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Comparative Analysis of Different Controllers forTracking of Manipulator

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ABSTRACT

Engineers have struggled to control robots since the 1950s, when the PID controller was first used to regulate complex systems. Since its release, this controller has been a top pick among manufacturers due to its low price and ease of assembly. For nonlinear systems, fuzzy logic controllers have been used by researchers and scientists to overcome the drawbacks of PID. However, as time goes on, new controlling techniques develop that are more powerful in terms of control than the previous ones. Complex, nonlinear, and dynamically ununderstood systems need neuro logic controllers, which, when paired with standard controls, comprise the neuro PID controller or neuro Fuzzy PID controller. This paper takes a comprehensive look at the many control systems utilised in the functioning of robotic manipulators, from the first controllers to the present.

Keywords: *PID Controller; Complex System; Manipulator; Fuzzy PID Controller; Neuro PID Controller.*

1.0 Introduction

There is little doubt that robots are becoming more vital as the world moves toward automation and robotization. It is possible to make high-quality items more quickly with the aid of robots; this will help us overcome labour shortages, keep up with market demands for faster production, and enhance product quality and efficiency. We need a controller to keep the robot from becoming a disaster if we don't have one. The Czech word "robota," which means "slaved or forced labour," is the root of the word "robot." In robotics, the term "robotic manipulator" refers to the arm of a robot[1-5]. Various controllers and techniques may be used to control and operate the manipulator. Engineers have a major challenge in the coming year in developing a control system that can handle non-linearities and complexity. The present demand necessitates an intelligent control system that is both versatile and robust. Control systems for robotic manipulators, for example, would need a mechanical model of the robot and an electrical and computer engineering controller for the plant (which would come under electronics). If the controller design falls within electrical engineering, it would then come under that discipline. Fuzzy controllers, which combine artificial intelligence with control engineering, have earned a name for themselves in the corporate world[6-9]. There are various advantages to using fuzzy controllers, one of which is the simplicity with which they can deal with any non-linearities that may arise.For researchers, fuzzy logic provides a little more wiggle room since the parameters aren't just true or false. Using an autonomous car as a case study, it is possible to demonstrate the power of fuzzy logic in managing unforeseen obstacles like pedestrians or other vehicles.

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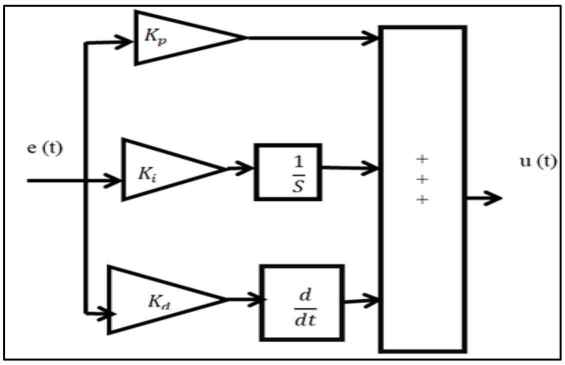
2.0 Analysis of Conventional Controller

In 1788, james watt used feedback control loop technology to manage the flyball governor. The primary function of this device was to control the engine's speed in a way similar to a proportional controller. Even though the PID controller was initially created in 1911, mechanical sheep steering still uses this controller combination. In 1922, after Minorsky's thorough examination of the three controllers, he wrote an essay addressing the problem. Since 1933, pneumatic controllers have been available for purchase. However, the model 56R fulscope controller from taylor instrument business is not capable of controlling a process variable by itself. A proportional controller will always have some residual error or offselection due to the inverse relationship between steady state error and proportional controller. As a consequence, the field of control engineering has found this to be a laborious process. Finally, in 1930, they came up with a technique that allowed the set point to be reset to either a higher or lower number in order to avoid this long-term mistake. In this approach, the error is integrated again and again whenever the set point is reset, and the output from this method is blended with the prp. With the introduction of Taylor Instrument Company's upgraded version of the above-mentioned control system, as well as Foxboro Instrument Company's hyper-reset control system (the derivative of the error signal), these issues were overcome in 1935. The integral of the error signal is regulated by both of these controllers, making them PID controllers. If a rapid shift in the setpoint happens, the derivative controller may aid by providing a spike in the PID controller.[30] The most difficult part of developing this PID controller was determining which settings would work best for it.

Figure 1: Block Diagram of Controller



When Taylor engineers Ziegler and Nichols devised a tuning technique that is still widely used in the twenty-first century, they addressed this problem in. The term given to this tuning method is based on their name. Both open loop and closed loop tests were conducted on plants, and further research into parameter tunning was conducted for 2-3 years. In 1950, cohen and coon provided flexibility in tunning by providing an alternative parameter choice for a specific plant, allowing for a more efficient use of resources.

3.0 Analysis of Fuzzy Pid Controller

It has been observed that a robust control system may be developed when the PID controller and fuzzy logic are integrated . Fuzzy logic control methods are examined in detail by Wang and

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Kwok before they advocate using a fuzzy pd and fuzzy I controller in combination. Adding even more functionality by tweaking the fuzzy-PI controller. Li and Gatland proposed an effective fuzzy three-term controller with a little change in fuzzy PI controller using a traditional and fundamental two-dimensional rule foundation. A comparison study was carried out by ketata and his colleagues after a thorough examination of the structures of fuzzy and pid controllers and the combinational structure of the fuzzy pid controller. When it comes to controllers, fuzzy logic has made them significantly more economical to design and build than they were before. Fuzzy and PID controllers may be combined to overcome their own faults. – Researchers have 38tilized this controller to manage a robotic manipulator and have found that the results are quite exact, whether we're talking about monitoring trajectory or dealing with uncertainty. In 2010, Nguyen Gia Minh employed pid and fuzzy logic to manage grid-connected solar inverters. This combination now readily controls nonlinear objects like electrical grids and automatically modifies the gain value anytime there is a change in demand and desired power. Semiglobal asymptotic stability has been shown by J.L Meza and his colleagues in 2011 with the creation of a fuzzy self-tuning PID semiglobal regulator for controlling a two-link robotic manipulator .

Figure 2: Schematic Diagram of Fuzzy Controller

For a robotic manipulator, D. Vyas et. al. conducted a comparison of conventional and fuzzy-based sliding mode PID controllers in 2013. A study by RichaSharma and colleagues .

4.0 Analysis of Neuro Network Controller

A non-linear plant will have a non-linear function. For a linear plant, selecting and delivering the appropriate input vector is a complex task that requires a great deal of effort. For non-linear plants, we're using linearization as a workaround. The researchers and engineers have to put in a lot of time and effort, and the computing is also rather challenging.The basic objective of neural network controller training is to drive the plant. The amount of time the neural network spends training will be determined by this value. Reinforcement learning, inverse control, and the optimal controller have all been utilised to achieve the desired state. Stearns Widrow and Jordan have provided a wide range of different training approaches. Training starts with the plant in its starting condition, regardless of whether it is linear or non-linear, and the random input from other plants. We can forecast the plant's future state using this strategy since the plant's present state is equivalent to its input into the neural network and backpropogation is applied.

5.0 Conclusion

Following the development of traditional PID controller and its eccentricity, the advancement of traditional PID controller using fuzzy logic has been discussed, as fuzzy logic is based on heuristic approach, which plays a significant role in the improvement of PID controller, has been discussed in this paper Fuzzy logic has been combined with PID control to produce a Fuzzy PID controller, which reduces rise time and overshoot while increasing runtime. However, this controller was not robust enough to implement a learning strategy because the capability to receive feedback was very low in fuzzy PID controller. After extensive research, neuro controller has made a controller that is robust enough to implement a learning strategy. Additional optimization methods such as genetic algorithm and particle swan optimization may be used to get the best possible benefits from a neurofuzzy interference system. Researchers and control engineers who are interested in working in this field would benefit greatly from reading this article since it provides an overview of the different approaches, their strengths and weaknesses, so that they may keep this information in mind when designing new controllers.

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