Journal of Futuristic Sciences and Applications
Vol. 2(2), Jul-Dec 2019, pp. 1-5
doi: 10.51976/jfsa.221901
www.gla.ac.in/journals/jfsa

Designing and Modelling of Nonlinear Controller

Arunesh Kumar Srivastava and Rashmi Sharma***

ABSTRACT

Researchers and control engineers have long struggled with the challenge of creating a non-linear controller. Multiple inputs and outputs are available to the robotic manipulators. The focus of this research is on two types of link manipulators. Automation has reduced the number of workers needed to deliver a thorough description of NPID controller dynamics and control structure. NPID was shown to be superior to other proportional integral and derivative controllers because of the nonlinear multiplier it uses in conjunction with the integral controller. Welding, underwater robotics, the industrial painting industry, spot welding, and a slew of other applications all use this controller. It was possible to eliminate the drawbacks of traditional PID controllers while also improving the overall advantages by merging PID controllers with fuse logic, resulting in the development of both of these resilient technologies

Keywords: *NPI; PID; Modelling; Nonlinear Controller; Nonlinear Multiplier.*

1.0 Introduction

The robotics business has profited from both increased technology and an expanding population, since robots and automation are now employed in almost every industry. We explored and built the dynamic model and construction of a non-linear controller for PID in this paper [1]. The dynamic model and the structure were explored and established in this paper. There are many things that are difficult for humans to execute that are readily accomplished by robots, and this is particularly the case when a robot is involved in the process of performing the activity. Robotics [2] is the amalgamation of various fields. [3]. Mechanical engineering may provide the robot's output while computer engineering and electrical engineering can be employed to operate the manipulator. In order to operate a non-linear robotic manipulator, a non-linear controller must be time-variant in nature.

The complexity of the manipulator system increases as the number of ties increases; thus, it is a straightforward effort to develop a controller that can regulate a highly non-linear controller as well as offer optimum results [5]. [6]. System state information and output performance comparison are two of the primary functions of non-linear controllers, which are used to control uncertain systems. Adaptive controllers are used to control these systems because their performance is dependent on the controller through which they are attached. The algorithms are used to properly tune the gains in order to get the required performance. The method has been tried and tested in the past.

**Corresponding author; Assistant Professor, Department of Mechanical Engineering, M. G. Institute of Management & Technology, Lucknow, Uttar Pradesh, India (E-mail: arunesh_srivastava15@yahoo.com)*
***Assistant Professor, Ajay Kumar Garg engineering College, Ghaziabad, Uttar Pradesh, India (E-mail: rashminonumanu@gmail.com)*

Doi: 10.51976/jfsa.221901

2.0 Literature Survey

More and more people have been interested in employing state feedback to explicitly linearize nonlinear systems' input-output responses, and this interest has grown over the last several years. Several works, such as Porter (1970), Singh and Rugh and Isidori and coworkers, have done detailed work on this (1981). It was successfull' applied in many practical applications, such as light control (eyer and Cicolani, 1980) and stiff robot control via the so-called computed torque approach, a virtually same synthesis process independently (Freund. 1975).

Isidori and Dyrnes and Isidori. IG8S, for example, have expository sun'ethat !'s explain the idea.Because they depend on correct cancellation of nonlinear factors and employ a nonlinear pole-ze ro cencellation 'ersion, the main drawbacks to translating these enormous advantages into an effective design process are the following:Because it is so inexpensive to implement the model, nonlinear controller architecture design and simulation has been a challenging task for engineers since 1950 [7-8].

After the researcher's investigation revealed this management-controlling approach known as the adaptive technique of management, the findings revealed that it is enough for dealing with complexity [9-13]. In the past, the controller's foundation was built on a MATLAB SIMULINK model of the dynamic system. In order to achieve ideal performance, a full mathematical model must be developed, which makes it challenging to construct a trajectory configuration that can manage the primary operating point.

Thus, a novel strategy has been studied for models that have been well tested. For these frameworks, a unique approach, namely the use of artificial intelligence, was examined . Using these control combinations, the sliding mode controller's capabilities may be increased in order to produce a system that is intelligent to upgrade approaches and to enhance this entire thing logical and adaptive fuzzy logic controller (FLC). Research into fuzzy logic continues to expand after Mamdani developed this fluorescent logic controller because of the continual development. When combined with artificial intelligence (AI) and neurofuzzy logic (NFL), Graham and Newell provide an entirely new perspective on the control theory.

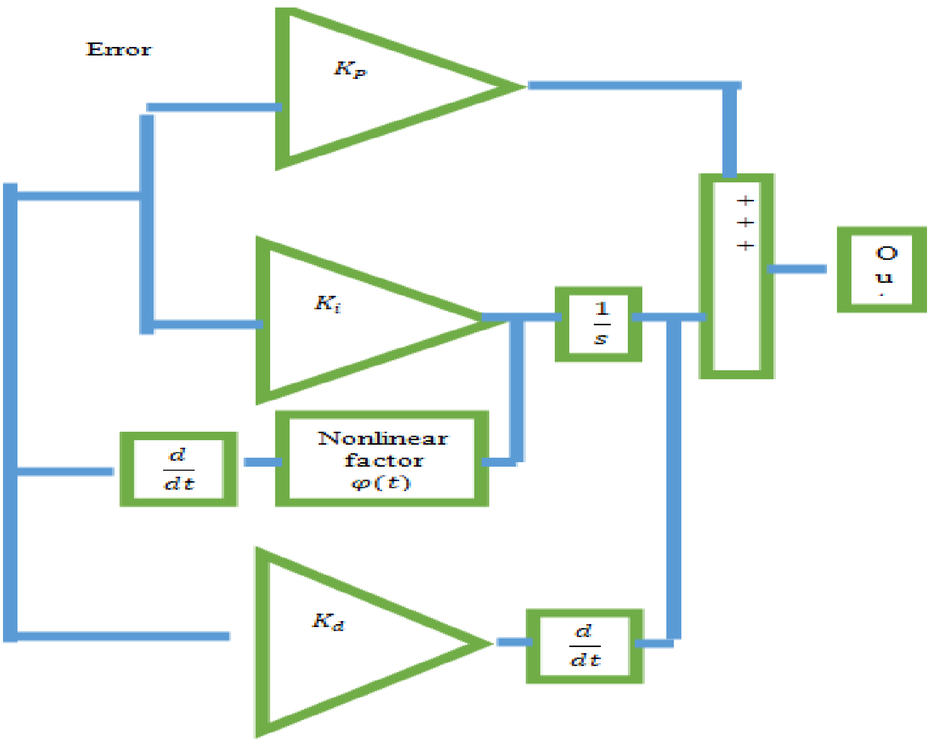
3.0 Designing Of NPID Controller

Robotic manipulators are now being controlled using linear controllers to a large extent. There may be no nonlinear controllers constructed at all, or just a handful. For nonlinear models, this controller is a game changer since it handles slow time variable mistakes and a wide range of unknown parameters very well. It is a kind of feedback control when the PI is regulated. Allows for faster response time execution to accommodate for the randomness of the situation. Is capable of stabilising and returning the system to its original state.

Faster, more precise, and more dependable devices are just a few of the advantages that this new controller offers over old ones. It is possible to remove all steady-state errors using the PI controller combination, which has a strong transient response and is durable enough to accept nonlinearity. An integral gain is added to the time-varying non-linear component, which is then used to adjust the non-linear system during programme execution and account for all of the random uncertainty. The industrial control market has long been dominated by proportional-integral-derivative (PID) controllers. In part, the widespread use of PID controllers may be a result of their simplicity and performance. PID controllers have been employed in a wide range of dynamic systems, from industrial processes to aviation and ship dynamics .

When operating conditions or environmental elements change, a simple PID controller is often inadequate to offer high-performance control, necessitating a more complicated controller. Linear PID controllers may now be made more adaptable and resilient by a variety of methods, including self-tuning, general predictive control, fuzzy logic, and neural network strategy, among others For industrial applications, nonlinear PID (N-PID) control is widely considered to be one of the most effective and simple approaches There are a variety of nonlinear PID controllers available, including the following options:

Figure 1: NPID Controller Diagram



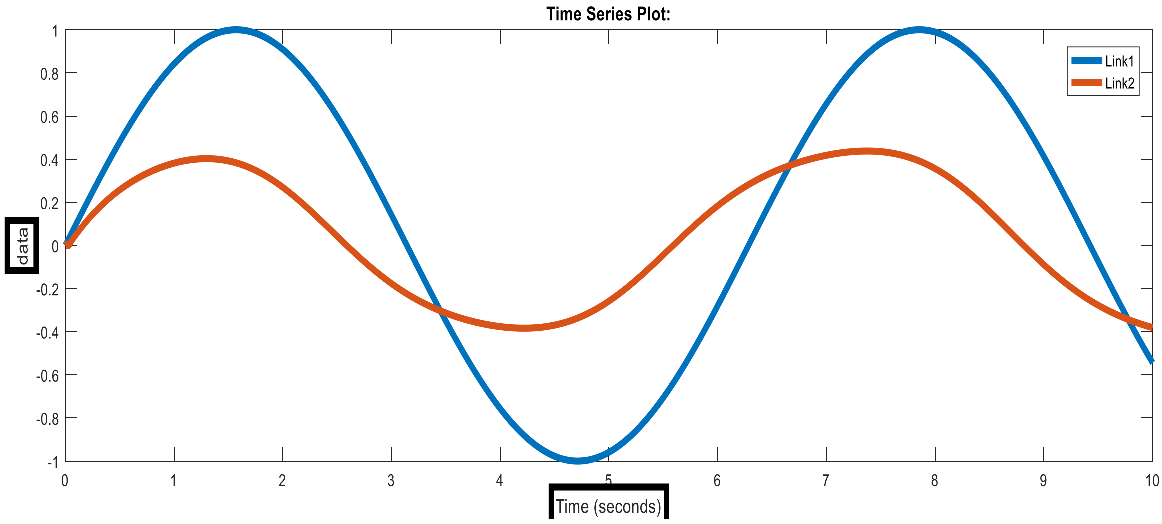
4.0 Modelling and Simulation of NPID Controller

Briefing of system modelling for controller has been explain in this section. Generally speaking, there are two models: There are two models: one is based only on (many) experiments, while the other is based on (a few) parameter identification experiments plus physical fundamental principles. In this article, just the second group of models is discussed. An effective control-oriented model must go through the six steps listed below: Accept that the system has its boundaries (what inputs, what outputs, etc. Make certain you understand the types and levels of resources you're working with Analyse each reservoir by creating differential equations. Represent reservoir flow rates as a function of level by developing (usually nonlinear) algebraic connections Conduct experiments to identify the system's unknown parameters. To check that the model is correct, do further experiments. This graph depicts the path of the sine wave here. sine wave was utilised as a reference wave and the NPID controller was used to keep track of the reference wave and accomplish the desired outcome a nonlinear element was multiplied by the integral controller, making the controller nonlinear. The

Journal of Futuristic Sciences and Applications, Volume 2, Issue 2, Jul-Dec 2019
Doi: 10.51976/jfsa.221901

trajectory of the valued ties is shown in this graph since this controller supervises two connection manipulators. It is the sine wave pattern of all trajectories in the blue and brown lines that indicates connection 1 and 2, respectively

Figure 2: Results Representing Tracking Waveform



5.0 CONCLUSION

Analysis of the controller's dynamic model and drawing of the controller's structure were done using Simulink. Using this model controller, we were able to monitor and achieve our desired results by using this sine wave as a reference. Enhancing the nonlinear PID controller by adding nonlinear tracking differentiators to the existing fixed-gain PID control architecture is presented in this paper. Scaled errors are the result of the nonlinear gain, which operates on the error in order to provide a quick reaction. In the face of measurement noise, the suggested nonlinear tracking differentiators choose a high-quality differential signal. An NPID controller has a number of advantages, including the ability to operate effectively with pneumatic controllers due to the non-linear feature.

References

[1] M. W. Spong, M. Vidyasagar, Robot Dynamics and Control, 2nd Edition, John Wiley and Sons,2004.

[2] M. Gopal. Digital Control and State Variable Methods, 3rd edition, Tata McGraw Hill,2009.

[3] RachidManseur, Robot Modeling and Kinematics, Firewall Media, 96-100,2007.

[4] M. W. Spong, Seth Hutchinson and M. Vidyasagar, Robot Modeling and Control, 1st Edition, John Wiley &Sons,Inc.

[5] M. Loudini, "Modeling and Intelligence Control of an Elastic link Robot manipulator, " Int. J. Adv. Robot System, vol. 10, pp. 1-18, January 2013

[6] A. F. Amer, E.A. Sallam, W. M. Elawady, "Adaptive Fuzzy Sliding Mode Control usingSupervisoryFuzzyControlfor3DOFplanerRobotmanipulators,"Appl.Soft Compt., vol. 11, pp. 4943-4953, December2011.

[7] V. Kumar, K.P.S. Rana, J. Kumar. Mishra and S.S. Nair, "A robust fractional order fuzzy *P*+ fuzzy *I*+ fuzzy D controller for nonlinear and uncertain system," *International Journal of Automation and Computing ,* vol. 14, no. 4, pp. 474-488, August 2017.

[8] V. Kumar and K.P.S. Rana, "Nonlinear adaptive fractional order fuzzy PID control of a 2-link planar rigid manipulator with payload, "*Journal of the Franklin Institute vol. 354, no. 2, pp. 993-1022,* 2017

[9] J. Kumar, V. Kumar and K. P. S. Rana, "A Fractional Order Fuzzy PD+I Controller for Three Link Electrically Driven Rigid Robotic Manipulator System," *Journal of Intelligent and Fuzzy Systems*, vol. 35, no. 5, pp. 5287-5299, November 2018.

[10] D.S. Weile,& E. Michielssen. "Genetic Algorithm Optimization applied to electromagnetics," A review. IEEE Transactions on Antennas and Propagation, Volume: 45 , Issue: 3 , Mar 1997C. I-Chuan; Y. Jeng-Rern, "2 – 13GHz broadband CMOS low voltage mixer with active balun designed for UWB systems," *IEEE International Conference on Electron Devices and Solid-State Circuits 2010*, pp.1-4, 15-17 Dec. 2010.

[11] Z. Kong, JiaWenhua, Zhang Guodong& Wang Lifu. "Normal parameter reduction in soft set based on particle swarm optimization algorithm". Applied Mathematical Modelling, Volume 39, Issue 16, August 2015

[12] A Ghanbari,SMRKazemi, F Mehmanpazir.,& MM Nakhostin. "A cooperative ant colony optimization-genetic algorithm approach for construction of energy demand forecasting knowledge based expert systems". Knowledge-Based Systems, Volume 39, February 2013

[13] X.S. Yang, & S. Deb, "Cuckoo Search via Lévy Flights. Proceedings World Congress on Nature & Biologically Inspired Computing," India, 978-1-4244-5053-4,january 2009