Intelligent systems and AI techniques: Recent advances and Future directions

Ismail Eyad Samara*

University Of Sharjah, UAE
Email: Ismaelsamara20@gmail.com

Abstract

In recent years, Intelligent systems and AI techniques have advanced significantly, thanks to breakthroughs in deep learning, reinforcement learning, and related fields. These advancements have led to the development of more efficient and accurate systems, including computer vision, natural language processing, and autonomous systems. The future of intelligent systems and AI techniques involves further improvements in deep learning, explainable AI, transfer learning, and human-AI collaboration. As these systems continue to be adopted, they have the potential to revolutionize our lives and create new opportunities for progress. However, ethical concerns such as bias and privacy must be addressed, and future research should focus on developing more secure systems and integrating these technologies with emerging technologies like quantum computing and blockchain. Overall, the field of intelligent systems and AI techniques is primed for continued growth and innovation, offering exciting possibilities for solving some of the most pressing challenges of our time.

Keywords: Intelligent systems; AI techniques; deep learning; quantum computing; Blockchain; human-AI collaboration

1. Introduction

The world has witnessed a remarkable transformation in the field of artificial intelligence (AI) and intelligent systems over the past few years. The advent of AI has brought with it a revolution in the way we think about and interact with technology. With intelligent systems, we can automate tasks and processes that were previously impossible, and AI techniques can be used to make predictions, provide recommendations, and automate decision-making in various industries.

Recent advances in AI techniques have revolutionized the field of computer science, and these intelligent systems are now being used in areas such as healthcare, transportation, finance, and many other sectors. Machine learning, natural language processing, computer vision, robotics, and reinforcement learning are some of the recent advances that have enabled intelligent systems to handle complex tasks and make accurate predictions. These advances have the potential to transform various industries and have opened up new opportunities for innovation and growth.

In addition, the future directions of intelligent systems and AI techniques are even more exciting. Explainable AI, edge computing, quantum computing, multi-agent systems, and autonomous systems are some of the emerging areas that have the potential to transform various industries further. These future directions will enable intelligent systems to work together to solve complex problems and will open up new opportunities for innovation and growth.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

This paper aims to provide an overview of the recent advances in intelligent systems and AI techniques and discuss the future directions of this field. By exploring these new directions, researchers and industry experts can continue to advance the field of intelligent systems and AI techniques, ultimately improving the way we interact with technology and transforming various industries for the better.

2. Literature Review

Intelligent systems

Intelligent systems are computer-based systems that can perform complex tasks that traditionally require human intelligence. These systems are designed to analyze and interpret data, make decisions, and provide recommendations based on that analysis. They can be classified into different categories, including expert systems, artificial neural networks, fuzzy logic systems, and genetic algorithms.

Expert systems are computer programs that mimic the decision-making capabilities of a human expert in a particular field. They use a set of rules and a knowledge base to reason through a problem and provide a solution. Artificial neural networks, on the other hand, are modeled after the structure and function of the human brain. They can learn from experience, recognize patterns in data, and make predictions based on that learning. Fuzzy logic systems use mathematical algorithms to represent uncertainty and imprecision in data, while genetic algorithms use evolutionary principles to optimize solutions to complex problems.

Previous studies have highlighted the potential of intelligent systems in various industries. In the healthcare industry, intelligent systems have been used to improve diagnosis and treatment decisions, as well as to predict patient outcomes. In finance, intelligent systems have been used for fraud detection, risk assessment, and investment decisions. In transportation, intelligent systems have been used to optimize traffic flow, improve safety, and reduce congestion.

One of the challenges in developing intelligent systems is ensuring that they are transparent and can be trusted. Explainable AI, or XAI, is a growing area of research that focuses on making AI systems more transparent and understandable to humans. This is important for ensuring that users can understand how decisions are being made and can trust the recommendations provided by the system.

In addition, ethical concerns have been raised about the use of intelligent systems, particularly with regards to bias and privacy. Previous studies have shown that AI systems can be biased if they are trained on data that reflects societal biases. This can result in unfair treatment of certain groups of people. Privacy concerns arise when intelligent systems collect and use personal data without the user's knowledge or consent.

Overall, the development and application of intelligent systems have the potential to transform various industries and improve decision-making processes. However, there is a need for ongoing research and development to address ethical concerns and ensure that these systems are transparent and trustworthy.

AI techniques

Intelligent systems (IS) offer a standardized methodical approach to tackle significant and somewhat complicated issues and produce repeatable and reliable solutions over time [2]. The ability to grasp, to understand and benefit from experience is what intelligence, as defined by many dictionaries, is. Of course, there are additional definitions as well, such as the capacity to learn and remember information, mental prowess, and the capacity to react swiftly and effectively to novel circumstances, etc.

It is a challenging issue, and there is much discussion surrounding the notion of intelligent systems. From a computational perspective, a system's intelligence can be described by its adaptability, memory, learning, temporal dynamics, reasoning, and capacity for managing ambiguous and imprecise input.

Artificial intelligence (AI), regardless of the definition, is unquestionably a necessary foundation for creating intelligent systems. AI can be divided into two primary directions, claims [13]. One is humanistic AI (HAI), which explores devices that behave and think like people. The other is rationalistic artificial intelligence (RAI), which looks at devices that can be created using knowledge

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

of intelligent human behavior. Following are a few examples from [9] that provide citations to their original sources. The practice of building intelligent machines is known as human-assisted intelligence (HAI). It is the study of how to program computers to perform tasks that, at the present, people are more skilled at. RAI is a field of research that aims to model and replicate intelligent behavior using computational methods. It is the area of computer science focused on automating intelligent behavior. The current generation of intelligent systems is more a product of rationalistic than humanistic AI. In addition to HAI characteristics, IS accepts intelligent behavior as seen in nature as a whole; consider, for instance, how evolution, chaos, and natural adaptability are examples of intelligent behavior. The need to resolve complicated issues while maximizing efficiency is another factor driving IS. A system is considered intelligent if it mimics some features of the intelligence displayed by nature. These include information compression (data to knowledge), extrapolated thinking, learning, adaptability, robustness across issue domains, and improvement in efficiency (through time and/or space).

Human-engineered systems that exhibit intelligent behavior or features were made possible by the introduction of digital computers. Artificial intelligence is the field of study and science that resulted from such systems. The AI research community limits the use of this general term to top-down symbolic representations and manipulations, as opposed to using it to refer to nearly any approach to intelligent systems [3]. In other words, AI develops an intelligent system by first understanding the problem's structure (usually expressed in formal logical terms), and then applying formal reasoning techniques within that framework.

Alternately, non-symbolic and bottom-up approaches to intelligent systems are also known (in which the structure is found and came from an unordered source). Even in the early phases of developing an effective mathematical model, the traditional methodologies for comprehending and projecting the behavior of such systems based on analytical techniques may prove to be insufficient. Such an analytical technique may use a computing framework that is too categorical and rigid to handle the complexity and intricacy of actual industrial processes. As it turns out, working with such systems requires one to accept imprecision and deal with a high level of uncertainty, and trying to increase precision can be quite expensive [11].

Researchers used fuzzy logic, neural networks, and evolutionary computation to produce a hybrid system known as computational intelligence (CI) in order to overcome the issues highlighted. There is disagreement about the precise meaning of CI despite the fact that it is often employed. The concept is believed to have been introduced at the IEEE World Congress on Computational Intelligence in 1994, and several books, conferences, and articles have subsequently tried to define it. Here we give a brief history of the phrase, focusing on the oldest and most fascinating interpretations. Marks outlined the components of computational intelligence (CI) in [10], one of the seminal works on the subject, by naming neural networks, genetic algorithms, fuzzy systems, evolutionary programming, and artificial life. Note that in more contemporary jargon, evolutionary computing is the phrase used to refer to both genetic algorithms and evolutionary programming.

The term "computational intelligence" refers to a methodology involving computing (whether with a computer, wetware, etc.) that demonstrates an aptitude for learning and/or handling novel situations in a way that makes the system appear to have one or more attributes of reason, such as generalization, discovery, association, and abstraction. Eberhart et al. emphasizes pattern recognition above stress adaption (Bezdek). Computational intelligence and adaptability are equivalent concepts, as stated explicitly. To put it another way, CI, in this sense does not depend on explicit human knowledge [7]. You'll notice that the first definition also lists flexibility as one of the essential characteristics of intelligent systems. We quickly summarize three common viewpoints on the link between AI and CI in this section's conclusion leaving it to the reader to evaluate them.

In [7], Fogel developed a third viewpoint. He claims that AI systems emphasize artificial intelligence rather than intelligence, starting with adaptability as the primary trait of intelligence and noticing that classic symbolic AI systems do not adapt to new challenges in novel ways. It follows that CI systems are intelligent, whereas AI systems are not.

In his innovative approach to machine intelligence, Professor Lotfi A. Zadeh [14] distinguished between Computational Intelligence, which is based on Soft Computing techniques, and Artificial Intelligence, which is based on Hard Computing techniques (Figure 1).

Hard computing is focused on the study and design of physical systems and processes and has the traits of formality, categorization, and accuracy. Binary logic, crisp systems, numerical analysis,

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

probability theory, functional analysis, mathematical programming, approximation theory, and crisp software are the foundations of this system.

The goal of soft computing is to analyze and create intelligent systems. It contains approximation and dispositionality properties and is based on fuzzy logic, artificial neural networks, probabilistic reasoning, genetic algorithms, chaos theory, and some aspects of machine learning.

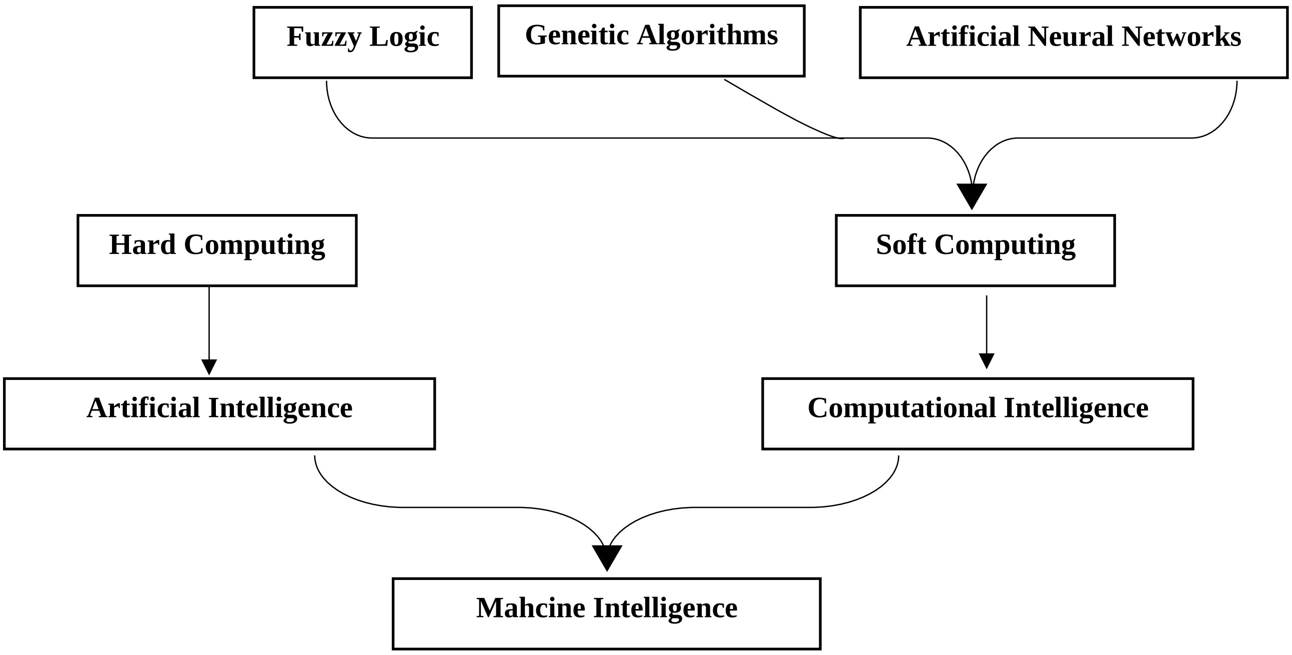

Figure 1: Artificial Intelligence vs. Computational Intelligence

While imprecision and uncertainty are undesirable characteristics in hard computing, they are tolerated in soft computing in order to create an acceptable solution with low cost, tractability, and a high Machine Intelligence Quotient (MIQ). According to Prof. Zadeh, the basis for true machine intelligence should be considered soft computing rather than hard computing. According to him, soft computing is a collection of approaches that serves as a basis for the conception and design of intelligent systems with the goal of formalizing the amazing capacity of humans to make defensible decisions in the face of uncertainty and imprecision.

Fuzzy Logic

Information and facts that are fuzzy or ambiguous are not statistically precise. In our world, most concepts are ambiguous or difficult to define. An element is either a member of a set or it is not, according to crisp logic, a kind of classical logic. This means that each element has a membership degree in the set of either 1 or 0. Fuzzy membership values in a set represent the membership levels of its constituents. Basic to fuzzy set theory, which is based on "approximate reasoning" logic known as fuzzy logic, is the membership function. It is a broadening of traditional (two-valued or crisp) reasoning. Imprecision, approximation, and vagueness are all represented by fuzzy sets. Crisp logic cannot address issues that fuzzy logic can.

Numerous engineering fields, including robotics and control, architecture, and environmental engineering, use fuzzy logic in a variety of applications. Medicine, management, decision analysis, and computer science are further application fields. Almost daily, new applications are released. Fuzzy expert systems and fuzzy control are two of the key application areas.

Neural Networks

An analytical paradigm known as an artificial neural network (short for neural network) is based on the brain's massively parallel structure. It replicates a parallel, highly networked computing architecture with numerous, comparatively basic individual processing units. It is renowned for its capacity to handle erratic and loud input.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

There are five areas where neural networks are best applicable [6] Classification; Content Addressable Memory or Associative Memory, Clustering or Compression, Generation of Sequences or Patterns, and Control Systems.

Evolutionary Computing

In order to improve and categorize solutions, evolutionary computing uses machine learning techniques that imitate biological genetics and natural selection. It consists of evolutionary programming, genetic algorithms, particle swarm optimization, and genetic algorithms. These algorithms modify hierarchical tree structures, develop computer programs, and propel particles through the problem space using techniques including crossover, mutation, survival of the fittest, and recombination. Numerous applications, including multiple-fault diagnosis, robot track determination, schedule optimization, conformal DNA analysis, load distribution, neural network explanation, and product ingredient mix optimization, have used evolutionary algorithms for optimization and classification tasks.

Hybrid Systems

For the purpose of creating intelligent systems, hybrid systems integrate two or more distinct technologies (such as fuzzy logic, neural networks, and genetic algorithms). Each technology stands for a different part of the human intellect that is required to improve performance. Every technology, though, has its limitations and restrictions. The ability to combine two or more of them to create a hybrid system improves the system's functionality and performance while also advancing our knowledge of human cognition.

Table 1: The constituents and the characteristics of hard and soft computing

	Based on	**Characteristics**
Hard Computing	▪ Binary Logic ▪ Crisp Systems ▪ Numerical Analysis ▪ Differential Equations ▪ Functional Analysis ▪ Mathematical Programming ▪ Approximation Theory ▪ Crisp Software	▪ Quantitative ▪ Precision ▪ Formality ▪ Categoricity
Soft Computing	▪ Fuzzy Logic ▪ Neurocomputing ▪ Numerical Analysis ▪ Genetic Algorithms ▪ Probabilistic Reasoning. ▪ Machine Learning ▪ Chaos Theory ▪ Evidential Reasoning ▪ Belief Networks	▪ Qualitative ▪ Dispositionality ▪ Approximation

Intelligent systems are integrated using a variety of models. The classification system employed in [8] divides hybrid architectures into the following four groups:

Combination: A common hybrid design of this type combines rule-based or fuzzy rule-based systems sequentially with neural networks.

Integration: This design often employs three or more distinct technologies and establishes a hierarchy among the various subsystems. One subsystem, for instance, can be dominant and assign responsibilities to other subsystems.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

Fusion is a design that tightly couples and merges, typically relying on the powerful mathematical optimization capabilities of genetic algorithms and neural networks. The effectiveness of the resultant system's learning is improved when other approaches integrate these properties.

Association: The technological framework that combines many individual technologies and facilitates pairwise knowledge and fact exchange.

According to Lotfi A. Zadeh's prediction, hybrid systems "are likely to emerge as a dominant form of intelligent systems in the coming years." The prevalence of hybrid systems is anticipated to have a significant influence on how human-made systems are developed, produced, deployed, and used.

Neural networks are primarily concerned with learning and curve fitting, fuzzy logic with imprecision and approximate reasoning, and evolutionary computation with searching and optimization. Table II compares their capabilities with those of control theory and artificial intelligence in terms of several application areas.

Table 2: control theory and artificial intelligence in terms of several application areas.

	Mathematical Model	**Learning Data**	**Operator Knowledge**	**Real Time**	**Knowledge Representation**	**Nonlinearity**	**Optimization**
Control Theory	*Good*	*X*	*Needs*	*Good*	*X*	*X*	*X*
Neural Network	*X*	*Good*	*X*	*Good*	*X*	*Good*	*Fair*
Fuzzy Logic	*Fair*	*X*	*Good*	*Good*	*Needs*	*Good*	*X*
Artificial Intelligence	*Needs*	*X*	*Good*	*X*	*Good*	*Needs*	*X*
Genetic Algorithms	*X*	*Good*	*X*	*Needs*	*X*	*Good*	*Good*

Explanation of Symbols: Good = Good or suitable, Fair = Fair, Needs, Needs some other knowledge or techniques, X= Unsuitable or does not require.

Artificial Intelligence (AI) has transformed the world of technology, making it possible to automate many tasks and processes that were previously impossible. Intelligent systems, powered by AI techniques, are now being used to make predictions, provide recommendations, and automate decision-making in various industries. Recent advances in AI techniques have revolutionized the field of computer science and have opened up new opportunities in various sectors. This paper aims to provide an overview of the recent advances in intelligent systems and AI techniques and discuss the future directions of this field.

Recent Advances in Intelligent Systems and AI Techniques

The following are some of the recent advances in intelligent systems and AI techniques that have transformed various industries:

Machine Learning

Machine learning is a subset of AI that involves building algorithms that can learn from data. Recent advances in machine learning have led to the development of deep learning algorithms that can handle complex tasks such as image and speech recognition. Deep learning algorithms use neural networks to process data, and they have been successfully used in various applications such as natural language processing, autonomous vehicles, and healthcare.

Natural Language Processing

Natural language processing (NLP) is a branch of AI that deals with the interaction between computers and human languages. Recent advances in NLP have led to the development of chatbots and virtual assistants that can understand and respond to human language. NLP is also being used in the healthcare industry to analyze medical records and help with diagnosis and treatment.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

Computer Vision

Computer vision is a field of AI that involves teaching computers to interpret and understand visual data. Recent advances in computer vision have led to the development of image recognition and object detection algorithms that can be used in various applications such as surveillance, autonomous vehicles, and medical imaging.

Robotics

Robotics is a field of AI that involves the development of robots that can perform tasks autonomously. Recent advances in robotics have led to the development of autonomous drones, robotic exoskeletons, and surgical robots that can assist surgeons during operations.

Reinforcement Learning

Reinforcement learning is a subset of machine learning that involves building algorithms that can learn from trial and error. Recent advances in reinforcement learning have led to the development of intelligent agents that can play games, navigate complex environments, and learn from experience.

Future Directions of Intelligent Systems and AI Techniques:

The following are some of the future directions of intelligent systems and AI techniques that have the potential to transform various industries:

Explainable AI

Explainable AI (XAI) is a field of AI that aims to develop algorithms that can explain their decision-making process. XAI is important for applications such as healthcare and finance, where the decisions made by AI systems can have a significant impact on people's lives. XAI will enable users to understand the reasoning behind AI decisions and will increase the trust and transparency of AI systems.

Edge Computing

Edge computing is a distributed computing paradigm that involves processing data near the edge of the network, where the data is generated. Edge computing is important for applications such as autonomous vehicles and IoT devices, where real-time processing is required. Edge computing will enable intelligent systems to make decisions faster and will reduce the latency associated with cloud computing.

Quantum Computing

Quantum computing is a new computing paradigm that involves using quantum bits (qubits) instead of classical bits. Quantum computing has the potential to solve problems that are currently intractable for classical computers, such as factoring large numbers and simulating quantum systems. Quantum computing will enable the development of new AI algorithms that can handle complex tasks and will open up new opportunities in various industries.

Intelligent systems and AI techniques

Intelligent systems and AI techniques have seen significant advancements in recent years, with a range of applications across multiple domains. This literature review aims to provide an overview of the recent advances in intelligent systems and AI techniques and explore their potential future directions.

One of the most significant advances in intelligent systems is the development of machine learning techniques, particularly deep learning. These techniques have enabled intelligent systems to learn from vast amounts of data and make accurate predictions or classifications. Deep learning algorithms have been applied in various domains such as healthcare, finance, and image and speech recognition [25].

Another significant area of progress in intelligent systems is natural language processing (NLP), which has the potential to revolutionize human-computer interactions. NLP techniques enable machines to understand and respond to natural language inputs, such as speech or text. Recent advances in NLP have led to the development of chatbots and virtual assistants that can interact with users in natural language[24].

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

Computer vision is another area where significant progress has been made, particularly in the development of deep learning-based algorithms for image and video recognition. These techniques have been applied in various domains such as security, robotics, and autonomous vehicles[23].

Reinforcement learning is another area of AI that has seen significant progress, particularly in the development of algorithms for training agents to perform complex tasks in dynamic environments. Reinforcement learning techniques have been applied in various domains such as gaming, robotics, and autonomous systems[29].

Explainable AI (XAI) is an emerging area of research that focuses on developing AI systems that can provide transparent and interpretable outputs. XAI is critical for applications such as healthcare and finance, where transparency and interpretability are crucial for making informed decisions [22].

In addition to these advances, future directions of intelligent systems and AI techniques include edge computing, quantum computing, multi-agent systems, and autonomous systems. Edge computing involves performing data processing and storage closer to the edge of the network, reducing latency and improving performance [28]. Quantum computing has the potential to revolutionize AI by enabling faster computations and solving complex problems that are not solvable using classical computing techniques[21]. Multi-agent systems involve developing intelligent systems that can work together to solve complex problems, such as traffic management or disaster response[26]. Autonomous systems involve developing intelligent systems that can operate and learn independently without human intervention, such as autonomous vehicles or robots [27].

In conclusion, intelligent systems and AI techniques have seen significant advancements in recent years, enabling them to solve complex problems and transform various industries. The future directions of this field are even more promising, with emerging areas such as XAI, edge computing, quantum computing, multi-agent systems, and autonomous systems offering new opportunities for innovation and growth.

Data collection Using AI

AI is increasingly being used for data collection and analysis, particularly in areas where large volumes of data are generated, such as social media, e-commerce, and healthcare [1],[4],[5] . AI algorithms can process vast amounts of data quickly and efficiently, identifying patterns and trends that would be difficult for humans to discern. One example of AI being used for data collection is in social media monitoring[1] . Companies and organizations can use AI-powered tools to track mentions of their brand or products on social media platforms, analyze customer sentiment, and identify emerging trends. AI can also be used to monitor social media for potential security threats or to detect fake news and misinformation. Another example is in healthcare, where AI can be used to collect and analyze patient data to improve diagnosis and treatment [4]-[5]. AI algorithms can sift through large amounts of medical records, images, and other data to identify patterns that can help doctors make more accurate diagnoses and develop more effective treatment plans. However, there are also concerns about the use of AI for data collection, particularly with regards to privacy and security [20]. As AI systems collect and analyze vast amounts of personal data, there is a risk that this data could be compromised or used inappropriately. It is important to ensure that appropriate safeguards are in place to protect personal data and ensure that AI systems are used ethically and responsibly.

Data Collection Using AI Challenges

Data collection using AI poses several challenges that need to be addressed to ensure the quality and integrity of the collected data[15]. One of the main challenges is the potential for bias in the data, as AI algorithms can be trained on biased data sets, leading to biased results [16]. To address this challenge, it is important to use diverse and representative data sets and to regularly evaluate and retrain AI algorithms to minimize bias.

Another challenge is the need for data privacy and security (Dignum & van den Hoven, 2019). As AI algorithms collect and analyze large amounts of personal data, it is essential to ensure that appropriate safeguards are in place to protect the privacy and security of this data. This includes implementing robust data protection measures, such as encryption, access controls, and data anonymization, and complying with relevant data protection regulations.

A further challenge is the interpretability of AI algorithms, as it can be difficult to understand how these algorithms arrive at their conclusions [15]. This lack of interpretability can limit the trust and

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

confidence in AI systems, particularly in areas such as healthcare where decisions can have significant consequences. To address this challenge, there is a need for more transparent and explainable AI systems that enable users to understand the reasoning behind AI-generated decisions.

According to [17] in their report titled "Top 10 Data and Analytics Technology Trends That Will Change Your Business," one of the challenges of using AI for data collection is data quality. AI algorithms require large amounts of high-quality data to operate effectively, but data collected from different sources may be inconsistent or incomplete. Another challenge is the need for human oversight to ensure that AI algorithms are making accurate and ethical decisions [18]. Additionally, the use of AI for data collection raises concerns about privacy and security, as personal data may be vulnerable to theft or misuse [20] Finally, there is the challenge of ensuring that AI algorithms are transparent and explainable, so that their decision-making processes can be understood and evaluated [19].

These challenges and others related to data collection using AI need to be carefully considered and addressed to ensure that AI systems are used ethically and responsibly.

Applications of intelligent systems and AI techniques in Real life

Intelligent Internet of Things (IoT) models for traffic management Systems

Using Raspberry pi and camera to monitor vehicle leading to time-based monitoring system.

To keep traffic moving more smoothly, a smart traffic control system integrating camera data, communication, and automated algorithms is being created. The goal is to optimally manage the length of a particular traffic light's green or red period at an intersection. The length of the green or red flashes at the traffic signals should vary depending on the volume of traffic. Green lights should be on for a longer period of time when traffic is heavy in one direction; conversely, red lights should remain on for a longer period of time when traffic is light. This method is anticipated to reduce traffic congestion, pollution, and inefficiencies at crossings.

The System Design consists of:

1. Raspberry Pi
2. LED lights which are used for the purpose of signalling.
3. Traffic cameras which are used for monitoring traffic.
4. Node MCU Microcontroller

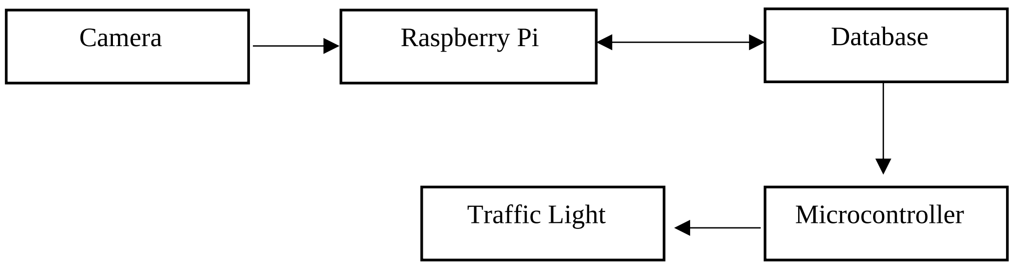

Figure 2: Flowchart of Using Raspberry pi and camera to monitor vehicle leading to time-based monitoring system

System Implementation

The first steps in the suggested traffic light control system would be:

Use a camera to record traffic footage continuously.

1. **Read Image:** Read the traffic image's frames.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

2. **Grayscale Image Conversion:** This process changes a colour image into a grayscale form. This approach is founded on various colour transforms. It determines the grayscale value and turns the image into a grayscale image based on the image's R, G, and B values.
3. **Image binarization:** This technique turns grayscale images into monochrome ones.
4. Changing the timing of traffic signals and lighting up the corresponding LED based on the number of vehicles.

Monitoring urban mobility in populated cities such as Los Angeles and Amsterdam by an embedded circuit using RFID with clustered systems

The modern era has witnessed an exponential growth in urban populations, leading to increased mobility problems in large cities. A United Nations report shows that 56% of the global population was urban in 2015, with a yearly increase of 1.84%. It is predicted that by 2050, 64% of the developing world and 86% of the developed world will be urbanized. To address the issue of traffic congestion in big cities, a new system is proposed. The traditional traffic management system using traffic lights and manual control by police officers is insufficient as it does not take into account real-time traffic data. The new system consists of a circuit in each vehicle that interacts with the system through either a wired or wireless connection to the user's smartphone. It uses Radio Frequency Identification (RFID) as part of the Internet of Things (IoT) and a more efficient Local Positioning System (LPS) for vehicle location, instead of GPS. Big data analytics is implemented using clustered workstations to maximize the throughput and form a regional computing unit.

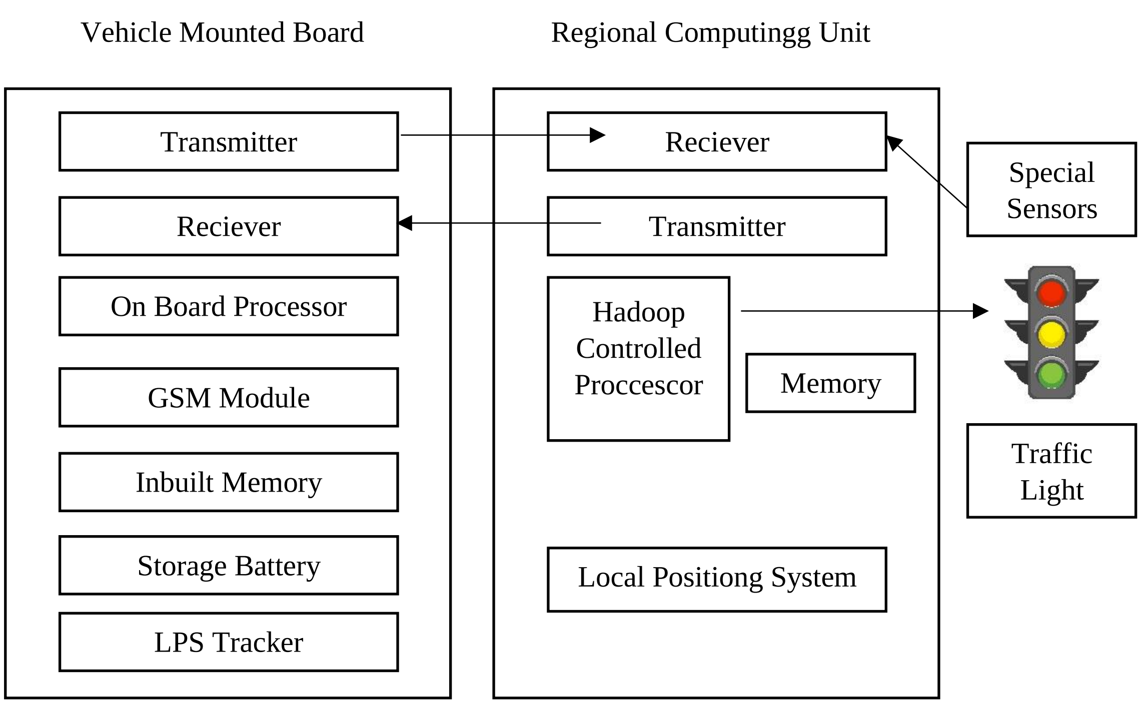

Figure 3: Block diagram of the proposed system

Figure 4: The Vehicle Mounted Board

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

The regional computing units receive data from vehicles that includes information about the vehicle's location, velocity, and other attributes. Instead of relying on the Global Positioning System (GPS), the system uses a Local Positioning System (LPS) to determine the location of each vehicle. LPS utilizes local beacons such as radio broadcast stations instead of signals from satellites used in GPS. LPS is more efficient in terms of time complexity compared to GPS. The regional computing units receive the location information from the LPS system and share it with other regional units. This data is analyzed using the MapReduce tool to determine the overall traffic flow in a region and control traffic lights, helping to estimate the maneuverability rate of a road and other relevant parameters.

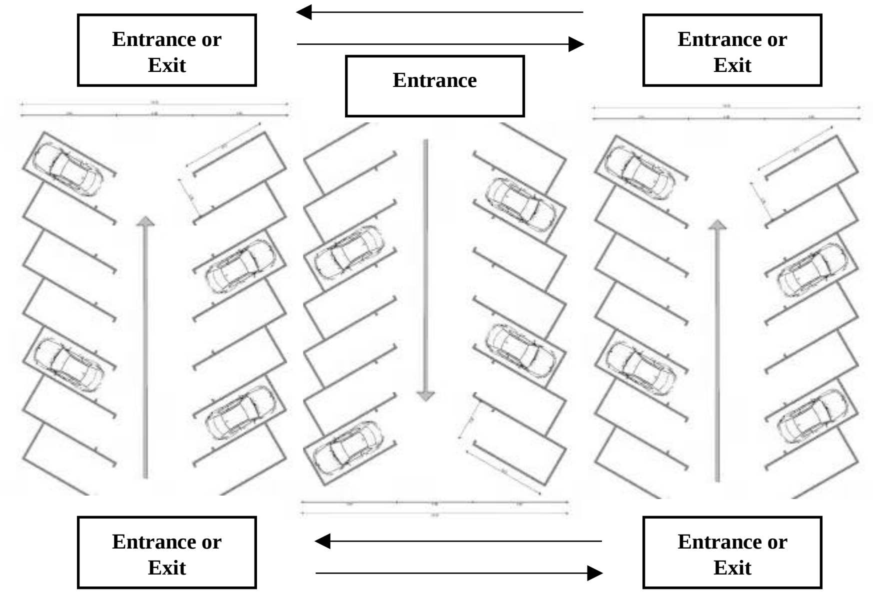

Figure 5: Parking space indentification and reserveration system

The computing unit, using reliable reports of a missing vehicle, is programmed to locate the stolen vehicle and disable its operation. To accomplish this, a specific frequency range is established, which instructs the internal system to cut off the electrical power supply from the battery to the engine, thereby disabling the vehicle. A noteworthy feature is that the rechargeable battery built into the system allows the vehicle to be monitored even when it is turned off.

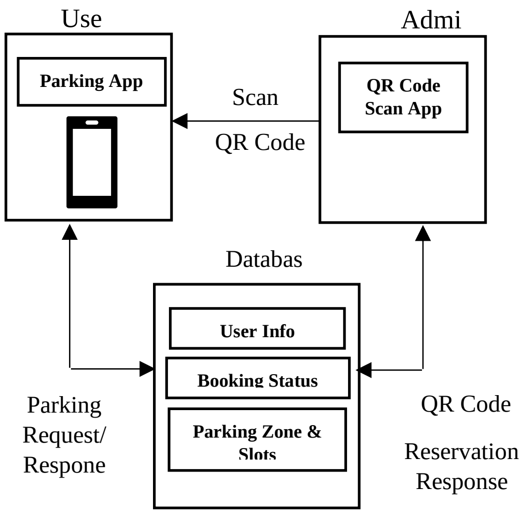

Figure 6: System Architecture

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

Anti-theft Security System

The computing unit has been tasked with finding the missing vehicle, as reported, and disabling it. To accomplish this, a specific frequency range has been set which will turn off the flow of electrical energy from the battery to the engine, effectively preventing the vehicle from operating. The inbuilt rechargeable battery in the system is noteworthy, as it allows the vehicle to be tracked even when it is turned off.

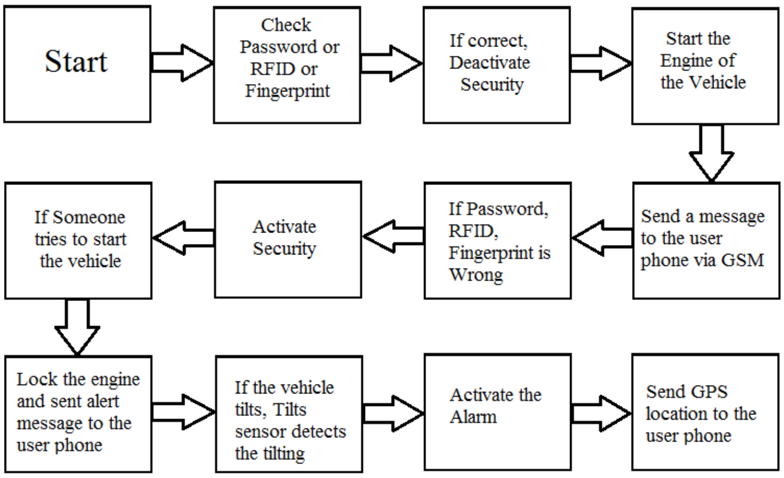

Figure 7: Anti-theft System Architecture

3. Preliminaries in Neutrosophic-Operational and Multi-Decision Analysis

Neutrosophic-Operational analysis is a relatively new method that has been gaining attention for its ability to handle uncertain, incomplete, and indeterminate data in decision-making processes. It provides a comprehensive framework for evaluating multi-dimensional problems by considering three components: truth-membership, indeterminacy-membership, and falsity-membership. This allows for a more nuanced evaluation of complex issues and can provide insights that traditional methods may not be able to capture. Multi-Decision Analysis is another important tool for evaluating complex problems by considering multiple decision criteria.

Fuzzy Logic:

The basic fuzzy logic equation for a single input variable is:

$\mu A(x) = (x - x0)/(x1 - x0)$ for $x0 \leq x \leq x1$

Where $\mu A(x)$ represents the degree of membership of x in fuzzy set A, x0 is the lower bound of the fuzzy set, x1 is the upper bound of the fuzzy set.

Neural Network:

The neural network equation for a single layer feedforward network is:

$y = f(w * x + b)$

Where y is the output, x is the input, w is the weight vector, b is the bias vector, and f is the activation function.

Hybrid Systems:

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

The hybrid systems equation for a system that combines continuous dynamics with discrete events is:

$dx/dt = f(x, u)$

where x is the state of the continuous system, u is the input to the system, and f is the continuous dynamics function. The discrete event part of the system can be modeled using a finite state machine, where the state of the machine determines the behavior of the continuous dynamics.

Note: The above equations are simplified examples and do not represent the full complexity of these AI systems.

Here's an example of a genetic algorithm, which is a type of ***evolutionary computing***:

```
function geneticAlgorithm(populationSize, fitnessFunction) {
  let population = generateInitialPopulation(populationSize);

  while (!terminationConditionMet()) {
    let parents = selectParents(population);
    let offspring = crossover(parents);
    let mutatedOffspring = mutate(offspring);
    population = selectSurvivors(population, mutatedOffspring, fitnessFunction);
  }

  return getBestIndividual(population, fitnessFunction);
}
```

This genetic algorithm takes a population of individuals, evaluates their fitness using a fitness function, and then evolves the population over multiple generations. The selectParents() function uses a selection strategy (such as roulette wheel selection or tournament selection) to choose parents for the next generation. The crossover() and mutate() functions use genetic operators (such as one-point crossover or uniform mutation) to create offspring from the parents. Finally, the selectSurvivors() function selects individuals to survive to the next generation based on their fitness, and the getBestIndividual() function returns the best individual from the final population. This genetic algorithm can be applied to a wide range of optimization problems, such as finding the shortest path in a graph or optimizing the weights of a neural network.

4. Discussion of the research outcomes

In recent years, there have been significant advances in intelligent systems and AI techniques, including machine learning, natural language processing, computer vision, reinforcement learning, and explainable AI. These techniques have revolutionized various industries and have the potential to transform even more in the future.

One of the most significant recent advancements in intelligent systems is the development of deep learning techniques, which have enabled machines to learn from vast amounts of data and make accurate predictions or classifications. Deep learning has been applied in various domains such as healthcare, finance, and image and speech recognition [25]. Another significant area of progress is natural language processing, which has led to the development of chatbots and virtual assistants that can interact with users in natural language [24]. Additionally, computer vision techniques have been applied in various domains such as security, robotics, and autonomous vehicles[23].

Moreover, the development of reinforcement learning algorithms has enabled machines to perform complex tasks in dynamic environments, such as gaming, robotics, and autonomous systems [29]. The emerging area of XAI has focused on developing AI systems that provide transparent and interpretable outputs, which is critical for applications such as healthcare and finance [22].

Future directions in intelligent systems and AI techniques include edge computing, quantum computing, multi-agent systems, and autonomous systems. Edge computing

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

involves performing data processing and storage closer to the edge of the network, reducing latency and improving performance [28]. Quantum computing has the potential to revolutionize AI by enabling faster computations and solving complex problems that are not solvable using classical computing techniques [21]. Multi-agent systems involve developing intelligent systems that can work together to solve complex problems, such as traffic management or disaster response [26]. Autonomous systems involve developing intelligent systems that can operate and learn independently without human intervention, such as autonomous vehicles or robots [27].

In conclusion, the recent advances in intelligent systems and AI techniques have enabled them to solve complex problems and transform various industries. The future directions of this field are even more promising, with emerging areas offering new opportunities for innovation and growth. However, there are still challenges to overcome, such as data quality, privacy, and ethical concerns, which need to be addressed to ensure the responsible development and deployment of AI systems.

5. Future Directions

Future studies in the field of intelligent systems and AI techniques can focus on several areas to advance the field even further. First, there is a need for continued research into developing more transparent and explainable AI systems. This can be achieved through the development of new XAI techniques and approaches that allow for better understanding and interpretation of the decision-making processes of AI systems. Second, research can focus on developing more efficient and robust machine learning algorithms that can handle large and complex datasets. This can include developing new deep learning techniques, improving the performance of reinforcement learning algorithms, and exploring new ways to integrate human feedback into machine learning models. Third, there is a need for more research on the ethical implications of AI systems, particularly in areas such as bias, privacy, and security. This can involve developing new ethical frameworks and guidelines for the development and deployment of AI systems, as well as exploring new ways to ensure that AI systems are fair and transparent. Fourth, future studies can explore new applications of AI systems in areas such as education, social welfare, and environmental sustainability. This can involve developing new AI-based tools and systems that can help address critical societal challenges and improve the quality of life for people around the world. Overall, future studies in the field of intelligent systems and AI techniques can play a critical role in advancing the field even further and ensuring that AI systems are developed and deployed in a responsible and ethical manner.

6. Conclusion

In conclusion, the recent advances in intelligent systems and AI techniques have shown great potential for solving complex problems and transforming various industries. Machine learning techniques, particularly deep learning, natural language processing, computer vision, and reinforcement learning, have all contributed significantly to the development of intelligent systems. Furthermore, emerging areas such as XAI, edge computing, quantum computing, multi-agent systems, and autonomous systems offer new opportunities for innovation and growth. However, as intelligent systems become more prevalent, it is important to address the ethical and social implications of their use. It is crucial to ensure that these systems are transparent, explainable, and ethically sound. This requires a multidisciplinary approach involving researchers, policymakers, and industry stakeholders to develop guidelines and regulations that promote responsible and ethical AI development and use. Moreover, there is a need to address the issue of data quality and security to ensure that AI algorithms are making accurate decisions and protecting personal data from misuse. This requires ongoing efforts to improve data quality and security, as well as transparency around data collection and usage.

In terms of future directions, there is a need for continued research and development in the areas of XAI, edge computing, quantum computing, multi-agent systems, and autonomous systems. These emerging areas offer new opportunities for innovation and growth, and their potential impact on various industries cannot be overstated. It is

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

important to prioritize research and development in these areas to continue driving the advancement of intelligent systems and AI techniques.

To sum up, the recent advances in intelligent systems and AI techniques have the potential to transform various industries and solve complex problems. However, it is important to address the ethical, social, and technical challenges associated with their use. By doing so, we can ensure that these technologies are developed and used responsibly to benefit society as a whole.

References

[1] Mittal, S., & Jain, R. (2019). Artificial intelligence in social media. In Handbook of Research on Social Media Applications for the Tourism and Hospitality Sector (pp. 277-295). IGI Global.

[2] T.A. Byrd and R.D. Hauser, “Expert systems in production and operations management: research directions in assessing overall impact,” Int. J. Prod. Res., Vol. 29, pp. 2471-2482, 1991.

[3] B.G.W. Craenen, A.E. Eiben, “Computational Intelligence,” Encyclopedia of Life Support System, EOLSS Co. Ltd., http://www.eolss.net, 2003.

[4] Shickel, B., Tighe, P. J., Bihorac, A., & Rashidi, P. (2018). Deep EHR: A survey of recent advances in deep learning techniques for electronic health record (EHR) analysis. IEEE Journal of Biomedical and Health Informatics, 22(5), 1589-1604.

[5] El Emam, K., Jonker, E., Arbuckle, L., Malin, B., & Pompa, J. (2020). Artificial intelligence in health research and healthcare: National survey of attitudes and practices among Canadian stakeholders. Journal of the American Medical Informatics Association, 27(6), 845-854.

[6] R.C. Eberhart and Y. Shui, Computational Intelligence - Concepts to Implementations, Elsevier, 2007.

[7] D. Fogel, “Review of computational intelligence imitating life,”IEEE Transactions on Neural Networks, Vol. 6, pp. 1562-1565, 1995.

[8] Dignum, V., & van den Hoven, J. (2019). Responsibility by design for AI. Ethics and Information Technology, 21(1), 1-3.

[9] K. Krishnakumar, “Intelligent systems for aerospace engineering – an overview,” NASA Technical Report, Document ID: 20030105746, 2003.

[10] R. Marks, “Computational versus artificial,” IEEE Transactions on Neural Networks, Vol. 4, pp. 737-739, 1993.

[11] I.J. Rudas, Hybrid Systems (Integration of Neural Networks, Fuzzy Logic, Expert Systems, and Genetic Algorithms), In:Encyclopedia of Information Systems, Academic Press, pp. 114-1 - 114-8, 2002.

[12] I.J. Rudas and M.O. Kaynak, “Techniques in Soft Computing and their Utilization in Mechatronic Products,” In: C.T. Leondes, Ed., Diagnostic, Reliability and Control System Techniques, Gordon and Beach International Series in Engineering, Technology and Applied Science Volumes on Mechatronics Systems Techniques and Applications, Vol. 5, Singapore, pp. 101-138, 2000.

[13] S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, New Jersey, 1995.

[14] L.A. Zadeh, “Fuzzy Logic and Soft Computing: Issues, Contentions and Perspectives,” In: Proc. of IIZUKA’94: Third Int.Conf. on Fuzzy Logic, Neural Nets and Soft Computing, Iizuka, Japan, pp.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022

1-2, 1994.

[15] Hagendorff, T. (2020). The ethics of AI ethics: An evaluation of guidelines. Minds and Machines, 30(1), 99-120.

[16] Kitchin, R. (2014). Big Data, new epistemologies and paradigm shifts. Big Data & Society, 1(1), 2053951714528481.

[17] Gartner. (2021). Top 10 data and analytics technology trends that will change your business. Retrieved from https://www.gartner.com/smarterwithgartner/top-10-data-and-analytics-technology-trends-that-will-change-your-business/

[18] Tassey, G. (2018). The impact of artificial intelligence – widespread job loss. Journal of Business and Economic Policy, 5(2), 23-30.

[19] Rudin, C. (2019). Stop explaining black box machine learning models for high stakes decisions and use interpretable models instead. Nature Machine Intelligence, 1(5), 206-215.

[20] Bartneck, C., Lütge, C., Wagner, A., & Welsh, S. (2020). Privacy issues of ai. An Introduction to Ethics in Robotics and AI, 61–70. https://doi.org/10.1007/978-3-030-51110-4_8

[21] Biamonte, J., Wittek, P., Pancotti, N., Rebentrost, P., Wiebe, N., & Lloyd, S. (2017). Quantum machine learning. Nature, 549(7671), 195-202.

[22] Gunning, D. (2017). Explainable artificial intelligence (XAI). Defense Advanced Research Projects Agency (DARPA).

[23] Hinton, G. E. (2012). Deep neural networks for acoustic modeling in speech recognition: The shared views of four research groups. IEEE Signal Processing Magazine, 29(6), 82-97.

[24] Jurafsky, D., & Martin, J. H. (2021). Speech and language processing (3rd ed.). Pearson.

[25] LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. Nature, 521(7553), 436-444.

[26] Liu, J., Li, Y., Zhao, D., & Zhang, M. (2019). Multi-agent systems and their applications. Wiley Online Library.

[27] Russell, S. J., & Norvig, P. (2022). Artificial intelligence: A modern approach (4th ed.). Pearson.

[28] Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge computing: Vision and challenges. IEEE Internet of Things Journal, 3(5), 637-646.

[29] Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction (2nd ed.). MIT Press.

Doi: https://doi.org/10.54216/IJAACI.010202
Received: January 14, 2022 Accepted: May 21, 2022