Application of Artificial Intelligence Model for Manufacturing Engineering: A Case Study on the Production Pipes

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Abstract- **Manufacturing engineering is able to offer businesses the integration of information and manufacturing processes. Artificial intelligence is being used in industry to support, solve and enable technological processes and grow production of more qualitative products. Different algorithms are developed to help the compound parts of the artificial intelligence to make a decision, to work in autonomy and be part of automatic systems.**

The aim of this paper is to present our work in integration of AI and manufacturing engineering and to present the benefits of AI, presented AI model as well in a real working environment.

Key words: **Artificial Intelligence, Manufacturing engineering, Artificial neural networks, Natural language processing, Internet of Things etc.**

I. INTRODUCTION

Modern technology helps optimize many processes to be more automatically and autonomously, decreasing human supervision. AI is the easier way of giving a lot of benefits during production. This is due to the many approaches that artificial intelligence offers and the versatility that allows companies to exceed expectations for the purpose of using artificial intelligence. A system that applies AI provides a set of instructions that allow the computer to write its own algorithms without being programmed [1, 2]. Although we define intelligence as the computational part to achieve certain objectives, intelligence can be used as the capacity to learn and solve problems in a constantly changing environment. Human beings function through observation of the physical world and the connection of phenomena between cause and effect, artificial intelligence is completely driven by data and has no prior knowledge of the connection between that data.

It is called artificial precisely for this reason because it does not derive from physical laws but only from data [3]. We can compare artificial intelligence with a human being, if the bodies are similar to each other, it must possess a brain that helps it perform tasks, and the brain of artificial intelligence is Natural language processing (NLP). Machine learning can be seen as specific movements, actions, thoughts that we develop and improve by practicing them. The Internet of Things (IoT) corresponds to human feelings, it is a way to perceive the world around us. The data that artificial intelligence receives and transmits is equivalent to the food we eat and the air we breathe [6].

II. BACKGROUND

According to the Capgemini Institute, artificial intelligence is a collective term for the abilities displayed by a learned system that are perceived by humans as intelligence. Today typical artificial intelligence includes language, images, video recognition, autonomous objects, natural language processing, language agents, prescriptive modeling, argumentative creativity, intelligent automation, advanced simulation, etc [4].

In the context of manufacturing operations, most artificial intelligence uses center around the following machines [2]:

1. Machine learning: the ability of algorithms and coding to use data and learn automatically from its own tracks it creates and programs.
2. Deep recognition: an advanced form of machine learning that uses artificial neural networks to analyze and interpret images and videos [12].

3. Autonomous objects: as they are known by the name of artificial agents such as collaborative robots or tools that move automatically and can perform tasks given to them.

There are six models of artificial intelligence, models that belong to three different macro approaches.
• Logic-based tools: they are tools used for knowledge representation and problem solving.
• Knowledge-based tools: based on large databases of information and rules.
• Probabilistic methods: tools that allow agents to act in scenarios with incomplete information
• Machine learning: tools that allow a computer to learn from data.
• Personified intelligence: assumes that a body is required for higher intelligence.
• Search and optimization: tools that allow intelligence to search through possible solutions

These three macro approaches are divided into: symbolic, sub symbolic and statistical approaches. The symbolic approach states that human intelligence can be reduced through manipulation, the sub-symbolic approach states that no specific knowledge should be provided, and the statistical approach is based on mathematical tools to solve various problems [13].

III. STATE OF THE ARTS

There is no doubt that today the manufacturing sector around the world is moving towards the use of artificial intelligence because it has been proven to facilitate many processes. Starting from the reduction of unplanned errors, the implementation of powerful artificial intelligence software for data analysis, cloud computing, the improvement of product quality, the safety of employees at work and many other aspects that are facilitated by artificial intelligence. Initially, the need for automatic supervision arose since the manufacturing industry has lost billions all over the world from unplanned defects, which have blocked the production process. Therefore, this solution was offered to manufacturers through the implementation of artificial intelligence, bringing robotic systems that can supervise themselves and notify through various alarms about potential defects. There are cases when the machine alerts the engineers before the defect is reported and in this way measures are taken much earlier and big serious mistakes are prevented. This is one of the many possibilities that artificial intelligence has offered for manufacturing engineering [14].

There are also intelligent systems that are used to help production and provide services to different users. New meanings for the system are intelligent integrated systems that include digitization, Internet of Things, virtualization, services, system changes, flexibility, and intelligence [10]. The new forms that develop mainly affect ecology with special characteristics for environmental protection, they are forms that collect data, integrate with autonomous intelligence and massive innovations. The deep integration of AI application will form an intelligent manufacturing ecosystem which will ultimately serve to show the full meaning of Artificial Intelligence (AI) [15, 16].

According to Pascal et al. [4], the construction of a system to manage data and artificial intelligence is presented. First, the acquisition of data is done, in our case the data of the factory, products and everything about production is entered. The second step is the storage and management of this data, it means we must have a separate system to manage, for example, different cloud systems. Then the data is processed, and these data are used by the system depending on what they are needed for. These data serve the AI to make decisions regarding their application even for specific problems. Such as problems such as intelligent maintenance, failure prevention, quality inspection, demand planning, performance evaluation and many other problems. At the end, the feedback is received in the MES (Manufacturing execution systems), it means the automatic decision-making that receives the information from the artificial intelligence systems. While further we have the AI system platform. In our case, the platform includes Internet of Things (IoT) devices, PLM (Product Lifecycle Intelligence) applications, ERP (Enterprise Resource Planning) applications, etc.

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IV. THE ROLE OF ARTIFICIAL INTELLIGENCE IN MANUFACTURING ENGINEERING

Production is making something new whether it is a product or a service. Before, production meant only tangible physical products, while today services are also considered [9]. Manufacturing can also be defined as the application of physical and chemical processes to change the geometry, properties, and appearance of a starting material to transform it into parts or products. Manufacturing also involves joining many parts to assemble certain parts. The process of carrying out production involves the combination of machines, tools, power, and human labor to reach the final product [11].

Advantages of artificial intelligence in manufacturing:

-*24/7 non-stop production*: Factories that constantly use physical labor can see the implementation of artificial intelligence as something very positive, because it helps solve many problems that factories currently have. One of these problems is the work schedule, because it is known that in order to be as productive as possible, as

many hours as possible should be put into production. With the help of artificial intelligence and robots, it becomes possible to carry out production on a 24-hour schedule.
-*Security*: Another important aspect that is affected using artificial intelligence as a technology is security. When manufacturing in high-risk factories this aspect is vital. In factories there are also risks at work due to the very fact when metal is being worked with and of different sizes where a small mistake can cost a person's life. The inclusion of robots and devices with artificial intelligence in these sectors allows accidents at work to be avoided, if not eliminated.
-*Cost reduction:* Artificial intelligence has also proven so far that it is able to reduce costs in any industry where it operates. Although these technologies have high investment costs in them, their capabilities still justify their price. Artificial intelligence technologies also contribute to increasing companies' analytical capacities by eliminating employee downtime, as well as reducing maintenance costs through automatic problem detections [5].
-*Very quick decision making*: Thanks to the IoT sensors that are applicable today, manufacturers can receive large volumes of data and filter this data for use in decision making. This allows manufacturers to respond much faster, so that the reaction is also faster.
-*Quality*: Quality includes the use of artificial intelligence algorithms to alert the manufacturing team of damage and errors that may be found in the system as well as in the products being created. The proposed model also has this goal in one of its branches. Machine vision tools are able to detect even microscopic defects in products.
-*Smart maintenance*: In production, especially in the production of the same line as in our case, the production of only pipes, the equipment is a costly expense that has a very big impact if it is not properly maintained. Therefore, predictive maintenance has become a very good solution for many manufacturers.

V. AI MODEL FOR THE MANUFACTURING ENGINEERING

The architecture of the applied system consists of two modules:
- Image recognition module
- Adaptive quality improvement module.

The image recognition module is responsible for associating an image with a defined image number, based on the evaluation previously performed on the received images. Based on the identified images the adaptive quality enhancement module manages the selection and execution of correction strategies for the image. The modular design allows the system to be implemented very easily and to be connected to many tools operating on different platforms such as: C++, Python, JAVA, etc [8]. Different scripting methods between these programming languages exist making it possible to run multiple connections. Among others, these tools can be imaging systems or image processing modules.

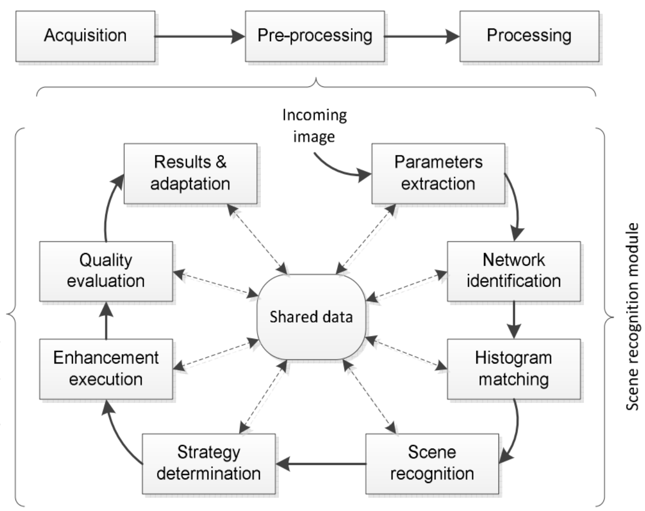

Figure 1. The architecture of the applied model [7]

In the pre-image processing approach, a routine is executed throughout the program section. In this routine, high quality images corresponding to different possible scenarios are obtained. A parameter extraction process takes place, and the resulting image also shows the inputs of the neural networks. Image pixels are not considered as direct inputs but are considered as image parameters, figure 1. Then the scheme numbers introduce the corresponding system, for example numerical values 1,2,3,...n. this phase also contains the first training network, this designed network is implemented through multi-layer feed-forward architecture [7].

The size of the hidden layer is determined by an iterative process until the desired performance is achieved. When the network is trained, the system can receive, recognize, and associate images with certain schemas.
The introduction of the scenario recognition module makes it possible to receive and process images in a routine way depending on system priorities, which allows the execution of sequences through many stations at the same time. This is a radical change for the old models that were used and did not have the possibility of distribution to many stations. Successful implementation of pre-processing system that can execute strategy improvements as well as self-learning through artificial intelligence.

The diagram shows a simple AI work process, where you can also see the robotic hand which is able to detect and remove parts that have potential defects. This model is expected to bring many benefits such as increasing the overall quality of the company. It also won't waste much on the factory side for final checks because AI does it automatically, figure 2.

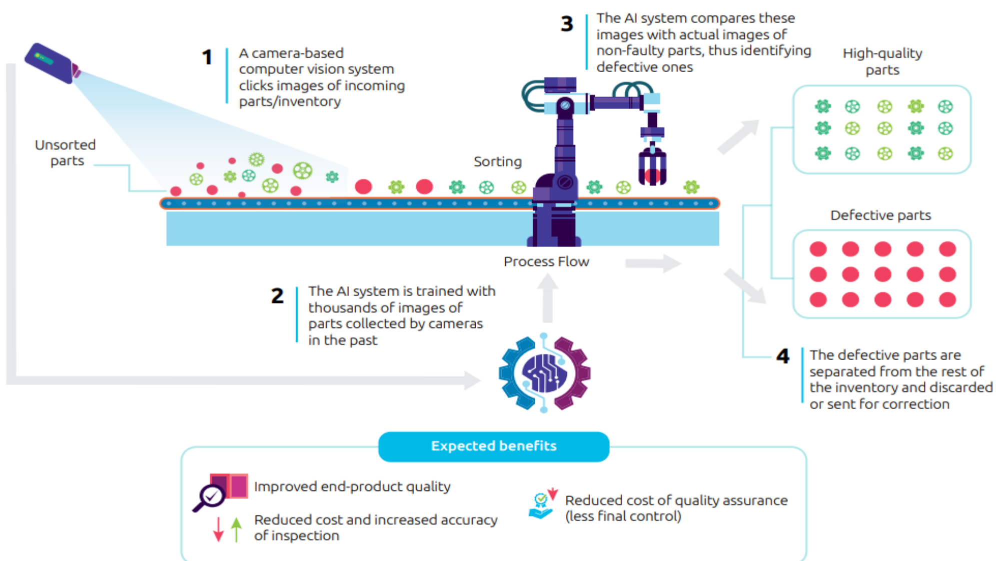

Figure 2. Automatic inspection process with AI [4]

The need to increase the quality of the products has pushed the manufacturer to increase the control levels for finished and unfinished parts. Optical systems and the use of digital images have shown that it is a very good and effective instrument not only to increase quality and control, but also to obtain information that helps management in production. Because information today is key to achieving success. The use of this technology can significantly reduce the time and need for inspection while at the same time increasing the number of components inspected. First, the system architecture (software and hardware) will be shown, explaining the characteristics of the components and the software procedures. The purpose of this application is to identify the dimensional characteristics of components such as overall size, corner length, hole diameter and others.

VI. CONCLUSION

Artificial intelligence is a technology that for years has proven to have an impact on increasing production and efficiency in production. This is because this technology brings convenience and fully automated actions which are extremely important in mass production.

Furthermore, artificial intelligence has also been proven through this work that it does not work as a single system, it means that there is no single AI system, without being composed of other components, each of these components is equally important when entering the AI system forming thus a platform or a system for intelligent manufacturing. Today smart manufacturing helps to achieve the best possible product quality, it also helps to facilitate the product distribution process. And many other functions and advantages which are mentioned in this paper. And ultimately through the model that AI applies, it also affects the way products are manufactured and inspected.

Bringing advanced and inventive methods, the applied model significantly facilitates the work in product inspection. As it brings one side to the use of AI systems for manufacturing engineering, not including other uses that offer endless possibilities [10].

The next steps that we plan to do:

• Implementation of the model in real production environments.

• The results achieved by the implementation of the model can be compared with other solutions that have been offered.

• The architecture of the presented system and model can be modified to achieve better manufacturing strategies through AI.

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Artificial Intelligence and IoT Implementations for Remote Dentalcare Information Systems

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Abstract— **The Internet of Things (IoT) and the Artificial Intelligence (AI) are two technologies growing faster than all other technologies in the world. The transformation of the healthcare sector by increasing its efficiency, lowering costs, and putting the focus back on a better patient care system, is one of the main columns of the smart city idea.**

Dentalcare is one of the main sectors of the healthcare system. The IoT and AI implementation in dentalcare systems requires a deep understanding of different frameworks in smart cities. These frameworks include the integration of technologies, devices, systems, models, designs, use cases, and applications. The IoT-based dentalcare system mainly employs both AI and machine learning (ML) by gathering different records and datasets. The technology used helps to support dentalcare applications and analyse activities. This paper provides a survey that focuses on the identification of health Internet of Things (H-IoT) and health Artificial Intelligence (H-AI) applications, with focus in dentalcare, supported by smart city infrastructure. Finally, this research contributes to scientific knowledge by highlighting the main limitations of the topic and recommending possible future opportunities in this research area.

Keywords: Internet of Things, Artificial Intelligence, Machine Learning, Dentalcare Systems, Healthcare Systems, Smart City

I. INTRODUCTION

The population is in an ongoing growth facing the healthcare sector with many challenges. One of the main sectors of the healthcare is occupied by the dentalcare. Indeed, there is a need to address these problems, which this paper aims to do. The internet of things (IoT), resource availability, security, and networking are the main priorities for developers. Smart cities generate and utilize smart solutions as populations increase to create a more conducive environment. If we want to ensure productivity, we need a sound healthcare with focus in dentalcare sector, so that people can perform their jobs with minimal worries. In 2017 T. Alizadeh put forward a smart city model that consists of a patient record system integrated with various healthcare applications that is enabled with IoT devices and machine learning (ML) protocols. The technology and architecture consist of a patient record system that integrates well with the appropriate sensing mechanisms and collects structured and unstructured data for ML analysis. Communication protocols have become essential for transmitting data and signals between IoT devices, systems, and models. Smart cities offer quality of life to their residents. The smart city's communication systems are categorized into proximity wireless, personal area networks, wireless local area networks, wireless metropolitan area networks, and wireless wide-area network technologies.

II. BACKGROUND

The concept of smart city dentalcare is one that many traditional cities aim to emulate by setting up conventional devices and equipment for integrating dentalcare resources with smart solutions. Smart solutions and information and communication technology (ICT) play a crucial role in ensuring smart cities' success in providing citizens with quality dentalcare services. The smart city's vital goals include making provision for high-quality living, conserving healthcare with focus in dentalcare service quality, and promoting more conducive quality conditions for citizens. There must be a particular model to generate and provide creative and productive dentalcare services.

Different systems, architectures, and frameworks work together for a common purpose, where the essential elements of an IoT-enabled smart city dentalcare system are implemented. A smart city delivers a much better, more comfortable living environment. It also grants citizens the opportunity to be actively involved in actions that benefit their requirements and to be functional members of society. Citizens make use of many smart devices to engage with and utilize these services. Smart service is an explicit, sophisticated network configuration in which a substantial amount of individual data is delivered from citizens using the Internet.

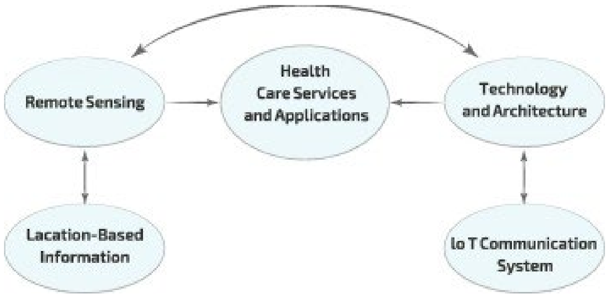

Figure 1. Basic elements of an IoT-enabled smart city healthcare system

III. STATE OF THE ARTS

In a smart city, services are delivered to resolve the issues faced by residential. The practical systems consist of health with focus in dental services and monitoring services. The concept of remote sensing is commonly used in Dentalcare monitoring services with high number of researches and applications. Smart city dentalcare system is a patient record management center (PRMC) that helps collect, manage, and preserve patients' electronic dental records. Important indications internal to the patient, such as x-rays, intraoral images, etc., are sensed and collected. External indications refer to critical climatic conditions, such as humidity and temperature; they are obtained from the medical sensor connected to the patient and transferred to the dental service for further examinations including remote dentalcare services.

The dental monitoring system is a system that obtains information from both the medical sensors attached to the patient's mouth and the smart device of the custodian. The dental monitoring server (DMS) serves as the controller; it delivers an individualized dentalcare plan in real time through an analysis of the current dental situation and historical records. It also generates signal notifications, warnings, and exceptions during periods involving critical situations. The smart service's essential elements include dental monitoring system for evaluation and oversight, clinic service for procuring dental problem identification, and instant reaction. At the same time, the PRMC deals with storing and utilizing information. The dental monitoring system serves the DMS in real time. The clinic system permits dentist specialists to make inferences on the patient's dental status concerning the documented report delivered by DMS and the past dental records obtained from the PRMC, where all personal records are kept.

The PRMC is a central storehouse in which all the dental records and data of patients and the prevailing dental conditions in the digital dental records of patients are kept. The dental monitoring system also has local storage. This storage holds the patient's dental history and dental records as the main requirement for a simplified technology architecture for smart dentalcare system, as shown in Fig. 2. The patient central electronic dental record (PC-EDR) is versatile storage that embodies patients' past dental records and their detailed information, such as name, address, phone number, etc

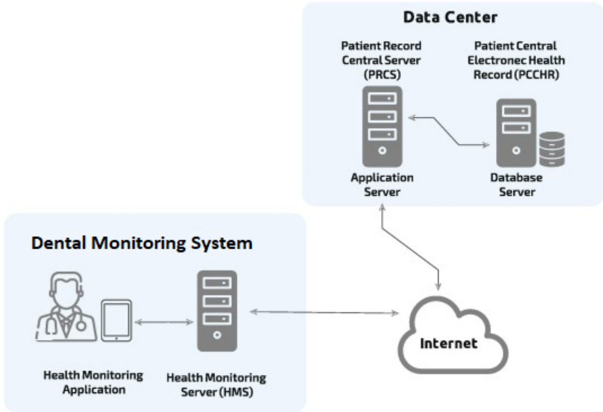

Fig. 2. Simplified technology architecture for smart dentalcare system

Sensors, monitoring, and control are required to make dentalcare cities smarter. These sensors' feedback values help dentalcare providers conduct monitoring and control through automation. These sensors' feedback values help dentalcare providers carry out monitoring and control through a series of automation. The IoT, wireless sensor networks, deep learning, and other technologies can be used successfully to accomplish these goals. Smart cities can quickly attend to many people's dentalcare needs at once by having access to real-time information. IoTs, AI, and computing technology have changed the face of dentalcare.

Location-based services work best with smart city data analytics systems and implementations. Data, such as demographics and global positioning, are integrated to locate the user. The data collected are integrated and analysed by the smart city, enabling dentalcare providers to offer the best dentalcare services at the right time and location. The data are collected through smart devices, that have multiple advanced sensors. Longitude and latitude are detected by a location-based information system integrated with a global positioning system (GPS).

IV. MODELS AND DESIGNS FOR REMOTE DENTALCARE SYSTEMS

The system of dental monitoring within the smart city framework is problematic. The design of such systems requires problem formulation and product. Stakeholders determine the overall concept and prospects of the new system development. This requires incorporating future end users and needs capture for the development of the new system. The focus is more on the smart dentalcare system's goal, starting with a proper initial assessment of the problem and evaluating its workability.

Stakeholders define the desired design and functions of the proposed smart dentalcare system. The required technology and algorithm choice must be thoroughly undertaken in three steps: selecting algorithms and technology, selecting a model and prototype, and solution validation. Appropriate technologies and algorithms are chosen by the designers, which is aligned with the specified needs and requirements, as stated by the users and the stakeholders at the problem development phase. Therefore, in selecting the right technology and algorithms, environmental considerations are crucial. Within these constraints, the designer develops creative solutions or modifies current ones. IoT-based and AI-based dentalcare systems aim to improve patients' well-being and the life quality of smart city dwellers. There has been tremendous input into developing models and designs for remote dentalcare systems in the last decade.

V. IoT AND AI DENTALCARE APPLICATIONS, IMPLEMENTATIONS USING SMART DEVICES APPLICATIONS

Another additional component in IoT and AI services is the close monitoring of IoT and AI applications. Research has been undertaken to develop a framework for dentalcare systems that provides a wide variety of analytical data applications for managing data sources ranging from EDRs to medical photographs. While it is inevitable that patients or other users use applications, it is obvious that application development is based on the services required. Thus, it could be said that services are based on what the developer has to offer, while applications are developed to suit the users. Divergent ML methods have recently been used in several related applications in various areas. IoT and AI driven dentalcare systems and technologies have received considerable R&D coverage, as well as how the IoT can assist with dental historic tracking. These new dentalcare items and devices could be seen as part of IoT and AI innovativeness and creativity to provide different clinical interventions.

In recent times, there has been an upsurge in developing devices that work electronically with sensors connected to smart devices that control them. This development shows that smart devices have risen to become drivers of IoT and AI technologies. Integrating IoT and AI with specific disciplines is crucial for achieving quality service parameters, such as perfection, reliability, and mobility across different devices. Different software applications and hardware products have been designed to ensure their compatibility with smart devices, enabling smart devices to become a useful tool in administering dentalcare.

The features added to smart devices today could efficiently carry out the dental checks and data required for the dental condition. Furthermore, advancements are useful in the dental sciences for accurately diagnosing and assisting.

VI. CONCLUSION

IoT and AI solutions have evolved in the healthcare with focus in dentalcare sector from a simple design to much more complex and smart systems. Where AI and IoT have played an essential part in dentalcare, their implementation was also equally important. The primary purpose of this research analysis was to specify that applications were functional with smart-city frameworks. Moreover, this paper highlighted tools that influenced dentalcare availability. A comprehensive survey of related publications determined which tools and technology could be implemented.

This paper analysed smart-city dentalcare implementation in terms of applicability. The practical analysis was designed to deliver intriguing and unique ideas. This paper also presented a secure and low-cost method to develop a remote dentalcare system, which provided real-time monitoring of patients by employing IoT and AI technology and ML practices.

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