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Artificial Intelligence: Evolution, Developments, Applications, and Future Scope

Abstract. Artificial intelligence (AI) or Machine Intelligence (MI) is the most important and interesting technology in recent decades due to its vast application in almost every field of science and engineering. The MI techniques are the study of making intelligent machines that have human-like behaviors. The speedy advancement in this area has triggered the curiosity of many technologists, and researchers around the world, and various companies across several domains are inquisitive to explore its capabilities. AI technology is continuously changing the landscape of businesses as well as the personal and social activities of human beings due to advancements and research in this field. For any field which has obtained so much popularity in a very short duration, it is essential that technologists who focus on endeavors in AI, study its evolution, developments, applications, and future aspects of augmentation to achieve a better intuition into the area. This paper presents a comprehensive study of the past, present, and future aspects of AI technology for researchers and technologists. In this paper, we discuss the evolution, historical developments, important breakthroughs in continuous research, real-world applications, challenges of AI implication, and the future perspective of AI technology. Finally, we have discussed the role of AI in the optimization of the Integrated Circuit (IC).

Streszczenie. Sztuczna inteligencja (AI) lub inteligencja maszyn (MI) to najważniejsza i najbardziej interesująca technologia ostatnich dziesięcioleci ze względu na jej szerokie zastosowanie w niemal każdej dziedzinie nauki i inżynierii. Techniki MI to nauka o tworzeniu inteligentnych maszyn o ludzkich zachowaniach. Szybki postęp w tej dziedzinie wzbudził ciekawość wielu technologów i badaczy na całym świecie, a różne firmy z kilku dziedzin są zainteresowane zbadaniem jego możliwości. Technologia AI nieustannie zmienia krajobraz firm, a także osobiste i społeczne działania ludzi dzięki postępom i badaniom w tej dziedzinie. W przypadku każdej dziedziny, która zyskała tak dużą popularność w bardzo krótkim czasie, niezbędne jest, aby technolodzy, którzy koncentrują się na przedsięwzięciach w dziedzinie sztucznej inteligencji, badali jej ewolucję, rozwój, zastosowania i przyszłe aspekty rozszerzenia, aby uzyskać lepszą intuicję w tej dziedzinie. Niniejszy artykuł przedstawia kompleksowe badanie przeszłych, obecnych i przyszłych aspektów technologii sztucznej inteligencji dla badaczy i technologów. W tym artykule omawiamy ewolucję, wydarzenia historyczne, ważny przełom w ciągłych badaniach, zastosowania w świecie rzeczywistym, wyzwania związane z implikacją AI oraz przyszłe perspektywy technologii AI. Na koniec omówiliśmy rolę AI w optymalizacji układu scalonego (IC). (Sztuczna inteligencja: rozwój, zastosowanie i przyszłość)

Keywords: Artificial Intelligence, deep learning, integrated circuit, machine learning, neural networks, Turing test.
Słowa kluczowe: Sztuczna inteligencja, głębokie uczenie, układ scalony, uczenie maszynowe, sieci neuronowe, test Turinga.

1. Introduction

The continuous digitalization of our community, science, and technology is revolutionizing the research methodology of every field of research. Human beings are overlong been interested in the feasibility of automating tasks. Human beings are considered the most intelligent and wise species among the whole species living on the earth. Research is still going on for thousands of years to understand how humans think; that means how the human brain works. The field of AI tries not only to understand it but as well as to create intelligent systems. It is a novel field in engineering and science.
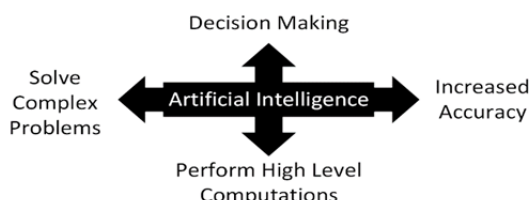

Fig. 1. The Engineering and Science of making Machines intelligent through AI

Fig.1 demonstrates the major benefits of AI applications in the systems. This figure illustrates the science and engineering behind making machines intelligent through AI applications in the machine. AI is a novel technology that can be developed, researched, applied, and utilized to stimulate and augment the theoretical technique and technology implementation of human intelligence [1]. The evolution of AI can be traced to traditional philosophers who try to explain human behavior as a mnemonic system. Work in the field of AI was started just after the second world war, and the name Artificial Intelligence came into this world in 1956 at Dartmouth College at a conference [2]. This technology is now applicable in almost every field of study and research. We can reduce the human burden in every industry by utilizing AI techniques. This paper presents a brief description of the state of the art of AI.

1.1. Turing Test

Some ancient references to hominoid automata can be experienced in Homer's Iliad and, after that, in Leonardo da Vinci's explanations of the design of complex robots. One of the most famous and outstanding tests was carried out by Alan Turing in 1950 to examine the ability of machines to demonstrate intelligent behavior and ability to win a game of human imitation [3]. A. M. Turing proposed a question in 1950, "Can machines think?". Definitions of this question begin with the meaning of the words machine and think [4]. This question later explained the intelligent behavior of machines and it was proved with the help of a game called the imitation game. The Turing test is an important breakthrough to start the research and study in the field of Artificial intelligence.

1.2. Definition of Artificial Intelligence

The term AI is prominently tough to define. It is probably the best astounding and most complex generation of humanity yet. Generally, AI is a part of science, and it can be described as a group of technologies for computation that are motivated by the manners humans utilize their nervous systems and like human bodies to sense, observe, understand, and act [5]. AI is an assortment of biology, computer science, philosophy, logic, psychology, and various other fields, and it has already attained prominent results in many applications like natural language processing, speech recognition, intelligent robots, automatic theorem proof, and image processing [6]. AI can provide a set of techniques that permit a few aspects of the behavior of human beings to be smoothly delivered to a machine and as well as the techniques used to motivate a novel type of belief regarding the essence of such comportments because they emphasize attentiveness on the kind of knowledge presumed, as well as a feasible presentation of it [7]. AI is eminently multidisciplinary; it endeavors to acknowledge and, perhaps eventually, imitate the complete extent of activity that we can adequately label intelligent [8].

1.3. Types of Artificial Intelligence

Research in AI focuses to make machines more intelligent to mimic human behavior and the degree of mimicking at which human behavior is copied by machines is the base of determining the types of AI. Fig. 2 demonstrates the type of AI, type-I is based on the level of intelligence such as if the machine can work only for some specific or predefined or pre-programmed task, then it is called artificial narrow intelligence, if the machine can work on general tasks, that means the machine is able to work for any general or common task then it is called artificial general intelligence, and if a machine is able to do any task that means the machine will be capable to adapt any environment easily and perform according to the requirement, then it is called artificial superintelligence [9]. Also, type II is based on the behavior and capacity of the human brain if the machine has small or predefined memory then it is called limited memory AI machine, if the machine has a self-awareness capacity that means the machine defines there environment by himself then it will be a self-aware AI machine, if a machine can understand the requirements of other systems then it will be a theory of mind AI machines, and if the machine has no memory but has the ability to reacts to different motive then it will be reactive AI machines.
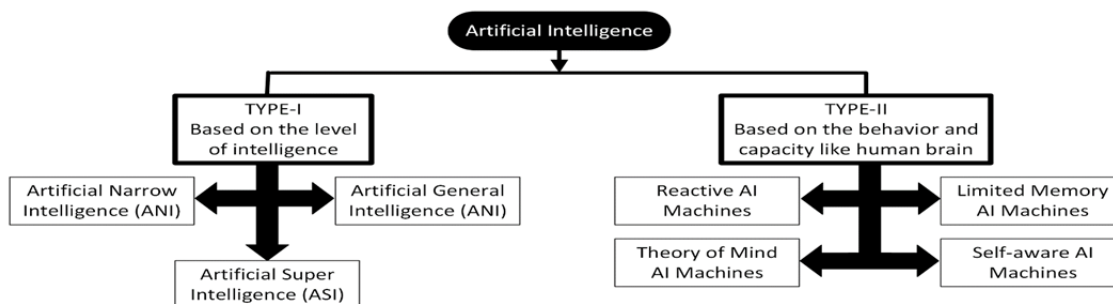

Fig. 2. Types of Artificial Intelligence

1.4. Expert Systems

An expert system is an AI-integrated computer program technology to predict the behavior and judgment of an organization or a human that has experience and expertise in a specific field. It is an important part of AI, which gives the ability of decision-making potential like human beings to the computer system. An expert system is a type of computer program that can mimic human activity. In other words, a computer program that utilizes AI methodology to resolve problems associated with a particular domain generally needs human expertise [10]. Expert systems are reliable, highly responsive, understandable, and highly efficient. User Interface, Inference engine, and knowledge base are the main components of the Expert systems. In recent decades, Expert systems are widely used in almost every field of business and research because it is highly secure and gives optimal performance. Expert systems are mostly used for the prediction, diagnosis, designing, interpretation, monitoring, planning, debugging, repairing, controlling, and providing control. Fig. 3 shows an excellent connection between the expert users, expert systems, and non-expert users and expert systems contain a user interface as well.
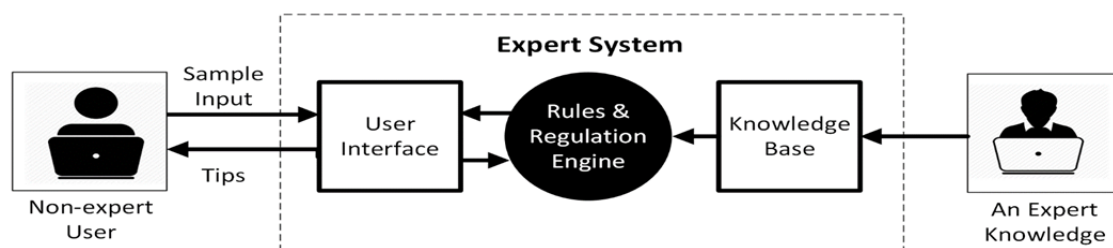

Fig. 3. Functionality of an Expert System

1.5. Some Important Historical Developments

Almost every human being thinks that AI hasn't experienced quick development over the decades. Mainly the important breakthroughs in the field of AI have been guaranteed in 25years for over 60years. AI is playing a major role in combating various types of pollution. Table1 represents the major development of AI from its evolution in 1950 to date.

Table 1. Some major developments in the field of artificial intelligence from 1950 to 2021 [11]

Year's	Some Major and Important Development in the Field of AI Since its Evolution
1950	Alan Turing presents the Turing test to find the intelligence of the machine.
1956	The term "Artificial Intelligence" was coined by John McCarthy at the Dartmouth College summer conference.
1958	Lisp Programming Language was invented by John McCarthy of MIT, USA.
1959	The first AI Lab was founded by J. McCarthy and M. Minsky at MIT, USA.
1960	AI- the mathematical theory was founded by Ray Solomonoff and universal Bayesian methods were introduced for prediction and inductive inference.
1966	A workshop at Edinburgh "Machine Intelligence" was organized by Donald Michie and others. It was the first annual influential series.
1969	The first joint international conference was held at Stanford University on "AI".
1970	An important group of Natural language processing at SRI was established by Don Walker and Jane Robinson.
1978	H. A. Simon got the Nobel prize for his theory in Economics for bounded rationality, it was one of the milestones of AI known as "Satisficing".
1980	First expert system developed and applied commercially. Lisp machines were also developed and marketed. As well as American Association for AI (AAAI) organized the first national conference.
1985	Neural networks become famous used with the Algorithm of backpropagation.
1990	A major development in almost every field of AI occurred, such as data mining, vision, virtual reality, games, intelligent tutoring, machine learning, etc.
1995	The first international IJCAI workshop was organized by Cindy Mason at NASA on the environment and AI.
1997	The chess machine "Deep blue" of IBM defeats the champion "Garry Kasparov" in the World chess championship.
2000	An emotional agent and intelligent room were demonstrated at the AI- lab of MIT, USA. The remote region of Antarctica was explored by the Nomad robot for meteorite samples.
2002	An iRobot's Roomba was developed which was able to vacuum the floor autonomously while avoiding obstacles and navigating.
2005	The blue brain was born which was a technique to simulate the brain in molecular details. Recommendation technology depends on tracking media usage or web activity bringing AI technology into marketing.
2007	A team of researchers solved "Checkers", at the University of Alberta.
2009	An autonomous car was built by Google.
2011-2014	Siri of Apple (2011), Google Now of Google (2012), and Cortana of Microsoft (2014) are smartphone applications that answer questions by using natural language, able to give recommendations, and perform actions.
2017	At the International 2017 Dota 2 tournament in August 2017, an open AI-machine-learned bot game won during 1v1 demonstrations.
2020	Deep-Speed- the library was created by Microsoft for PyTorch that runs T-NLG.
2021	AI of Facebook developed SEER (Self-supervised) computer vision model.

1.6. Big Data

The big data concept is an important and novel technology; the evolution of big data sets goes back from 1960 to the 1970s when the first data centers were developed in the world. Around 2005, people started to think about just how much and which types of data users produced through YouTube, Facebook, and other online services [12]. The advances of machine learning have generated still large data. Big data is more complex and larger data sets, for new data sources. Finally, big data is a set of data that contains a higher variety, arriving in more volumes and with very high velocity. Big Data is an integration of characterized data by higher multiplicity and approaching enterprises in higher amounts and at a higher velocity. In another way, it is the combination of unstructured, semi-structured, and structured data gathered by enterprises that can be considered for information and utilized in predictive modeling, machine learning projects, and many more advanced applications. Systems that store and process big data have the most important part of the architecture of data management in organizations, integrated with concepts that help big data analytics utilizes. Fig. 4 shows AI and big data integration is driven by the research, policy, and industry intersections in the future AI and big data research trends.

Fig. 4. Major developments and important future perspectives at the research, industry, and policy intersections driven by AI and big data

2. Parts of Artificial Intelligence

In recent years, AI embraces many technologies. Two of them are machine learning (ML) and deep learning (DL). These days, intelligent systems that deliver AI capabilities often depend on ML. ML narrates the ability of systems to get knowledge from training data of problems specific to simulate the technique of building the analytical model and resolving associated problems [13]. AI and ML are becoming major and best problem-solving methodologies in various fields of industry and research, notably because of the latest triumph of DL [14]. DL is the subset of ML and ML is the subset of AI, which has been presented in Fig. 5.
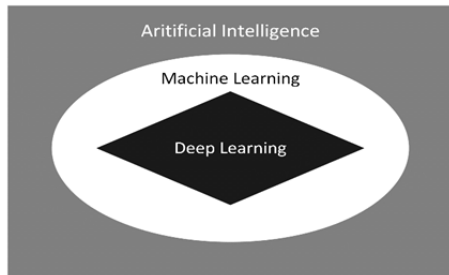

Fig. 5. Representation of the relation between AI, ML, and DL

2.1. Machine Learning

ML explains the idea of building computers that enhance automatically with experience. In recent years it is the fastest-growing technology, situated at the intersection of statistics and computer science, and belongs at the core of data science and AI. The availability of ML methods for the adoption of data-intensive can be searched throughout technology, commerce, and science, sending to highly evidence-based result-making through several walks of life, containing manufacturing, education, policing, health care, marketing, and financial modeling [15]. ML techniques can be applied to novel types of problems, such as facial recognition, character recognition, game playing, natural language processing, discovery in databases, medical data analysis, speech recognition, character recognition, and robot control system [16], [17].
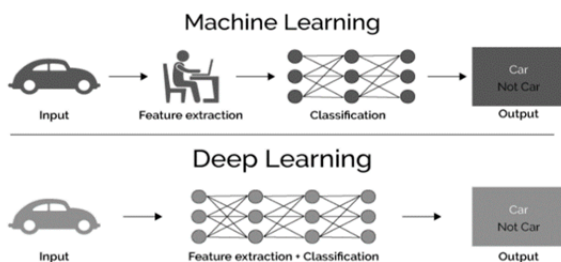

Fig. 6. Fundamental difference between machine learning and deep learning [19]

2.2. Deep Learning

DL is an ML technique that instructs computers to work what naturally comes to humans: understand by example. In DL, a model of computer understands to do tasks of classifications directly from text, sound, or images. Models of DL have the potential to achieve higher accuracy, sometimes exceeding the performance of human-level. DL technology is a key behind autonomous cars, enabling them to do their performance without drivers such as recognizing a stop sign. DL is an ML postulation based on ANN. DL technique can be applied to computer vision, data mining, supercomputers, fraud detection, natural language processing, management systems of customer relationships, human activity recognition, and autonomous

vehicles [18]. Fig. 6 presents the differences between the ML and DL working principles. It shows that feature extraction and classification are two different steps in ML, but feature extraction and classification happen together in a single step in the DL.

3. Artificial Neural Networks

The illustration of artificial neural networks (ANN) is part of data mining and machine learning. These networks are a set of models of measurable learning by the brain that is biological neural networks. The principle of working this neural network is like the neural system of the human brain works. ANNs look like frameworks of various interconnected neurons that exchange messages with one another [20].
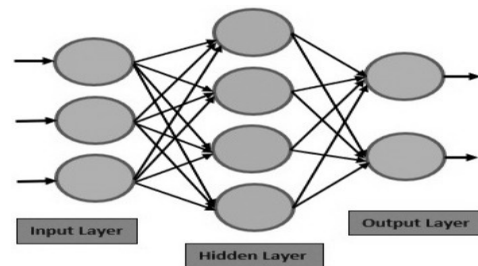

Fig. 7. The architecture of a simple ANN

Artificial neural networks are the most important part of AI technology, which are mainly part of control systems. ANN architecture is like the human brain. The theoretical concept of ANN supposes regular arrays of neurons (units) interconnected by individual connections with synapses (linking weights) [21]. ANN is mainly divided into three parts input layer, hidden layer, and output layer. Fig. 7 is a typical example of a simple ANN.

3.1. Types of Artificial Neural Networks

Currently, there are mainly seven types of artificial neural networks that have been defined. These neural networks are classified based on their applications and structure. Fig. 8 illustrated the classification of artificial neural networks. These types of neural networks are demonstrated as; Perceptron neural networks are the most basic structure which are among the several ANN, which impacted historically and started the study and research in the area of artificial networks, with inherent algorithm learning and classification property [22]; A multilayer perceptron is called "Feed-forward neural networks" if it falls in the lone neuron, the decision follow unidirectional path, approaching in the successive layers from the input layer to the output layers, without loops or cycles; Recurrent neural networks (RNN) are a group of neural networks which can be implemented in the sequence data modeling and it gives better predictive results for any sequential data with respect to other algorithms; Modular neural networks is the fastest growing area in ANN research, which has learning schemes, techniques for task decomposition, and strategies of decision making for multi-module system [23]; Convolutional neural networks (CNN) is the part of deep learning field, which is used in various field such as natural language processing and computer vision field. CNN-based computer vision has allowed human beings to get better insights into autonomous vehicles, intelligent medical treatments, supermarkets with self-service facilities, and face recognition [24]; The idea of Radial basis neural networks is defined from the approximation of the theory of function. These networks have the capacity for hybridization and illustrate a few outstanding emergent behaviors, with some advantages such as rapid training and capability of global approximation with local responses [25], and the long

short-term neural network is a type of recurrent neural network with a multilayer cell structure and state memory. LSTM neural networks might be utilized to perform several tasks such as different types of recognition, prediction, pattern classification, sequence generation, and analysis [26].
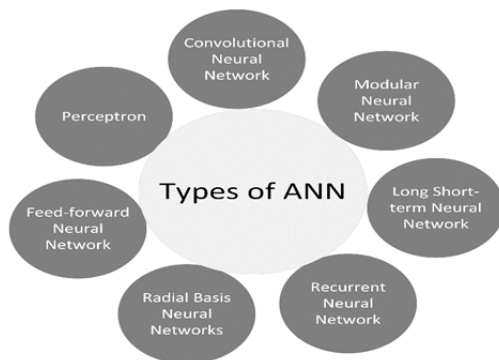

Fig. 8. The major classification of artificial neural networks

4. Previous Work in the Field of Artificial Intelligence

In the last seven decades, starting from 1956 when the name artificial intelligence was coined, much research has been carried out. In the research paper, M. Minsky (1961) [27] presented a comprehensive literature survey on AI. The presented literature survey deals with the problem of modeling machines to act intelligently. AI has been divided into different categories and the references are cross-indexed accordingly. R. J. Solomonoff (1966) [28] explained a review of some important approaches to AI which were carried out between 1960 to 1966. This review article is mainly focused on pattern recognition, simulation of organic evolution, and linguistics problems that are directly related to the induction issues. In the paper, C. V. Page (1969) [29] presents a study of AI applications in computers. The development of intelligence by human beings in a structured way in computers has been studied. The way of programming a computer to adapt the technology in two different ways logic of syntax and semantics uses have been discussed in this paper. J. R. Carbonell (1970) [30] proposed an approach to AI applications in the intelligent instruction provided with the help of computers. Only the conceptual and educational prospects of AI-based computer systems are explained in this paper. An ISO (information structure-oriented) computer-assisted instruction system is dependent upon the use of concepts, a network of facts for information, and procedures, which can produce text, questions, and answers for the given question has been discussed in this paper. In the paper, K. Fu (1971) [31] discusses the intelligent control systems and normal control systems in machines. Three different types of control systems are reviewed in this paper, which are human-controlled control systems, man-machine-controlled control systems, and autonomous robotic systems. B. Raphael (1973) [32] presents the complete overview of AI technology research carried out until 1973 in this paper. Various applications of AI technology such as pattern recognition and algebraic manipulation have been discussed in this paper. Also, the application of computers in the AI field has been studied to enhance the capacity of computers. B. Chandrasekaran et al. (1974) [33] explain the AI application for agnosticism. Most of the argument happens between the true believer and the agnostic swivels on the difficulty of the simulation of the system. Description of the agnostic thinking that the human mind is considered a simple machine has been defined in this paper. Agnosticism is considered a belief, not real action. I.

Aleksander (1976) [34] presents the relationship between AI and pattern recognition. The pattern recognition capacity for random access memory that might be used in network implementation of very high intelligence has been discussed in this paper. R. L. Blum et al. (1978) [35] proposed the RX project for developing software, which is for the purpose of the storage and induction of medical knowledge collected from the medical data banks. This project is an effort to traverse the space between systems of clinical data banks and systems of medical consultation-based knowledge. These two ways of effort can be integrated with the help of statistical techniques and knowledge-based techniques which utilize mainly AI. C. Rieger et al. (1979) [36] presented and explained some important software programming languages for AI, which are LISP, SAIL, MLISP, POP-2, AL, QLISP, CONNIVER, and MICROPLANNER respectively. These AI programming languages are explained based on some tasks done by these languages. C. A. Kulikowski (1980) [37] explained major AI issues that came with designing a program of consultation including types of knowledge representations, strategies of diagnostic interpretation, and strategies of treatment planning. This paper presents AI techniques and systems for medical consultation. G. Granlund et al. (1982) [38] described a hierarchical processing approach by which structural features are solved together with the data values analysis. A worthwhile utilization of a hierarchical structure to settle vigorous restrictions upon the representation of information and operations has been discussed. The proposed methods have been verified in many problems in image processing and image analysis with higher accuracy. E. A. Feigenbaum et al. (1983) [39] explained the impact of AI technology on the computing of the next generation. This article provides the current aims and background of AI. Some major machine properties explored in this article are speech recognition, computer vision, natural language processing, and machine reading ability. J. Gaby et al. (1984) [40] proposed an AI technique for the estimation of the power spectrum of a random process that is stationary. The proposed system integrates the produced estimates by an array of estimation techniques of the current spectrum towards the formulation of mixed spectral estimates. This paper explained the AI application in signal processing. J. Canny (1986) [41] presents an edge detection approach based on computational methodology. This approach is based on defining a collective set of goals for the edge points computation. This paper explains localization and detection criteria in a type of edge and provides mathematical forms for functionals of these criteria on the response of operator impulse. And another criterion is integrated into previous criteria to confirm that the detector for a single edge has just a single response. R. M. Adler et al. (1989) [42] demonstrate DAI (distributed artificial intelligence) applications in which various fields of agents solve the problems of multiple domains. After that, the development environment of the DAI-system work progress has been described, which is called social. Now, Social has three components that are based on primary language. The language of knowledge object explains models of knowledge reasoning and representation. Finally, the language of meta-Agents explains models for the coordination of agent organization, resource management, and control. G. Evans (1991) [43] provides an AI technique to solve the problems related to home automation. This paper explains, how existing AI techniques are applied directly to solving the problem of the human interface of the products related to home automation even in the case of the intelligence of the system distributed throughout the different products installed in the home which shares a

common network. It utilizes AI techniques such as expert systems, pattern recognition, language processing, and learning. K. H. Jung et al. (1993) [44] proposed an expert system to resolve the issues of the feeder overload or main transformer and constraints violation of the feeder in automatic distribution systems, in that case, every feeder must be in the voltage drop limits and at the thermal overload. The proposed system acquires a tree search technique which is the best and first technique. Then, techniques of recursive programming and list processing are utilized to resolve the problem of combinatorial type optimization. L. Campbell et al. (1997) [45] illustrate the real-world application of AI techniques and study the research carried out at the Military academy of the United States to achieve this goal. This paper also explains the performance of a terrain analysis for the creation of mission plans which can be added with computer-generated forces as the member of the system of automated reasoning. Finally, they examine the knowledge-based system's application to the development systems in the testing of material in simulation and examine the recent signs of progress in the recognition of automated targets. R. J. Patton et al. (1999) [46] present an AI approach for the detection of a fault in the signal. In the control system, engineering fault diagnosis can be done by the generation of signals that show inconsistencies between the operation of the faulty and fault-free system, which are called residual signals. This paper provides some new methods to generate residual signals by integrating qualitative and quantitative system knowledge with the help of AI technology. M Bertozzi et al. (2002) [47] This paper explains the most sophisticated approaches to the acclimatization of the task related to the road following by utilizing artificial vision which is onboard systems. The features of obstacle detection, pedestrian detection, and lane detection are classified and described. Finally, the future aspects of the vehicles for future application have been discussed. M. Kaiser et al. (2003) [48] analyze the AI applications in modern telecommunications systems. This paper analyzes the AI needs for its application, indicates important fields in the architecture of communication, where AI application is needed, and explains the elemental parts of one proposed scheme for the implementation in networks. H. R. Tizhoosh (2005) [49] introduced a novel technique for machine intelligence as opposition-based learning. This approach is basically based on weights and opposite weights, actions, and counteractions, and estimates and counter-estimates. This paper also explains the probability of the extension of algorithms of existing learning. X. Hao et al. (2007) [50] proposed an algorithm for the detection of a fault in the power transformer, which is called artificial immune network classification (AINC). This algorithm is based on the natural immune system which can acknowledge the multiple numbers of foreign pathogens, which is presented in this paper. AINC mimics the functionality of the immune network system, such as acknowledgment of the samples of the fault of power transformers. As well as AINC can evaluate a small number of antibodies representing almost every sample of fault-distributing features and structures, which finds to achieve dynamic classification. The proposed algorithm has better and higher accuracy. E. S. Brunette et al. (2009) [51] present an overview of AI aiming at embodied AI. This paper demonstrates the models of agent-based AI, artificial consciousness, and philosophical illustrations of AI. Also, the achievements, applications, and developments in the field of AI have been discussed in this article. This article explains and reviews almost every section of artificial intelligence in detail. L. Li et al. (2011) [52] proposed an

AUTS (artificial urban transit system) which depends upon agent-based AI modeling and simulation. With the proposed system, which is an important and special type of ATS (artificial transportation system), they are comfortable modeling the behavior of passengers dynamically and choice of route and utilizing the system to find the transit demand for a basic transit network. The proposed AUTS system has some important applications such as: setting parameters key for networks of urban transit; the flow of forecasting transit, finding an alternative change to bus routes and subway rail and finding the effect of emergency or special functions on the transit network. G. Acampora et al. (2013) [53] present a survey report on the evolution of ambient intelligence techniques in the domain of healthcare, for the purpose of providing the necessary overview of this technology to the research community. This paper explains the technology and infrastructure required for getting an overview of ambient intelligence such as wearable medical devices and smart environments. Finally, a complete overview of the State-of-the-art AI technologies utilized for the system of ambient intelligence in the domain of healthcare, which includes several techniques of learning, techniques of reasoning, and techniques of planning. Also, the discussion of support systems provided to mental disability or chronic disease patients with the help of the ambient intelligence technique has been illustrated in this article. An important and higher level of a comprehensive study of artificial and computational intelligence applications in the field of games has been studied by G. N. Yannakakis et al. (2015) [54]. This article illustrates mainly ten research areas in this field, which are search and planning, learning of non-player characters, generation of procedural content, AI-assisted design of the game, believable agents, computational narrative, AI applications in commercial games, AI-based general game, player modeling, and game with AI-benchmark. Three main aspects of this area such as the methodology of dominant AI utilized under every area, every area relation with respect to the human or end-user, and implementation of every area within player and game interactions, has been discussed. The proposed technique provides a progressive overview of artificial intelligence and computational intelligence applications in-game. K. C. Morris et al. (2017) [55] present a special report which explained, "how Artificial intelligence is concerned with disappointment and hubris since its initial days, has incidentally become important and demanded field in technology". This report also explained the machinery questions. The impact of AI technology on the industrial revolution in the field of automation technology and our society has also been discussed in this report in detail. Y. S. Ong et al. (2019) [56] explain an overview of some important and stroking questions currently arising in the fields of computational and artificial intelligence. There are mainly five key points that are used to demonstrate the issues affecting artificial and computational intelligence, which are resilience, realism, reproducibility, responsibility, and rationalizability. A brief report and illustration of these five key points have been provided. E. Tjoa et al. (2021) [57] provide an excellent review of interpretability explained by various research works and differentiate them. The various categories show multiple dimensions in the proposed research, from methodologies that give interpretable information for the illustration of complex patterns. Thus, this logic is similarly applied to manipulability in medical research. These approaches can be taken by medical practitioners and clinicians with caution in health sciences. This paper explains an overview of AI applications in the medical field. A. Yarali (2022) [58] presents a comprehensive study of AI technology aspects

for their applications, development, and future aspects. Commercial and industrial applications of AI techniques have also been discussed. The effect of AI technology on businesses, GDP growth, and society is the major issue illustrated in this chapter.

5. Some Major Applications of Artificial Intelligence

A lot of growth in the field of AI has already happened and we can see this development in almost every field such as healthcare, robotics, education, finance, space exploration, gaming, social media, e-commerce, surveillance for defense and security, and in many more fields.
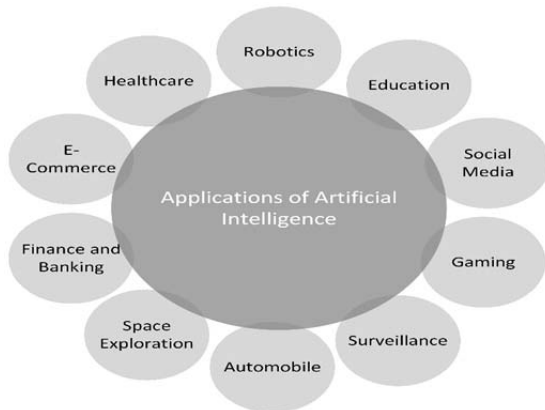

Fig. 9. Some major areas of applications for AI- technology

It is a dynamic tool utilized across industries to get better performance, increase efficiency, and overcome repetitive work. It is proven that AI is playing an important role in education, research, and practice in the fields of science and technology [59]. Fig. 9 demonstrates the real-world application of AI technology in various fields to get optimal efficiency. AI technology can be implemented in various industries to overcome drawbacks available in the functional part of industries.

5.1. Finance and Banking

AI is widely implemented in the field of finance and banking industries. With the utilization of AI, banks and financial sectors are now accepting help desks and customer support, which are affecting more on reducing the cost and increasing the efficiency of customer support. Banking and financial companies are utilizing AI technology and its several applications to confirm that the aim of the inclusion of digital financials is recognized is to confirm that the poor, women, low-income earners, small businesses, and youths participate in the market of mainstream financial [60]. Application of AI in financial sectors can increase security in financial transactions, reduce risk in lending, improve targeting customers, and automate compliance-related tasks as well as enhance privacy policy, suitable documentation, and transparency to ensure user acceptance [61].

5.2. E-Commerce

AI technology has become the most important force driving electronics commerce development. This technology has been implemented in various parts of E-commerce such as predicting demand, better personalization, marketing management, utilization of chatbots, logistics, etc. Amazon is a prominent company that uses AI technology for E-commercial business. AI integrated E-commerce design can mostly enhance the efficiency of design, reduce the costs of design, and promote the happiness of the development of E-commerce [62]. Retailers of E-commerce are rapidly implementing digital assistants or chatbots to support customers for 24×7 time periods.

5.3. Robotics

As AI technology rapidly develops, robots are becoming more advanced and efficient in accomplishing tasks that previously were too tough and complex. Integration of robotics and AI technology helps the robots to become autonomous which means robots are performing their tasks without human intervention. In recent years, robot manipulators are the most important part of industrial automation, which provides higher productivity while giving relief to human beings from hard and laborious tasks [63]. Also at the same time, safety and risk concerns have been illuminated in the human environment for the manufacturer of robots, and the researchers due to the induction of robots in different fields of our society.
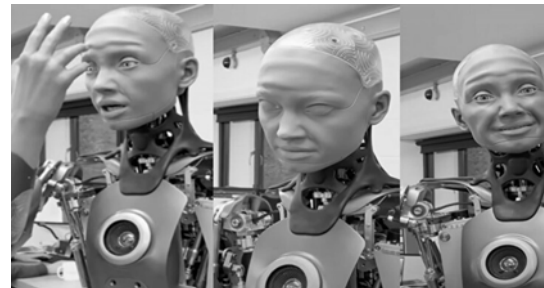

Fig. 10. The most advanced humanoid robot, "Ameca" [64]

Integrated Robotics and AI technology are widely used in various fields such as military purposes, manufacturing, assembly, mining, surgery, space, and earth exploration, packing and packaging, surgery, safety, transport, and the huge production of industrial and consumer goods [65]. Fig. 10 shows a humanoid robot which is a very advanced robot having almost similar facial expressions to human beings. This robot is the perfect platform for a humanoid robot for robot-human interaction.

5.4. Gaming

In the industry of Gaming, every computer and mobile phone game system is powered by AI technology. Modern computer games fulfill the realism of video games by integrating AI, physics, and graphics. With the improvement of game playability and many commercial game selling point, the AI of the game provides players a perfect way in-game to make interaction with non-player characters, thus it brings the experience of the game to a higher level in reality [66]. This technology is employed to get adaptive or intelligent, responsive behaviors basically in non-player characters as almost intelligent or human-like in video games.

5.5. Social Media

Social media is a specific platform that utilizes Artificial intelligence for expressing and networking with oneself. It intentionally shapes our temperament, ideologies, and choices. AI tools are working within the background of social media websites and applications silently and show us only those posts which might be liked by us with the help of our browsing and search history. Machine learning techniques enable the systems to learn and give feedback by themselves. AI techniques are integrated with social media platforms for various applications such as bioinformatics, crime detection, event detection, sentiment analysis, reputations and relationships, recommenders, image analysis, epidemics, anomaly detection, and behavioral analysis [67].

5.6. Space Exploration

In recent decades, AI techniques are used widely in rovers for the exploration of space. This technique is very helpful to discover various things in space such as stars, galaxies, and many more. As the automation and autonomy techniques levels are increasing due to the integration of AI, allows it for numerous space missions and as well as frees human beings to target tasks to that they are suited better [68]. American space agencies also utilize AI for space exploration to develop autonomous rovers, and spacecraft, automate image and video analysis and make communication networks better and distortion-free.

5.7. Automobile

In recent years demand for autonomous vehicles has been increasing rapidly, thus for the development of autonomous vehicles, AI technology must be integrated with normal vehicles with the help of software. Vehicles integrated with AI technology can acquire data related to the information of navigation from diverse sources, can enlarge the perception of the drivers, and can avoid vital accidents by predictions, therefore increasing the safety, efficiency, and comfort of driving [69]. Nowadays demand for driverless cars has increased gradually. Thus, the implementation of AI technology for driverless cars is useful due to users might have more free time and this technology provides better services for transportation [70]. "Tesla" is the leader in the driverless car market industry. AI can change the complete scenario of the automatic automobile industry. Nowadays the demand for the automatic car has increased rapidly.

5.8. Surveillance

Some of the major developments such as face recognition, pattern recognition, image processing, and many more computer vision technology have been already implemented in our society for security purposes with the help of AI technology. An AI-based surveillance system is based on detection and classification combination methods focusing on several computer vision programs such as object detection, object trajectory tracking, classification of objects, and many more [71]. This type of surveillance system can be applied for avoiding accidents on roads, border control, security of communication interfaces, protect personal data, and various ways in our daily life.

5.9. Education

AI technology is widely used in the field of education for solving various problems. Some of the major applications of AI in education are automation of tasks, personalized learning, smart content creation, universal access, identifying weaknesses in the classroom, assistance for teachers and students, and teaching the teacher. AI technology ensures that software for educational purposes is personalized for private uses. There is some AI-based software for adaptive learning, programs for students, and games that are already available. AI application in education is probably one of the most vital things as learning is smoother, more comfortable, and divided around personal knowledge. AI is a field of research and study and the resulting novel technologies and developments that have been implemented in machines, computers, and other artifacts have intelligence like human beings characterized by cognitive learning, abilities, adaptability, and capabilities of decision-making [72]. Thus, AI has extensively been used and adopted in educational institutions in various ways.

5.10. Healthcare

One of the most important and required applications of AI technologies is in the field of healthcare. Due to recent advancements in electronics engineering, AI integrated with medical devices is widely used in the field of healthcare for the diagnosis of diseases and providing facilitation to patients.
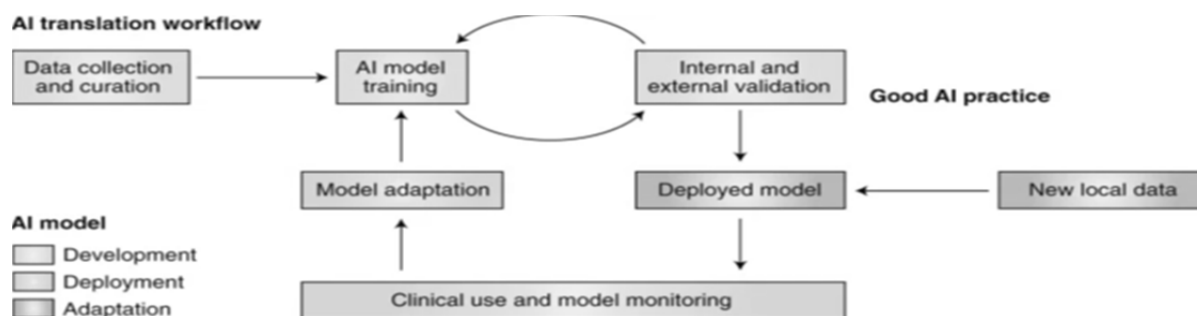

Fig. 11. Workflow of AI translation in healthcare [73]

AI is also helpful to provide physical assistance to physically disabled people. Visually impaired people are also getting precise navigation by using a global positioning system (GPS) and an infrared sensor utilized as an infrared matrix [74]. Fig. 11 illustrates a complete workflow chart of AI implementation in the healthcare field. AI is very useful to support healthcare workers with several tasks from clinical documentation to administrative workflow, and patient outreach together with specialized assistance such as in the automation of medical devices, image analysis, and monitoring patients [75]. The basic aim of AI implementation in healthcare is to explain and analyze the links between treatment or prevention methodologies and patient outcomes. Applications of AI techniques can reduce the cost and time for the management and diagnosis of disease states, therefore making more effective and convenient healthcare for human beings.

6. Role of AI in the Optimization of the Integrated Circuit

In recent decades, AI has been playing a major role in the optimization of IC. Integrated circuits (IC) are an important and most valuable part of any electronic equipment. The efficiency of almost every electronic piece of equipment mainly depends on the IC potential. We can enhance the efficiency of IC by analyzing the thermal behavior of the structure having a heat sink, IC, active fan, and temperature sensor in which the dissipation of the power is utilized as the parameter of control to achieve both optimal throughputs of an energy saving and microprocessor [76]. Also, reduction in the consumption of power in the combined digital ICs by reducing the total switching number of every gate operating in the circuit, which operates the necessary logical function for the

optimization of IC [77]. By controlling the temperature of the IC in electronics equipment with ML algorithms, computer systems can enhance their accuracy. There are mainly two ways are utilizing nowadays to design IC, which are the optimization of automated circuit size and enhancing the efficiency and accuracy of the performance models [78]. AI technology and IC are inseparable. AI technology depends on the computing ability and learning ability of computers. ICs contribute hardware support in the function of AI algorithms. The application of AI technology around IC mainly depends on the analysis of faults in the computer system due to ICs. Optimization of IC accuracy and efficiency can be done by utilizing AI techniques, which is the most important part of circuit systems. The particle swarm intelligence algorithm is the most influential and accurate way to optimize the IC because this algorithm has a very simple architecture and fast response time. Mainly this algorithm is generally trained with a dataset containing the dimensions of the transistor and measurements of performance which means the algorithm first learns the topology of the circuit with all nonlinear and nonidealities occasions towards optimizing the IC [79]. ANNs and DL are utilized to make appropriate analog ICs to optimize the performance of systems. ML techniques can be applied in automated optimization for the designing of electronic circuits that integrates ANNs and global optimization. A regressor of the neural network is built to predict the metrics of circuit operation such as phase margin, power, delay, and offset dependent on input parameters like supply current and voltage, temperature, device size, and process corner. This regressor will be an objective function for the ML tool to optimize the systems [80]. The genetic algorithm which is one of the most popular AI techniques plays an important role in designing, synthesizing, and optimizing the analog ICs to minimize the development time and enhance the precision of these circuits [81]. Thus, IC can be optimized by optimizing the cooling systems of the processing systems.

7. Future Perspectives

Kai-Fu- Lee in September 2018, at a book launch program, he told, "Artificial Intelligence is going to completely change the world spare than aught in mankind's history even more than electricity" [82]. Research and study into, and development of, solutions depend upon AI technology continue apace. AI technology is attracting huge investments from large multinational organizations and governments alongside progress in capital investments in enterprises of start-up type. The algorithms of ML will be the fundamental driver for almost every AI system in the upcoming future and solutions of AI will, in roll, impact sectors of almost every field [83]. The tempo of research in AI has been estimated, not only on advances in originative algorithms, but as well as on our capacity to access, generate, and store huge volumes of data, and on signs of progress in the architecture of processing graphics and together hardware to execute these huge amounts of data. This technology has some potential impact nowadays and will impact future people's lives in ways such as economic, ethical, and social impacts [84]. By the year 2030, technologists expect that human beings will be even more reliant on AI in complex digital systems. Some experts say we will regularly sustain the significant arch of supplementation of human lives with almost positive outcomes as we implement this technology widely. Researchers and technologists say the improvement of AI will make almost every person better off over the upcoming decades. It has been successful in emulating and occasionally replacing the expertise of humans in several domains right from games playing such as Poker, Chess, and Jeopardy, etc. to the diagnosis of some diseases like skin cancer, Covid-19, etc., and predicting voice recognition, facial recognition, etc. An American futurist and inventor, "Ray Kurzweil", has expected that researchers would be capable to achieve AI systems that will have similar intelligence as humans by 2029 [85].

AI is impacting every industry virtually in the future and almost every person. AI is extremely important to the future of human beings because it forms the extreme root of computer learning. This technology has impacted as the vital driver of trending technologies such as robotics, the Internet of things, and big data, and it will continuously play as an innovative technology for the future [86]. Generally, the Gartner Hype Cycle provides insight into when and how AI technology will evolve, therefore assisting businesses in regulating if the technology would be utilized to reach their goals of the business, depending upon their capacities of taking the risk. This cycle for AI technology helps us to understand the present position of different technologies belonging to AI and the time taken by them to get a stable state for large commercial usage [87]. This technology needs more attention from researchers and technologists to enhance the quality of perception of climate change soon to combat global warming and other environmental changes. Nowadays this technique is utilized by remote sensing experts, but more work is required to improve the potential of the experts. This technique can be implemented in mobile robots to make them more intelligent and autonomous. Many opportunities for research such as path planning of single and multi-robot systems, obstacle avoidance, planning of robotic motion in the tropical situation, and many more are still open for mobile robotics researchers.

AI can be widely applied to protect the power system from islanding conditions and other bad phenomena affecting power systems. Currently, this technology is widely used by several scientists and technologists to make a better and more important power system scheme. R. Raj et al. [88] present a technique to detect islanding by SMFS islanding detection technique. We can apply AI techniques to integrate with each islanding detection technique to enhance the accuracy of the protection scheme. There are various AI algorithms already defined to protect power systems. AI is playing an important and major role in the field of environmental science. ML and DL technology are used nowadays in remote sensing applications. AI technology can combat different kinds of pollution. This technology can be very useful in various environmental issues such as waste fire management, air pollution, water pollution, soil pollution, etc. to protect our environment from climate change problems. Fig. 12 presents the predicted profits of industries due to AI technology integration in the industries infrastructure. The presented profit scenario has been predicted in an Accenture and Frontiers systems research article [89]. Optimization of the IC is still a major challenge for researchers to enhance the performance of electronics types of equipment. Thus, researchers and tech-nologists can work towards optimizing the IC by utilizing AI.

This technology allows environmental scientists in the near future to make our environment more prosperous and healthier for human beings and other species. AI can enhance the efficiency and accuracy of remote sensing instruments to track climate change issues. By enhancing accuracy in keeping data for historical changes in climate change issues, we can learn and plan a better system for the protection of our environment. In the next upcoming decades, AI technology will contribute their contribution in

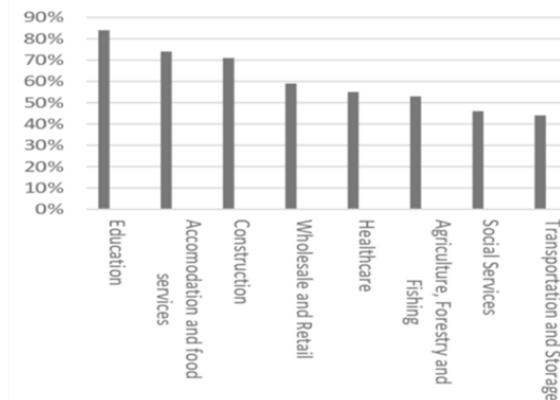almost every field of study and research to make our surroundings and environment wealthier and healthier.

Fig. 12. Projected industrial profit with AI implementation by 2035 [92]

8. Major Challenges

AI technologies have some major challenges in their applications and after implementation in the real world. The area of implementation for AI technologies is recently expanding rapidly into the health sector, finances, robotics, businesses, military surveillance, security, and many more in all its shapes and forms [90]. One of the major challenges in AI technologies is that it requires specific features for every application. AI systems grasp headway across various fields. While certain parts might not be seen in another form by end-users, our previous knowledge has shown that the interrelated components of each component play a vital role in the failure and success of an AI system [91].

Fig. 13. Some major challenges for AI technology implications

Fig. 13 demonstrates some important key challenges of AI technologies applications. AI learns from information available in such a way humans learn, but the identification of patterns requires much more data than we require [92]. Enthusiasm for research in the field of AI technology is not progressing rapidly, that's why the rate of adoption of AI systems in businesses has not increased so fast yet. As AI is a novel technology, there is an enormous lack of skilled manpower having data science and data analytics skills. As the demand for AI increases, businesses are short of professionals with skills who can fulfill the requirement and are able to work with AI technology [93]. AI systems are all about technology, science, and algorithms which generally human beings are unaware of, thus making it very hard to trust them. The initial cost of implementation of AI technology in businesses is very high. Any organization that depends on products based on AI cannot clearly illustrate its vision and anything they have received with the AI technique help.

The most important problem in the implementation of AI is security in the health industry, and the most diligent review is also required [94]. As well as security related to hardware, software, and human errors should be taken care of. Bias in algorithms is one of the important factors in AI technology right now and will be available in the upcoming time unless we strive to develop our technological products which are much better than we are. Thus, the idea that powerful AI techniques can be essentially hard is disconcerting. Finally, we can say that there are several challenges related to AI applications in businesses such as security, lack of data, low budget in the research related to AI, lack of experts, and many more.

9. Conclusion

Swift growth in Artificial Intelligence technology is mostly talked about recently. It is a technology of game-changing that would affect human life in every aspect. AI has quite come a long period ago, from first being forecasted as a system that could be identified by a human to nowadays being perceived in several fields in the almost everyday life of human beings. Some of the important historical developments, the main area of study in this field, and some major applications of this technology have been discussed in this paper. This paper is very useful for early-stage researchers and technologists in the AI field because it provides a deep insight into this field. As well as we explain some little insights into modern technologies such as big data, machine learning, deep learning, expert systems, and artificial neural networks in this article. Application of these technologies in various fields such as computer vision, robotic science, the health sector, character recognition, pattern recognition, and many more have been discussed in this article. As far as we know, this is the first article in the history of Artificial Intelligence research that provides insight into almost every part of this field. The main idea behind this analytical paper is to provide an overview of AI technique applications and their impact on science and engineering. The future aspects of this trending topic are illustrated from every point of view and major challenges related to AI technology have been discussed. Therefore, even though Artificial Intelligence considers a superpower that we might have the capacity to vanquish in the coming future novel technologies associated with AI should pass through ultimate phases of intensified expectations and critical discouragement before the AI technologies become steady and sufficient for commercial use. This article has provided some important and primary background information about the application of AI in the optimization of the performance of ICs.

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