

A Study of Transmission System with Artificial Intelligence Technique

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Abstract

Modern control theory-based power system controllers have substantial advantages over traditional designs, especially for HVDC transmission. To dampen electromechanical oscillations in AC-DC systems, optimal and model controls of rectifier current regulators have been used. AI controllers, such as fuzzy logic controllers, ANN controllers, and ANFIS, can be utilised to improve the performance of the HVDC system in addition to conventional controllers. The CIGRE Benchmark weak HVDC system is utilised in this proposed effort to analyse and assess the performance of the HVDC system and its ability to improve stability. To simulate the performance of the system, the proposed controller is implemented in MATLAB/Simulink. In this paper, we explain how to use an Artificial Neural Network (ANN) and an Adaptive Neuro-Fuzzy Inference System (ANFIS) to perform adaptive tuning of a PI controller in an HVDC system, and compare the different FACTS devices with simulation results to improve the system's stability. The purpose of this paper is to improve the power transfer capability of an HVDC transmission system. The use of artificial intelligence techniques such as fuzzy logic, neural networks, and Neuro-fuzzy logic to construct an effective and intelligent current controller to improve the gain in an HVDC transmission system was explored and reported. FACTS controllers can improve the power flow capacities of an HVDC transmission system. The current research looked at three devices: SSSC, STATCOM, and UPFC. A 12-pulse thyristor converter was used to simulate the HVDC transmission link in MATLAB/SIMULINK. The CIGRE bench model 2 was utilised in all of the trials conducted in this paper.

Keywords; HVDC system, AI controllers, Artificial Neural Network, AC-DC systems.

1. INTRODUCTION

Artificial Intelligence is a computer program's ability to learn and think. In the 1950s, John McCarthy invented the term "Artificial Intelligence." 'Every facet of learning or any other feature of intelligence can in theory be characterised so exactly that a machine can be built to replicate it,' he said. The goal will be to figure out how to get computers to speak, develop abstractions, and concepts, solve issues that are currently reserved for humans, and improve themselves.'

We'll go over the definition of artificial intelligence, look at some of the current trends in AI, go over some of the trends in further depth, and go over a few case studies and applications. We can't be exhaustive due to the nature of the subject, but we'd like to give you a sense of what's going on in the field of Artificial Intelligence research. The ability of computers or machines to accomplish various jobs has increased exponentially since their introduction. Humans have increased the power of computer systems by expanding their working domains, improving their speed, and shrinking their size over time. Artificial Intelligence is an area of computer science that aims to create computers or machines that are as intelligent as humans.

2. ARTIFICIAL INTELLIGENCE

The simulation of human intelligence processes by machines, particularly computer systems, is known as artificial intelligence. Expert systems, natural language processing, speech recognition, and machine vision are examples of AI applications.

AI is achieved by first understanding how the human brain works, as well as how humans learn, decide, and work when attempting to solve a problem, and then applying the findings to the development of intelligent software and systems.

Artificial intelligence refers to machines that act like humans, primarily computers. Machines in AI execute tasks such as speech recognition, problem-solving, and learning, among others. If given enough information, machines can operate and act like humans. As a result, knowledge engineering is critical in artificial intelligence. To execute knowledge engineering, the relationship between objects and properties must be established. Artificial Intelligence approaches are listed below.

Definition

According to the father of Artificial Intelligence, John McCarthy, it is “The science and engineering of making intelligent machines, especially intelligent computer programs”. Artificial Intelligence is a way of making a computer, a computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think.

3. HISTORY OF ARTIFICIAL INTELLIGENCE

As previously stated, John McCarthy created the phrase "artificial intelligence" in 1956 at Dartmouth College during the first-ever AI conference. JC Shaw, Herbert Simon, and Allen Newell built the first AI software programme, Logic Theorist, later that year. The concept of 'a machine that thinks', on the other hand, dates back to the Mayan culture. Since the invention of electronic computers, there have been a number of significant events that have shaped the progress of Artificial Intelligence in the modern era:

- **Maturation of Artificial Intelligence (1943–1952):** In the Journal of Mathematical Biophysics, Walter Pitts and Warren S McCulloch published 'A Logical Calculus of the Ideas Immanent in Nervous Activity.' They used basic logical functions to describe the functioning of human neurons, which prompted Alan Turing, an English mathematician, to publish 'Computing Machinery and Intelligence,' which included a test. This Turing Test is used to determine whether or not a machine is capable of intelligent behaviour.
- **The birth of Artificial Intelligence (1952–1956):** Allen Newell and Herbert A Simon produced the first AI programme, Logic Theorist, in 1955. It proved approximately 52 mathematical theorems and refined the proofs of others. At the Dartmouth conference, Professor John McCarthy developed the phrase "Artificial Intelligence," which was later recognised as an academic topic.
- **Golden years – early enthusiasm (1956–1974):** Researchers became more interested in AI after the advent of high-level languages such as LISP, COBOL, and FORTRAN, and devised methods to handle complex mathematical problems. In 1966, computer scientist Joseph Weizenbaum invented the first chatbot, dubbed ELIZA. Frank Rosenblatt created the 'Mark 1 Perceptron' computer a year later. This computer was built using a biological neural network (BNN) and learnt using a trial-and-error approach known as reinforcement learning. Japan created the first sentient humanoid robot, WABOT-1, in 1972. Robots have been designed and trained to execute difficult jobs in a variety of sectors since then.
- **A boom in AI (1980–1987):** After the first AI winter (1974–1980), governments began to recognise the potential of AI systems for the economy and defence forces. Expert systems and software have been built to mimic the human brain's decision-making abilities in robots. Back propagation, which employs neural networks to analyse a problem and find the best potential solution, was one of the methods employed.

How does AI work?

Vendors have been scrambling to showcase how their products and services integrate AI as the hoopla around AI has grown. What they call AI is frequently just one component of AI, such as machine learning. For designing and training machine learning algorithms, AI requires a foundation of specialised hardware and software. Although no single programming language is synonymous with AI, a handful stand out, including Python, R, and Java.

AI systems, in general, work by consuming huge volumes of labelled training data, analyzing the data for correlations and patterns, and then using these patterns to forecast future states. By examining millions of examples, a chatbot fed examples of text chats may learn to make lifelike exchanges with people, and an image recognition programme can learn to recognize and describe items in photographs.

AI programming focuses on three cognitive skills: learning, reasoning and self-correction.

- **Learning processes.** This element of AI programming is concerned with gathering data and formulating rules for turning it into useful information. Algorithms are rules that give computing equipment with step-by-step instructions for completing a certain task.
- **Reasoning processes.** This aspect of AI programming focuses on choosing the right algorithm to reach a desired outcome.
- **Self-correction processes.** This element of AI programming aims to fine-tune algorithms on a regular basis to guarantee that they produce the most accurate results feasible.

Why is artificial intelligence important?

AI is significant because it may provide businesses with previously unavailable insights into their operations and because, in some situations, AI can execute tasks better than humans. AI systems generally accomplish operations quickly and with minimal errors, especially when it comes to repetitive, detail-oriented activities like evaluating vast quantities of legal papers to verify key fields are filled in correctly. This has aided in the growth of efficiency and provided some larger businesses with totally new business options. It would have been difficult to conceive utilising computer software to connect riders to cabs prior to the current wave of AI, but Uber has grown to become one of the world's largest corporations by doing precisely that. It employs powerful machine learning algorithms to estimate when people are likely to require trips in specific places, allowing drivers to be on the road ahead of time. Another example is Google, which has become a major player in a variety of online services by utilising machine learning to better understand how people use their services and then improve them. Sundar Pichai, Google's CEO, stated in 2017 that the business would function as a "AI first" corporation. AI has been employed by today's largest and most successful businesses to better their operations and gain an advantage over their competitors.

Types of Artificial Intelligence

The most essential type of Artificial Intelligence is outlined in the following article. Artificial Intelligence's major goal is to enable machines to execute human-like tasks. As a result, the fundamental criterion for classifying AI is its ability to reproduce human-like actions. In general, AI may be divided into two categories, both of which are focused on its capacity to mimic the human brain. The "Based on Functionality" categorization classifies AI based on their resemblance to the human mind and their ability to think and feel like humans. The second classification method, "Based on Capabilities" of AI vs. Human Intelligence, is more popular in the tech industry.

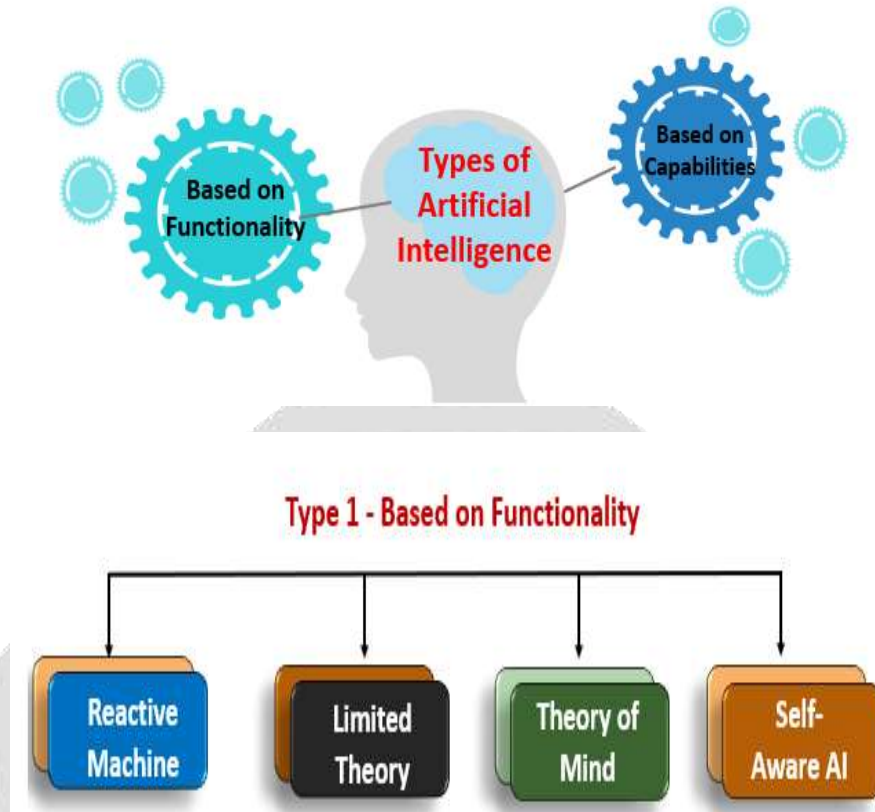


Figure 5 Types of Artificial Intelligence

➤ **Reactive Machine**

They are the most basic and oldest type of Artificial Intelligence. They mimic the ability of humans to respond to a wide range of stimuli. Because this type of AI has no memory, it is unable to enhance results by using previously learned information or experience.

➤ **Limited Theory**

This sort of AI, like Reactive Machines, has memory capabilities, allowing it to leverage prior data and experience to make better decisions in the future. This category encompasses the majority of the commonly used applications in our daily lives. These AI applications can be taught using a huge amount of training data stored in a reference model in their memory.

➤ **Theory of Mind**

Theory of Mind is the next level of artificial intelligence, with little to no impact on our daily existence. This type of AI is typically in the "Work in Progress" stage and is restricted to research labs. Once achieved, this type of AI will have a comprehensive understanding of human minds, including their needs, likes, emotions, mental processes, and so on. The AI will be able to change its own response based on their grasp of human minds and their whims.

➤ **Self-Aware AI**

This is the AI's final step. Its current existence is simply a rumour, and it can only be found in science fiction films. These AI systems are capable of understanding and evoking human emotions, as well as having emotions of their own. This type of AI is decades, if not centuries, away from becoming a reality. Elon Musk and other AI doubters are wary of this type of AI. This is because once it is self-aware, the AI can get into Self-Preservation mode; it might consider humanity as a potential threat and may directly or indirectly pursue endeavor to end humanity.

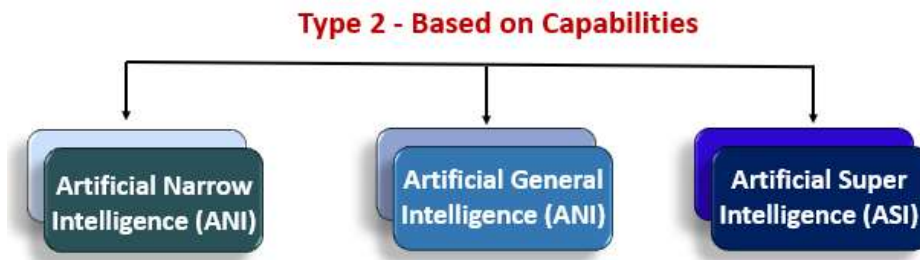


Figure 6 Type 2 – Based on Capabilities

➤ **Artificial Narrow Intelligence (ANI)**

This category includes all of the existing AI applications that we see around us. ANI encompasses an AI system that, like humans, can execute precisely defined particular activities. These machines, on the other hand, cannot accomplish jobs for which they have not been designed in advance, hence they are unable to complete an unprecedented task. This system is a mix of all reactive and limited memory AI, according to the categories given above. This area of AI includes the AI algorithms that we employ in today's world to do the most complicated Prediction Modelling.

• **Artificial General Intelligence (ANI)**

AGI can train, learn, understand, and perform functions in the same way as a human can. These systems will have multi-functional capabilities that span a variety of fields. These systems will be more agile, reacting and improvising in the same way that humans do when confronted with novel situations. Although there is no real-world example of this type of AI, significant progress has been achieved in this area.

4. ADVANTAGES AND DISADVANTAGES OF ARTIFICIAL INTELLIGENCE

➤ **Advantages**

A) Reduction in Human Error

One of the most major benefits of Artificial Intelligence is that it can drastically minimise errors while also increasing precision and accuracy. The knowledge obtained before and a set of algorithms are used to guide AI's decisions at each phase. These errors can be eliminated if correctly programmed.

B) Zero Risks

Another significant benefit of AI is that it allows people to avoid many dangers by delegating them to AI robots. Machines with metal bodies are resistant in nature and can survive adverse atmospheres, whether they are defusing a bomb, going to space, or exploring the deepest depths of the oceans. They can also deliver more accurate work with higher responsibility and are less likely to wear out.

C) 24x7 Availability

Many studies demonstrate that humans are only productive for 3 to 4 hours per day. Breaks and time off are also necessary for humans to maintain a healthy work-life balance. However, AI can function indefinitely without taking a break. They think much faster than humans and can complete numerous jobs at once with pinpoint accuracy. With the help of AI algorithms, they can even undertake boring repetitive tasks with ease.

D) Digital Assistance

Almost all large companies now use digital assistants to connect with their consumers, reducing the need for human personnel dramatically. You can communicate with a chatbot and ask them specific questions. Some chatbots have advanced to the point where you won't be able to identify whether you're conversing with a machine or a person.

E) New Inventions

In practically every domain, AI has aided in the development of innovative inventions to solve complicated challenges. Using advanced AI-based technology, a recent invention has assisted doctors in predicting early stages of breast cancer in women.

F) Unbiased Decisions

Emotions influence human behaviour, whether we like it or not. AI, on the other hand, is emotionless, and its approach is highly practical and rational. Artificial Intelligence has a significant benefit in that it is free of bias, allowing for more accurate decision-making.

➤ Disadvantages:

i. High Costs

It takes a lot of skill to build a machine that can mimic human intelligence. It takes a lot of time and energy, and it can be very expensive. AI also requires the most up-to-date gear and software to stay current and meet the most stringent criteria, making it highly costly.

ii. No creativity

One of AI's major drawbacks is that it can't learn to think creatively. AI can learn over time using pre-programmed data and previous experiences, but it can't be inventive in its approach. Quill, a bot capable of writing Forbes earnings reports, is a famous example. These reports only include information and data that the bot already has. While the fact that a bot can create an article on its own is impressive, it lacks the human touch that other Forbes articles have.

iii. Increase in Unemployment

One of the most serious drawbacks of artificial intelligence is that it is gradually replacing humans with bots for a variety of repetitive tasks. Many career prospects have been lost as the necessity for human intervention has decreased. A simple example is the chatbot, which is beneficial to businesses but a pain for employees. According to a McKinsey report, AI will replace at least 30% of human labour by 2030.

5. CONCLUSION

Artificial intelligence is making a big difference in our lives. Organizations are also adapting to AI technology, which can give them new methods of doing things and analysing data patterns, helping them to be more productive. Artificial Intelligence (AI) has immense promise, and it has already begun to show practical benefits in a number of industries. In terms of maximizing potential, we've only scratched the surface, and there's still a long way to go until we truly comprehend AI's true ability. The information offered in this article is significantly less vital and important than artificial intelligence. This is only going to get bigger in the future. Don't miss out; get involved and have as much fun with technology as possible. The purpose of this thesis is to improve the power transfer capability of an HVDC transmission system. The use of artificial intelligence techniques such as fuzzy logic, neural networks, and Neuro-fuzzy logic to construct an effective and intelligent current controller to improve the gain in an HVDC transmission system was explored and reported. FACTS controllers can improve the power flow capacities of an HVDC transmission system. The current research looked at three devices: SSSC, STATCOM, and UPFC. A 12-pulse thyristor converter was used to simulate the HVDC transmission link in MATLAB/SIMULINK. The CIGRE bench model 2 was utilized in all of the trials conducted in this study.

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