Arm, RPI, and a wireless camera on it. We have used DC motors for the moving robot and the gripper of the robotic arm. As we are not risking the life of an bomb expert or any other commando. Hence introducing the safest way for disposing the explosive to save life of common people. So with the help of IOT technology DEFENSE system also can get an advance defense device in the form of BOMB deposing ROBOT. As we know disposing of bomb is a big task for human being there is always fear of loss or life in case any mistake's done by human that's why robotics technology can give solution this problem

Rizwaan Areef Shaikh [5] proposed a project which is aimed to provide an handling of different type of hot discs prior to forming operation. In Present situation, hot discs (approx. at guided to operator by conveyor from the furnace. Operator pics the disc with the help of tounge and places it on forming setup. The process is slightly time consuming, due to that the temperature of disc decreases and that results in decrease in quality. In addition to that, as the weight of disc is quite high (22 to 35kg/disc),the process was taking large amount of human efforts. To address all these issues, the team decided to Design a pick and place type robot in the work area.

Kurt E Clothier [6] proposed a geometric approach to solve the unknown joint angles required for the autonomous positioning of a robotic arm. A plethora of complex mathematical processes is reduced using basic trigonometric in the modeling of the robotic arm. This modeling and analysis approach is tested using a five-degree-of-freedom arm with a gripper style end effector mounted to an iRobot Create mobile platform.

The geometric method is easily modifiable for similar robotic system architectures and provides the capability of local autonomy to a system which is very difficult to manually control.

III. PROBLEM IDENTIFICATION

Existing and conventional robot arms has no correspondence with humans. Robot arms were kept inside a cage as they were not designed to work alongside humans and all the existing robot arms will look scary to humans because of the same reason. Robot arms were always immobile and large in size which made them not suitable for day to day usages. Due to the excessive size and weight all the existing robot arms had so much limitations. They required a very frequent monitoring and maintenance.

A skilled labor was mandatory to operate the robot arm because there wasn't any user friendly interfaces were available, The person who is operating the robot arm should have good knowledge in programming and electronics as well as in pneumatics too. This causes various troubles and hazards because of the complexity in controlling a robot arm.

As mentioned above the only possible way to control a robotic arm was through complex programming which made it impossible to control a robotic arm with a joystick and implement gesture control in it. Due to the need of pneumatic systems and other heavy and high energy consuming actuators the operation of a robotic arm was always a nightmare for a common man. Due to the presence of all these heavy components the design of a robot arm was never that much aesthetic. Specific robot arms were used for performing specific tasks. Once a robot arm is programmed to do a specific task it could not do any other operation rather than that. Because of this for doing each operations different arms should be there for that and this made people to think like the implementation of robot arm is no longer feasible.

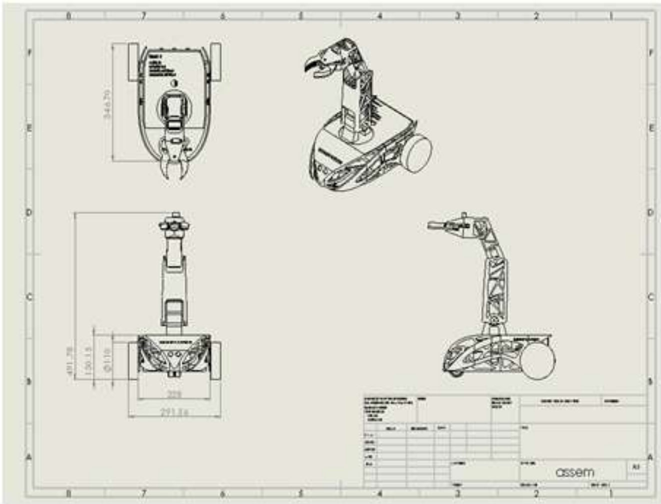


Fig 1. Dimensional Drawings of Front view, Left view and Top View

Figure 1.shows the dimensional specifications of the project design. All dimensions are in mm.

IV. FABRICATION TECHNIQUES

The problems which were discussed in earlier chapters are resolved and fabricated based on the following techniques:

- Used a PLA based filament to 3D print the joints and links of the robot arm and the body of the pendant as well as the body of the base of the robot.
- The base is made of thick acrylic sheets for greater weight bearing capacity.
- The Servo motors provides low speed and high torque giving much accuracy and precision.
- The NRF and Bluetooth module helps the robot to connect with the control unit wirelessly which is the pendant.
- The base of the robot arm is equipped with wheels which enables the movement of the robot. The base of the robot is thick and strong enough to bear the weight of the joints as well as the payload.
- The proximity sensors installed on board will detect the obstacles on the floor and the robot will choose the right path

to travel. Which will make sure risk free operation of the robot arm too.

• The control unit or the pendant is equipped with a joystick which helps to move the links and joints of the arm according to user's wish and it also helps to move the robot in forward, backward, left and right.

V.WORKING PRINCIPLE

The robot can be controlled by any person with the help of the pendant. Following are the steps involved in the working of the robot:

A. Controlling the Robot with the pendant

The robot communicates with the control unit or the pendant through radio frequency. The pendant grasps the movement of the joystick on board and the microcontroller placed in the pendant will transfer these input instructions into the robot. The receiver part in the robot will transfer these packs of instructions into the mother board of the robot and the micro controller will give instructions to actuate the servos for obtaining required positions of the links of the robot by varying the joint angles. The same joystick in the pendant can be used to navigate the robot in forward, backward, left and right directions.

B. Controlling with gyroscope

The easiest way of controlling a robot arm ever, is with the help of a gyroscope. The inbuilt gyroscope in the pendant will change the position of the links of the arm by varying the angles between each joints, in other words the robot can mimic the shape of your arm by grasping the values of your hand in the 3D space and the micro controller will do the rest of the job.

C. Controlling the robot with the help of a simulation software

The robotic arm can be operated by a unique software too. The software is designed to analyze and simulate the movement of the arm. User can enter the angles of each joints through the user interface and the software will analyze the motion of the arm in respect to the input values and it will simulate that same motion graphically. This helps to avoid many accidents caused due to wrong inputs. Any mistake caused by lack of attention of the user can be avoided with the help of this software. This software is easy to use and specially made to ease the controlling of this robot.

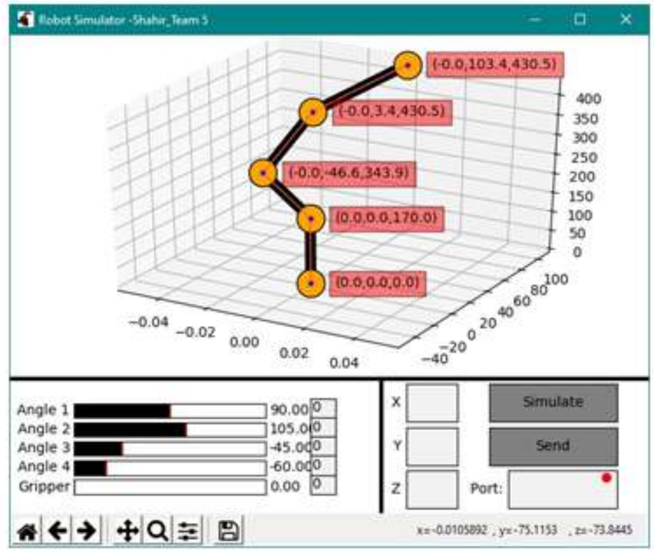


Fig 5.3 View of the Simulation software

With the help of incorporated AI in the software it warns the user in case of any accidents or collisions. The robot communicates with the software using Bluetooth connectivity after the initial pairing of the robot with the software. After getting the input angles through the user interface the software will use an algorithm to calculate the Inverse kinematics of the robot arm and it then performs the simulation.

Operation of the Robot in daily life of a physically challenged person's life.

A person who is differently abled but he or she has no other ways than spending their life on a bed could change their life with this multi- purpose robot. Even a partially paralyzed person could use the joystick on the pendant with the gyroscope to perform most of their daily tasks. Example tasks such as picking some medicine or picking a glass of water can be done with the movement of fingers even after he/she is lying on the bed. The movement of fingers will trigger the joystick and the movement of wrist and hand will trigger the gyroscope too. Therefore a second person's need in his/her life can be eliminated up to a point and he/she will feel more independent and socially secure.

VI. MODEL CALCULATION

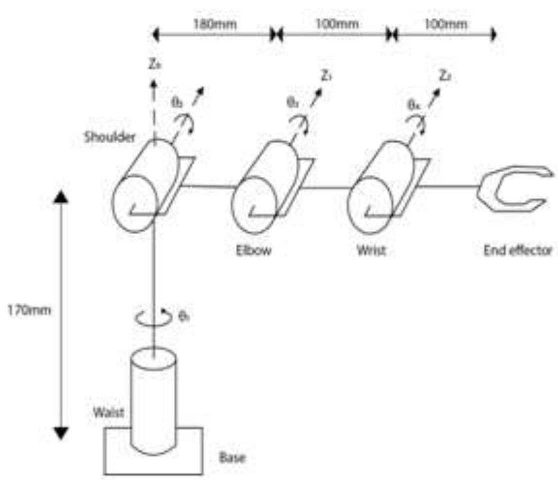
DEIGN PARAMETER OF THE MODEL:

- Operating Speed = 0.08 s/60 degree
- Material Used For Printing = PLA

PRINTING SPECIFICATIONS:

- Heat Bed Temperature = 60 Degree Celsius
- Nozzle Temperature = 200 Degree Celsius
- PLA Dimension = 1.75mm

GRIPPING FORCE UNDER NORMAL CONDITION:



Considering the following variables:

F: Gripping Force (N)

μ: Co-Efficient of Static friction between the fingers attachment and the work part

m: Work Part weight (kg)

g: Acceleration due to Gravity(9.8 m/s2)

The condition in which the work part does not drop when the work part is gripped statistically:

F μ > W

F> mg/ μ

Necessary gripping force as the recommended safety factor of 2 in normal transportation:

Therefore the force acting at the tip of the finger is given by F = Torque acting X Perpendicular Distance

F = 44 kgf. Cm X 38 cm F = 1675 kgf. Cm2

Hence total Force acting on the work piece by two fingers (F) F = 105.6 X 2

F = 211.2 kgf. Cm2

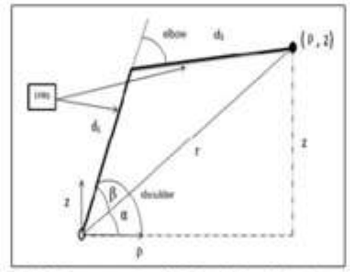


Fig.1. 2D representation of 3 DoF Articulated Robotic Arm

From the coordinate system transformation results we get,

$$r = \sqrt{p^2 + z^2} = \sqrt{x^2 + y^2 + z^2}$$

$$\text{Base} = \tan^{-1}(y/x)$$

From Cosine rule

$$r^2 = d_1^2 + d_2^2 - 2d_1d_2\cos(180 - Elbow)$$

Therefore,

$$\text{Elbow} = -cos^{-1}\left(\frac{x^2 + y^2 + z^2 - d_1^2 d_2^2}{2d_1d_2}\right)$$

From the figure 1, we know that,

$$\alpha = \sin^{-1}(z/r)$$

and from trigonometry,

$$\beta = \tan^{-1}(d_2 sin(elbow)/(d_1 + d_2 cos(elbow))$$

So,

$$\text{Shoulder} = sin^{-1}\frac{z}{r} + tan^{-1}\left(\frac{d_2 sin(Elbow)}{d_1 + d_2 cos(Elbow)}\right)$$

So, the final results for Inverse Kinematics are:

$$r = \sqrt{x^2 + y^2 + z^2}$$
$$\text{Base} = tan^{-1}\left(\frac{y}{x}\right)$$
$$\text{Elbow} = -cos^{-1}\left(\frac{x^2 + y^2 + z^2 - d_1^2 d_2^2}{2d_1d_2}\right)$$
$$\text{Shoulder} = \sin^{-1}\left(\frac{z}{r}\right) + tan^{-1}\left(\frac{d_2 sin(Elbow)}{(d_1 + d_2 cos(Elbow))}\right)$$

A. Inverse kinematics

B. FINAL ASSEMBLY OF PROJECT

Figure 2. Final Project Model

VII. CONCLUSION

1. It is working wonders in terms of increasing efficiencies all around. Possibly the greatest benefit is the implementation of Mobility, More human friendly than ever, and the ease of operating this robot arm.

2. Robotics has brought about a great impact on the error rate reduction soon after their application.

3. There has been effective and seamless assistance to physically challenged people.

4. The need of an extra labor to take care of the physically challenged person is reduced drastically by applying robotics.

5. The need of skilled labor for operating a robot arm alone is no more a concern.

6. There is a general shift toward that, which means costs will be going down in time which means robotics will be employed widely in near future.

7. Thus the replacement of human or a human body part such as hand can be used as a replica of that human.

VIII.REFERENCES

1. Chávez Rodríguez and J. Esquivel Villar. (2006). Remote Manipulation of a Robotic Arm by Using Infrared Sensors. Annual. Boston, Massachussetts.

2. Joaquin Ortiz, Ivan Godinez, Rosa I. Peña and Immanuel Edinbarough. (2005). Robotic Arm Vision System. Texas, United State.

3. Francesco Mondada, Edoardo Franzi, and Paolo Ienne. (1993). Mobile robot miniaturization: A tool for investigation in control algorithms. Proceedings of the 3rd International Symposium on Experiment Robotics. 501-513.

4. 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.

5. C. S. G. Lee, "Robot arm kinematics, dynamics, and control," Computer, vol. 15, no. 12, pp. 62–80, 1982.

6. Y. Liu, T. Mei, X. Wang, and B. Liang, "Multisensory gripper and local autonomy of extravehicular mobile robot," in Proceedings of the IEEE International Conference on Robotics and Automation, vol. 3, pp. 2969–2973, New Orleans, LA, USA, April 2004.

7. T. D. Thanh, J. Kotlarski, B. Heimann, and T. Ortmaier, "On the inverse dynamics problem of general parallel robots," in Proceedings of the IEEE International Conference on Mechatronics (ICM '09), pp. 1–6, Malaga, Spain, April 2009.

8. iRobot, "iRobot Create Owner's Guide," iRobot, Inc., 2006,

9. Z. Xu, T. Deyle, and C. C. Kemp, "1000 trials: an empirically validated end effector that robustly grasps objects from the floor," in Proceedings of the IEEE International Conference on Robotics and Automation (ICRA '09), pp. 2160–2167, Kobe, Japan, May 2009.

10.Balan, L., Bone, G.M., 2003. Automated Gripper Jaw Design and Grasp Planning for Sets of 3D Objects. J. Robot. Syst. 20, 147–162. doi:10.1002/rob.10076

11.Balasubramanian, R., Xu, L., Brook, P.D., Smith, J.R., Matsuoka, Y., 2012. Physical Human Interactive Guidance: Identifying Grasping Principles From Human-Planned Grasps. IEEE Trans. Robot. 28, 899–910. doi:10.1109/TRO.2012.2189498

12. Barber, C.B., Dobkin, D.P., Huhdanpaa, H., 1996. The Quickhull Algorithm for Convex Hulls. ACM Trans Math Softw 22, 469–483. doi:10.1145/235815.235821

13.Bicchi, A., 1995. On the Closure Properties of Robotic Grasping. Int. J. Robot. Res. 14, 319–334. doi:10.1177/027836499501400402

14. Bicchi, A., Kumar, V., 2000. Robotic grasping and contact: a review, in: IEEE International Conference on Robotics and Automation, 2000. Proceedings.ICRA'00,pp.348–353 vol.1. doi:10.1109/ROBOT.2000.844081

15. Bohg, J., Morales, A., Asfour, T., Kragic, D., 2013. Data-Driven Grasp Synthesis - A Survey. ArXiv13092660 Cs.

16.Brost, R.C., Peters, R.R., 1998. Automatic Design of 3-D Fixtures and Assembly Pallets. Int. J. Robot. Res. 17, 1243–1281. doi:10.1177/027836499801701201

17.Brown, R.G., Brost, R.C., 1997. A 3D modular gripper design tool, in: , 1997 IEEE International Conference on Robotics and Automation, 1997. Proceedings. Presented at the , 1997 IEEE International Conference on Robotics and Automation, 1997. Proceedings, pp. 2332–2339 vol.3. doi:10.1109/ROBOT.1997.619310

18.Bruyninckx, H., Demey, S., Kumar, V., 1998. Generalized Stability of Compliant Grasps, in: In Proceedings of 1998 International Conference on Robotics and Automation. pp. 2396–2402