

THE WORLD OF ARTIFICIAL INTELLIGENCE

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What is Artificial Intelligence?

[1][2] Artificial Intelligence is a field of research in science and engineering which focuses on understanding intelligent behavior. [3] Intelligent behavior not only means being capable of solving highly complex problems, but also being able to converse, see, walk; in general, being able to perform tasks which most humans easily can. [2] AI is dedicated to the creation of smart machines and programs that can not only solve difficult problems, but also can perform human like tasks.

History of AI

[4] The word Artificial Intelligence may be very recent, but the idea of machines or automated systems can be seen since ancient times. In one of his poetry, Homer mentions chairs called ‘tripods’ that were automated. He also mentions ‘golden attendants’, that were capable of movement. Many more such examples can be seen depicted in the paintings, sculptures and books of olden times.

In 1495, Leonardo Da Vinci, created designs for a robot, that was very life-like. He never brought his design to reality, but according to his sketches it was capable simple movement. [6] In 1642, a mechanical calculator was invented by Blaise Pascal. It was named as the ‘Pascaline’. This was followed by the creation of ‘Step Reckoner’, an improved calculator, by Gottfried Leibniz in 1673. [4] In 1738, Jacques de Vaucanson, a French inventor, created a mechanized duck. It was capable of simple motions and could also make duck-like sounds. These two inventions are the most notable of the many that was created during this period. Other than these actual inventions a lot of artists depicted automated machines and robots in their plays, stories and paintings.

[5][6] The first person to develop a language for logical reasoning was George Boole. After this development, in 1847, Alan M. Turing, a mathematician, built the first automated machine called Turing-machine in 1936, which succeeded in decrypting German intelligence messages in 1941 during World War II. In 1944, Eckert and Mauchly succeeded in developing ENIAC (Electronic Numerator, Integrator and Computer). This was followed by Walter Pitts and Warren McCulloch’s design of an artificial neuron. Donald Hebb modified the design of the neuron in 1949, granting it with the possibility to learn. Finally in 1951, the first ever neural computer was built by Dean Edmonds and Marvin Minsky.

[5] John McCarthy was the first person to define the term Artificial Intelligence, which brought the concept of human-like, smart machines to limelight. Within a year, researchers succeeded in creating and testing the first problem solver, a machine that is capable of solving general problems.

[5][6] McCarthy, the father of Artificial Intelligence, in 1957, developed a language named LISP. It was capable of designing AI software. In 1961, T. Evans created a program called ‘ANALOGY’, that was able to solve analogical problems seen in IQ tests. A program named ‘STUDENT’ was developed by D. Bobrow in 1964. This program was capable of solving algebraic word problems as this program could understand human language to some extent.

In 1967, a few knowledge-based programs came into picture; ‘DENDRAL’ for scientific reasoning, ‘MACSYMA’ for mathematics and ‘Mac Hack’ for chess-playing.

‘ARPANET’ was established in 1969. It was the predecessor to the internet. In the same year a mobile intelligence named ‘Shakey’ was created. This was followed by the creation of ‘AARON’ in 1971. This was an automated art-program created by H. Cohen. In 1972, Alain Colmerauer, built a programming language called PROLOG. Few years later, in 1981 AI was commercialized.

Growth of AI

[6] The type of AI, being researched on, has been continuously changed, due to both further advancements in sciences and setbacks faced by the researchers and inventors. [7] The journey of AI development was not smooth; 3 major setbacks occurred within 60 years. The first setback was in 1973 when AI development was still in its infancy. A report was written and published by James Lighthill highlighting the hindrances in the growth of AI in the fields of automation, robotics and medicine particularly the central nervous system. In his report James called for the termination of the AI related researches being carried out in these fields.

The second failure occurred when the development of a fifth-generation AI came to naught, in Japan even after spending 850 million dollars till 1992. The research to develop this smart computer began in 1982. The goal was to create an AI that was capable of speech and listening. It should also be able to gather, extrapolate and process knowledge.

The creation of Cyc, an encyclopedia of knowledge by Stanford University marked the third setback in the growth of AI. Its creation began in the year 1984 and waned out by the late 1990s. The goal was to create an AI that was capable of inferring data to a human-level. It was able to store large amounts of data and could also be linked to external databases like DBpedia, Freebase and Central Intelligence Agency (CIA), but it failed to reach its actual goal. Despite these setbacks AI has continued to develop through the years. Even now its continuously evolving, depending on the needs of the era.

[8] During the early years of AI development, focus was on creating machines or systems that could play games and solve logical or mathematical problems. This was due to the fact the scientists of that time considered intelligence, synonym to being able to solve complex problems. Keeping this theme in mind, ‘The Logic Theorist’, an AI program was created that could solve and find proofs for equations, sometimes much better than the already found proofs. ‘GPS’, another AI program was created during the same time and could solve toy problems. AI programs that could play Checkers and Chess were also developed. In 1952, Arthur Samuel designed a Checkers’ playing software, where two copies could play against each other. They were capable of learning from each other. In 1962, his Checkers’ program defeated the former Checkers champion.

By the mid-1950s, focus in AI research shifted to strong AI that could imitate a human’s mind. ‘Eliza’, an AI program developed by Joseph Weizenbaum in 1966 was capable of holding conversations with patients and could do a passable imitation of a psychologist. It was only able to do a passable imitation as it lacked emotions.

Other than these AI programs, systems that could solve practical problems were also developed. For example, ‘Dendral’, an AI software which was developed in 1965 by Stanford University. It used knowledge of basic chemistry and mass spectrometry graphs to study unknown organic molecules. ‘Macsyma’, an AI system created by Carl Engelman, is also an example of such systems. It was able to solve problems on integration.

After this in 1960s, focus was changed to bottom-up approach from top-down (Strong AI) approach. Keeping this trend in mind few developments in the fields of neurons and learning were

made. This includes the creation of ‘perceptron’ by Frank Rosenblatt. This was followed by the beginning of AI Winter in the 1970s, during which AI development suffered major setbacks as described earlier. Though there were setbacks, researches in some fields of AI continued. This includes evolution of expert systems like ‘MYCIN’.

The AI Winter ended around the late 1980s, after which focus was diverted in creating Weak AI, i.e., AI systems that concentrated on solving particular problems. New fields of research were introduced as well. Most notable of them was research on Ant Colony Optimization (ACO), a biological field.

[9] Development of AI has shown tremendous growth since the beginning of the 21st century. It is the era of interdisciplinary science. New researches in fields of cybernetics, linguistics and automation are continuously being going on. New online systems like AMiner, Google Scholar and Microsoft Academic Services were developed to provide people access to scholarly big data.

[7] Nowadays there is rarely any sector that has not incorporated AI systems. From industries to homes, AI can be seen everywhere. Many large technical firms like Google, Twitter, Microsoft, Apple and Intel are all incorporating AI. Google has boasted use of deep learning in many of its research projects. Recently Microsoft created ‘Xiaobing’, a robot that could chat. It is also working on incorporating AI technologies in the internet through LinkedIn application. IBM’s Watson system is now being used in hospitals to scan for cancer histories in the patients’ family. This helps in providing required treatments and can even prevent the cancer from reaching severe stages. Further research in various fields is continuously being carried out.

AI in Healthcare and Medicine

[10] Leonardo Da Vinci can be considered as the great mind behind development of AI in healthcare. A lot of robotic models used in healthcare are created on the basis of the designs sketched by him. AI is used in medicine and healthcare in two ways; virtual and physical.

AI can be used to provide active counsel in treatment decisions taken by the physicians. They can be also used in the management sectors; the best example being electronic records of patients. This constitutes the virtual method of incorporating AI in healthcare. Usage of robot in taking care of patients especially the elderly patients and robots acting as assistants to surgeons forms the physical method. [11] Intelligent prosthetics are also a part of the physical method of usage of AI in healthcare. [10] Nowadays, ‘nanorobots’ are used as drug delivery system. They are able to target specific areas in the human body to supply the required drugs.

[11] Nowadays, appointments to a hospital can be scheduled online. Reminders of follow-up check-ups and vaccination due dates especially for children are done using AI. ‘DXplain’ is an AI system developed to generate a list of differentials based on the patients’ symptoms. It basically acts as guide to a doctor in their treatment decisions. It is also used to educate the medical students. Germ watcher is an AI software that spot and analyze hospital acquired infections. It was created by University of Washington. ‘Babylon’ is another AI system which allows people to consult their doctors online. It also has the feature to monitor a person’s health. ‘Ai Cure’ is a software developed by The National Institute of Health. It is capable of monitoring patients’ medicine usage using webcam of smartphones. It prevents people from disobeying their doctor’s orders.

[11] [13] AI systems are also being used in therapy to treat social anxiety especially in youth at an early stage. Most of the AI systems that can be used to treat mental health problems are still in

development; the best example being ‘MOST’ (The moderated online social therapy) project. Till now, it has been successfully applied in six studies, though it is still in development.

[14] AI through the usage of its sub-field Machine Learning (ML) is able to identify suicide risk factors, which can be used to further program an AI to find individuals who are at a suicide risk in the near future, thus being able to provide them with appropriate medical care. This has not been fully perfected, but researches are going on to make it more reliable.

AI has been implemented in suicide management. They help in evaluating patients’ and suggesting treatments and follow ups. They also screen individuals at imminent suicide risk, thus helping in providing immediate care.

As a part of helping in preventing suicide AI that are able to hold conversations using text or voice have been developed. They are able to talk to individuals and act as conversational agents.

[11][12] Intelligent health trackers like Apple watches and Fitbits can keep track of one’s sleep levels, heart rates, activity levels and even ECG. These are very helpful as they give the medical practitioners an idea about the overall health condition of the patients. ECG tracking is especially helpful as it helps in early detection of Atrial Fibrillation. The best example of AI software that keeps track of a patients’ ECG is ‘Kardia’ created by ‘AliveCor’. Similarly, blood glucose level tracking AI monitors are also in use. They help people in keeping track of their glucose levels enabling them to regulate their blood glucose. This helps in reducing the chances of a hypoglycemic episode. To detect epilepsy seizures, a monitoring device named ‘Embrace’ was developed. It was created by ‘Empatica’. It can be worn on the wrist and on detection of a seizure it sends an alert to one’s relatives and doctors, along with the person’s location.

[11] The field of surgeries was revolutionized with the invention of The Da Vinci robotic surgical system. It was created by Intuitive surgicals. It has mechanized arms that can imitate a surgeon’s hand motions with much better precision. It also provides a magnified 3D view of the area where surgery needs to be performed, thus providing assistance to the surgeon. It especially proved to be helpful in the fields of urology and gynecology.

[12] Gastroenterologists have successfully employed artificial intelligence to detect various ailments. They make use of artificial neural networks for image processing in ultrasound and endoscopy. They are able to detect colonic polyps as well as diagnose ailments like atrophic gastritis.

Thus, implementation of these smart machines in health care is beneficial and increases efficiency of the medical system. New advances are continuously made in this field.

AI in Manufacturing and Production

[15] The incorporation of artificial intelligence in industries have revolutionized the manufacturing and production process. Development of sensor technologies and computing methods have resulted in smart and efficient manufacturing. Nowadays, artificial intelligence systems are used to analyze and monitor manufacturing processes. They are also capable of making decisions in regards to the processes without human input. Using these robotic AI systems that can process data and connect industrial devices in Manufacturing and Production is referred to as Smart Manufacturing.

[16] Manufacturing and Industry 4.0 is the new system of technology incorporated with AI that can be used to enhance manufacturing processes. Though still developing, it has been adopted by a number of industries now referred to as ‘Lighthouse’ industries, and have proved to be beneficial. It has also improved productivity, flexibility, and the speed of production. Improvement in quality of

goods produced was also seen. This improvement in quality has been achieved through the implementation of prognostic and health management systems that continuously observe the industrial plant set-up, and alerts the personals when maintenance is required.

[17] Nowadays, Distributed Artificial Intelligence system is in use in many production companies. It follows a hierarchical pattern to solve problems. It performs its functions by breaking down the problem into small sections or parts. Each part is then handled by one of its agents and together these smart agents reach to a solution. Actually, these agents list out all the possible solutions of the problem. A fuzzy coordination system then selects the most appropriate solution to be implemented.

AI in Security and Surveillance

[18] AI is very useful in detecting and thus preventing terrorist attacks. AI systems can analyze activity and communication patterns at a much more rapid pace than when done manually. This enables the targeted countries to take timely measure and save thousands of lives. Infrastructures like bridges and roads are likely targets of terrorist activities. Having AI surveillance that can identify suspicious behavior and alert the required personnel in timely manner, is beneficial and can prevent deaths of hundreds.

[19] Incorporating Artificial Intelligence in the various robotic systems already in use in the military will increase its efficiency and strength. AI with webcams or motion detecting sensors will be beneficial in collecting information. [20] Small robots with sensors capable of hiding themselves in strategic positions can be deployed to gather data. Larger robots with the ability to supervise the smaller ones should also be used. These larger robots must be capable to commute the gathered information to the required personnel. Such a system increases the efficacy and efficiency of defense tremendously. [19] Currently, neural networks are in use to classify images gathered by drones.

Artificial Intelligence systems are also beneficial to Homeland and Border security divisions. To detect false distress signals at the coast, US government employed the usage of voice recognition systems that are able to create a physical profile of the person on the basis of voice. AI systems were able to analyze information gathered by Transportation Security to detect transport of illegal items. AUDREY is an AI capable of suggesting course of action to fire fighters in real-time, ensuring maximum efficiency in a safe manner.

AI in Education

[21][22][23] Over the years a lot of development has been made in the field of Artificial Intelligence so as to improve the education sector. These improvements have been proved to be beneficial to not only students but also teachers. In general, robotic and automated teaching systems have been introduced into the education system. These help in personalizing the teaching-learning process as well as reducing the instructors' workload through automated evaluation of students' answer sheets. Some of the software's like 'TurnItIn' and 'Ecree' are also able to check the originality of students' works.

[21][22] AI also forms the backbone of Natural Language Processing (NLP), which is the key factor behind the intelligent tutor systems. These systems are capable of personalizing learning. They are also capable of answering deep questions, create logical questions and develop self-reflection in the users. 'Cognitive Tutors' for mathematics and science and 'Auto Tutor' for physics, computers and learning critical reasoning are examples of such a system. 'Auto Tutor' is a dialogue-based intelligent tutor system.

[23] Nowadays, assistant robots called ‘cobots’ are being incorporated in the education sector to assist the teachers in teaching, especially kids. This assistance involves helping the kids learn their spellings and pronunciations. AI educational networks like ‘Squeeze Net’ and ‘Mobile Net’ can be accessed through smartphones. They are highly convenient and are capable of providing interactive and personalized learning.

Advantages of Artificial Intelligence

[24] AI technologies and applications can provide permanency. For example, in an organization some intelligence was developed by a group of people. Without the use of AI, this knowledge would be lost as in a few years or so the group of people may not be available to the organization. AI is capable of storing this knowledge permanently till the data is not disrupted.

It is also capable of improving on the data by learning from the real-world. This is called ‘reinforcement learning’. It makes the knowledge or application more reliable, thus increase in its usage.

AI can also be cost efficient. They can minimize cost by reducing the staff and their working hours. AI is also capable of decision making by analyzing both quantitative and qualitative data. It is also able to take into account the real-life uncertainties.

The solutions or decisions made by AI are not only more reliable but also faster, as the AI is able to analyze data much faster than human mind. So complex problems can also be solved in a short amount of time.

[25] No matter how hard one tries, human decisions are never based on hard facts. Emotions always play a part in making decisions. On the other hand, AI is capable of making decisions solely based on facts.

Transfer of knowledge is much faster in an AI. It takes seconds to pass new knowledge gained by an AI to other machines, unlike when a person is needed to be trained in some field of knowledge.

Unlike humans AI systems do not get tired, thus increasing the number of hours worked. This is especially helpful in Manufacturing and Production sector.

[26] AI is able to solve even the complex problems easily and in a short amount of time. The probability of success is high as well. The calculations are prone to have less errors. Multiple problems can also be solved at the same time.

AI systems can be used to explore unexplored areas like deep oceans and space.

[11] Being precise and accurate, AI can be used for diagnosis of diseases or ailments. AI are capable of learning from successive cases. They are able to store and access vast amount of information in a matter of seconds. All these results in efficient diagnosis.

Using AI in healthcare in the form of monitoring system to keep an eye on the patients proves to be highly beneficial, as it reduces workload and allows the doctors to give more time to the critical patients. AI do not require rest thus they are able to monitor patients more efficiently than humans.

[27] Use of AI in education proves to be highly beneficial mainly due to the flexibility it offers. The students are able to choose their own course; they are able to decide the timings and place of learning depending on their situations. It also enables the student to access a varied variety of study materials.

During learning, using AI technologies most of the conversions, whether it be with the automated system or the teachers or other learners are through the mode of texting. This gives a chance to even the social anxiety prone students to clear their doubts and participate in discussions easily.

Learning using AI systems is also cost effective. It saves travel costs as well as costs of hiring academic staff and creation of school or college campuses. Problems due to shortage of teachers and professors is easily rectified by incorporating AI technologies.

[28] The major advantage of machine learning a sub-branch of AI is that it is able to analyze complex and large amounts of data in a short time. This is especially beneficial to the Manufacturing Industry where analyzing large amounts of data is extremely important.

AI systems are also capable of self-learning at least to some extent. This is advantageous when dealing with dynamic and complex data, as the norm in manufacturing industries.

Disadvantages or Challenges of Artificial Intelligence

[24][25] One of the major drawbacks of AI is that one can never be sure whether the AI program will reach to a definite and useful solution. Also, we are unable to see the internal intricacies that the program used, to reach the solution, i.e., AI is unable to explain the logic behind its solution. While solving a problem the mathematical way each step is clearly seen and can be separately analyzed unlike in the case of AI softwares. As AI cannot explain the reasoning behind a particular solution, one can never surely tell if the answers are even correct. This causes many problems.

[25] AI will soon start replacing humans in many fields, as AI technologies can perform the employees' job much more efficiently. This will result in mass-scale unemployment, leading to increase in crime and poverty. It can also severely affect mental health by causing anxiety, stress and depression in many.

[26][29][32] AI itself is not creative, all the creativity lies in the hands of the programmer. Thus, AI must be specifically programmed to complete certain creative tasks. Also, incorporation of AI in day-to-day life as part of smart phones or smart home devices makes the people lazy and increases the dependency on technology. This dependency on AI technology will lead to its excessive use, resulting in people getting addicted to it. This addiction can result in several health problems especially mental health problems. Its excessive use can result in loneliness, which in turn can cause increase in anxiety levels.

Also, we store our contacts and other private information on them, which in wrong hands, can lead to breach of privacy and other problems.

[27][31] Use of AI in education can be disadvantageous as well. Using AI technologies for learning requires immense concentration and motivation on the part of the learner. It is easier to get distracted during online learning as compared to classroom learning. Most communications are through texting thus, hampering a student's communication skills. It also limits firsthand experience, causing problems in learning some concepts which are better learned through hands on experience. AI solely relies on data provided, to create personalized learning programs for the students. If there is an anomaly in the data, or the data lacks knowledge regarding the obstacles experienced by minority students, it will hamper the learning process.

[30] Automated Banking System can be very disadvantageous. It can severely disrupt the day-to-day processes of the bank. It lacks the human touch, which can prove to be a hindrance, especially in the selling of various policies. Also, AI will not be able to make decisions in certain situations, that require a human's thought process. Fully automated banking system will lack supervision, thus requiring a higher number of safety protocols, lest chances of robbery or embezzlement increase.

[25][29] A failure in algorithm of AI especially in defense and healthcare sectors can lead to loss of multiple lives. Wrong diagnosis due to error in data fed to the AI can cause very severe problems. If fed wrong data by the enemy, AI in military system can cause disastrous effect. In the wrong hands, it can also lead to mass destruction.

[32] AI is advancing more rapidly in developed countries like USA and Japan as compared to developing countries. In the near future this may result in rifts between these countries. This can lead to a lot of fear and confusion along with many political problems.

Conclusion

Artificial Intelligence has already established its roots in various fields. More and more AI techniques are continuously being developed and researched on. Healthcare, education, transport and various other fields have evolved immensely. All of these advancements are aimed towards the betterment of human society.

From the data gathered we can say that Artificial Intelligence is a boon as well as a bane. In my opinion, its advantages outweigh its drawbacks. If judiciously used with proper rules and regulations AI can lead to a new era of technology. It has the capability to make human life easier and better. It also has the capacity to revolutionize various domains especially healthcare and education. By usage of AI, space exploration can reach new heights.

References

- Alzaidi, A. A. (2018). Impact of artificial intelligence on performance of banking industry in Middle East. *International Journal of Computer Science and Network Security*, 18(10), 140-148.
- Amisha, P. M., Pathania, M., & Rathaur, V. K. (2019). Overview of artificial intelligence in medicine. *Journal of family medicine and primary care*, 8(7), 2328.
- Arkorful, V., & Abaidoo, N. (2015). The role of e-learning, advantages and disadvantages of its adoption in higher education. *International Journal of Instructional Technology and Distance Learning*, 12(1), 29-42.
- Benko, A., & Lányi, C. S. (2009). History of artificial intelligence. In *Encyclopedia of Information Science and Technology*, Second Edition (pp. 1759-1762). IGI Global.
- Briganti, G., & Le Moine, O. (2020). Artificial intelligence in medicine: today and tomorrow. *Frontiers in medicine*, 7, 27.
- Charniak, E. (1985). *Introduction to artificial intelligence*. Pearson Education India.
- Cheatham, B., Javanmardian, K., & Samandari, H. (2019). Confronting the risks of artificial intelligence. *McKinsey Quarterly*, 1-9.
- Chen, H., & Wang, F. Y. (2005). Guest editors' introduction: Artificial intelligence for homeland security. *IEEE intelligent systems*, 20(5), 12-16.
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *Ieee Access*, 8, 75264-75278.
- Chowdhury, M., & Sadek, A. W. (2012). Advantages and limitations of artificial intelligence. *Artificial intelligence applications to critical transportation issues*, 6(3), 360-375.
- D'alfonso, S., Santesteban-Echarri, O., Rice, S., Wadley, G., Lederman, R., Miles, C., ... & Alvarez-Jimenez, M. (2017). Artificial intelligence-assisted online social therapy for youth mental health. *Frontiers in psychology*, 8, 796.

- Ertel, W. (2018). Introduction to artificial intelligence. Springer.
- Fonseka, T. M., Bhat, V., & Kennedy, S. H. (2019). The utility of artificial intelligence in suicide risk prediction and the management of suicidal behaviors. *Australian & New Zealand Journal of Psychiatry*, 53(10), 954-964.
- Hamet, P., & Tremblay, J. (2017). Artificial intelligence in medicine. *Metabolism*, 69, S36-S40.
- Horowitz, M. C., Allen, G. C., Saravalle, E., Cho, A., Frederick, K., & Scharre, P. (2018). Artificial intelligence and international security. Center for a New American Security..
- Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education.
- Jones, M. T. (2008). Artificial intelligence: a systems approach. Laxmi Publications, Ltd..
- Khanzode, K. C. A., & Sarode, R. D. (2020). Advantages and Disadvantages of Artificial Intelligence and Machine Learning: A Literature Review. *International Journal of Library & Information Science (IJLIS)*, 9(1), 3.
- Lee, J., Singh, J., & Azamfar, M. (2019). Industrial artificial intelligence. arXiv preprint arXiv:1908.02150.
- Liu, J., Kong, X., Xia, F., Bai, X., Wang, L., Qing, Q., & Lee, I. (2018). Artificial intelligence in the 21st century. *IEEE Access*, 6, 34403-34421.
- Luan, H., Geczy, P., Lai, H., Gobert, J., Yang, S. J., Ogata, H., ... & Tsai, C. C. (2020). Challenges and future directions of big data and artificial intelligence in education. *Frontiers in psychology*, 11.
- Malik, G., Tayal, D. K., & Vij, S. (2019). An analysis of the role of artificial intelligence in education and teaching. In *Recent Findings in Intelligent Computing Techniques* (pp. 407-417). Springer, Singapore.
- McCorduck, P., & Cfe, C. (2004). *Machines who think: A personal inquiry into the history and prospects of artificial intelligence*. CRC Press.
- Mohammadi, V., & Minaei, S. (2019). Artificial intelligence in the production process. In *Engineering tools in the beverage industry* (pp. 27-63). Woodhead Publishing.
- Nilsson, N. J. (2009). The quest for artificial intelligence. Cambridge University Press.
- Pan, Y. (2016). Heading toward artificial intelligence 2.0. *Engineering*, 2(4), 409-413.
- Ramesh, A. N., Kambhampati, C., Monson, J. R., & Drew, P. J. (2004). Artificial intelligence in medicine. *Annals of the Royal College of Surgeons of England*, 86(5), 334.
- Rouhiainen, L. (2018). *Artificial Intelligence: 101 things you must know today about our future*. Lasse Rouhiainen.
- Rybski, P. E., Stoeter, S. A., Erickson, M. D., Gini, M., Hougen, D. F., & Papanikolopoulos, N. (2000, June). A team of robotic agents for surveillance. In *Proceedings of the fourth international conference on autonomous agents* (pp. 9-16).
- Shih, W., & Srihari, K. (1995). Distributed artificial intelligence in manufacturing systems control. *Computers & Industrial Engineering*, 29(1-4), 199-203.
- Strong, A. I. (2016). Applications of artificial intelligence & associated technologies. *Science [ETEBMS-2016]*, 5(6).
- Wuest, T., Weimer, D., Irgens, C., & Thoben, K. D. (2016). Machine learning in manufacturing: advantages, challenges, and applications. *Production & Manufacturing Research*, 4(1), 23-45.