WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review Paper on WallCraftBot- With PID Controller

Miss. Madhura Sharad Gurav*[1], Miss. Vrunda Rahul Belekar*[2], Miss. Anushka Appasaheb Nirmale*[3], Miss. Shravani Sanjay Vadagve*[4], Miss. Shreeya Arunrao Mutalik-Desai*[5], Mrs. R. V. Karoshi*[6]

[*1,2,3,4,5] Student's Department of Automation and Robotics Engineering Sharad Institute of Technology Polytechnic, Yadrav.

[6*] Lecturer Department of Automation and Robotics Engineering Sharad Institute of Technology Polytechnic, Yadrav.

ABSTRACT

The proposed paper eliminates manual control for pick and placesystem. The robot manipulator has three joints and two links, powered by three DC motors controlledby an Arduino. We calculate the link length to support the weight of the desired object. The position of the arm's end is determined using kinematic modeling, which involves forward and inverse kinematics. A robotic toolbox helps with positioning the arm using these methods.[1]

PID control method is used for accurate position of the end effector. In this research the gain of the PID controller is tuned by using the Ziegler-Nichol method. This proposed paper introduces 2 new control methods for robot arm, addressing challenges like strong nonlinearity and coupling.[2] These methods effectively handle external velocity and position disturbance, ensuring stability inboth position unlike traditional adaptive PD control, these approaches enhance disturbance tolerance, improve trajectory tracking accuracy, and boost overall manipulator system dynamics.

The stability and convergence of the system are proven through analytical methods like Lyapunov stability theory and Barbalat's lemma. Simulations are performed for a planner manipulator with two rotary degrees of freedom to illustrate the viability and the advantages of the proposing controllers.[3]

(Keywords–PID Controller, Brick laying robotic arm, Servo motor, etc.)

I.I NTRODUCTION

A PID controller, or Proportional- Integral-Derivative controller, is a feedback control system commonly used in engineering and automation. It helps regulate a process by continuously adjusting the output based on the difference between a desired setpoint and the current position of the system. PID control in industrial robot arm regulation, highlighting a perceived lack of solid theoretical foundation.[4] The paper proposes a novel stability proof for robot arms under PID control, focusing on a model that emphasizes the nominal decoupled linear aspect. The key finding establishes a straightforward relationship between the exponential stability degree of the nominal closed-loop system and parameters governing nonlinear terms in the mechanical manipulator's dynamic model.

The paper discusses exploring relationships between nominal system eigenvalues and the extension of the stability region. Theoretical findings are then validated using a straight forward two DOF example. The interest in robotic arms has been increasing during the course of the years at a vertiginous speed. The futuristic air that surrounds them has aroused the curiosity of many companies, which have made great investments on their development. Their coordinated and smooth movements define these devices as dynamic machines. [4]Andtheir great precision is only compared to its overwhelming accuracy. It can be defined that these robotic manipulators are a superb engineering work. More exactly, the engineering branches that participate in their design are the mechanical, electronics and control ones, working together in all to have a mechatronic design. In this paper, the main elements are the robotic arm and its control.[5]

Therefore, a literature review along the robotic arms is made. Besides, their applications and importance for the industries are also discussed. Additionally, the significant need of a controller in the system to ensure a high efficiency is mentioned too. And for achieving a great control of the process, the PIDcontroller is recommended. Consequently, the different ways of calculating the parameters of the PID controllers are also shown.[6] After completing the literature review and consequently, learning the basis of robotic arms, everything leads to apply this knowledgeinto a real one. However, first of all it is important to specify the motive of this robotic

arm. That means assigning it a certain performance and behavior in relation with its environment. Once this is stated, it will be time toget into a more technical part. This part consist inputting forward the structure of a real robotic armand to study it thoroughly. For doing so, the elements that constitutes the robotic arm will be carefully studied, and based on them, the dynamic mathematical equations of the arm will be presented. Then, once the arm is modelled, it will be implemented in a software to check if its equations do really work or not.

After that, a simulation will be carriedout and the results will be analyzed in so that to know if the behavior of the arm would be right in case it was built in real life. After all the practical part has finished, it will be the moment to give another pointof view by suggesting future improvementsin the design. The current design will be judged with the goal of looking for enhancements in future approaches. The point of this section is just to lead the future designers into the possible ways to perfect the actual robotic arm proposed in this paper. [7] And at last, this paper will end up with a conclusion that summarizes all the parts discussed and shown along the whole project.

II. LITERATURE REVIEW

Amin A. Mohammed- study delves into the kinematics model of a 4 DOF robotic arm, specifically the RA-02.The Denvait- Hertenberg(DH)Parameters and the product of the exponential formula that is rooted in the screw theory is used to tackle the direct Kinematic problem .Both the approaches act identical solutions formanipulator kinematics. Additionally, an algebraic solution, employing trigonometric formulas, is presented for the inverse kinematics problem. Based on the DH convention, simulation results for kinematics model using the Matlab application are also given. Given the equivalence of the 2 approaches, theexponential formula's product is await to generate identical simulation results for the studied robotic arm.[6]

Ge and Jin :-In order to solve the forward and inverse kinematics problems, Ge and Jin devised an algorithm for redundant robot kinematics based on the product of exponentials (PE). A solution to the inverse kinematics problem was proposed when it was broken down into multiple smaller issues and examined one at a time. The forward and inverse kinematics of a robotic arm known as the Katana450 are studied using the exponential product method in [8], which also proposes three- merit virtual scene modelling techniques for robot manipulators. Based on these techniques, an interactive simulation system is constructed for robot manipulators.

These methods include OpenGL, VRML, and one more that uses the Matlab, Lab View, and Visual C++ platforms. A robot simulator built on Matlab was presented by Lodes [9], enabling the modelling of any robotic arm with known DH parameters. The forward and inverse kinematics of a robotic arm known as the Katana450 are studied using the exponential product method, and an interactive simulation system is built based on three-merit virtual scene modelling techniques proposed for robot manipulators shape and size was implemented. The program has successfully demonstrated accurate modelling for several example robots for robot manipulators is given in[7].

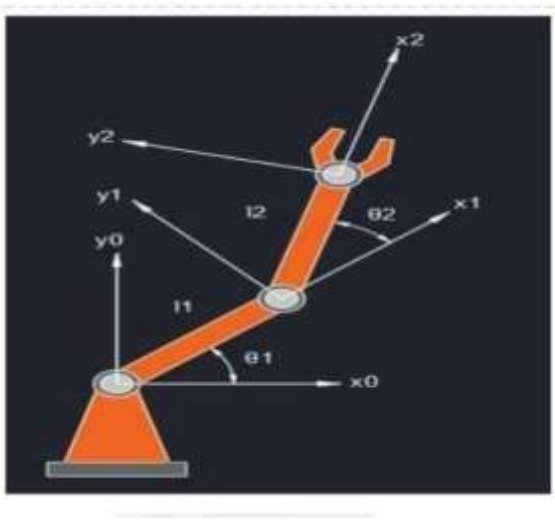
Jasjit Kaur et al- A three-link robotic arm manipulator was analysed and simulated by Jasjit Kaur et al. and associates. Two solutions were obtained using the inverse kinematics, and a genetic algorithm was used to identify the best one. The study concludes that genetic algorithms approach for optimizing the movement of robotic arms. Furthermore, an approach based on geometry is shown to deal with unknown joint angles for autonomous arm positioning.[8]

III. METHODOLOGY

The methodology employed by this paper starts with a deep research on the robotic arms world. It is important to understand every single thing related to these arms, so before starting the project, it has been looked for as much information as possible. Besides, this information is contrasted to check if there is any error or misleading data among the sources.[9]1.Robotic arm-Robotic Arm is a programmable mechanical arm that is very similar to a real human arm. This is because among its structure, it is possible to identify as shoulder, an elbow and a wrist. Robotic arms typically feature a gripper or robotic hand as their end effector, allowing them to autonomously interact with the environment. These robotic arms often surpass human arms in terms of applications and capabilities.[

Thisis due to although they have fewer degrees of freedom, their joints can move through greater angles, reaching more spots than the human one. Also, if the robotic arm is told to holdan object in the air, it will be able to do it indefinitely, while the human being would get exhausted after some time. Therefore, the importance of the robotic arms has been increasing more and more through the pass ofthe years.[10]

PID Controller - A PID controller is an instrument used to drive systems towards its target positions. They use a closed-loop control feedback to maintain the actual output of a system as close to the desired output as possible. For doing these, they offer a practical and effective have to work directly with the error signal, which is the difference between the setpoint and the actual output. The PID controller is composed of three different actions, the proportional (P) action, the integral (I) action and the derivative (D) action.[7]



Each action has a different functionality that can help the process to improve its performance. And depending on the system requirements, a certain combination of these actions is used. The possible combinations are: only proportional (P), proportional + derivative (PD), proportional + integral (PI) and proportional + integral + derivative (PID).[10] The most common and effective one is the PID action, although sometimes it is enough to have a P, PI or PD. Each control action equation and its application is going to be discussed, but first of all is important to define the signal properties that are going to be affected by the control actions.[5] [10]

IV. CONCLUSION

This paper has been useful to approach people who did not had any idea about robotic arms more than a basic knowledge on these manipulators. It has walked along a pathway in which the history of the robotic arms has been introduced prior to a presentation of a real design. Firstly,an overview has started the project putting forward the main topic and its motivations. And then, themethodology has defined the strategy in which the goals of the project have been followed. After that, the literature review has started talking about the robotic arms and their importance through thehistory. The necessity of a controller has been mentioned in this introduction in order to obtain the right efficiency. Moreover, it has been suggested that the best controllers are the PID ones and also, different methods of designing these PID controllers have been shown.

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