PRESENTED BY SHAHID BEHESHTI UNIVERSITY ELECTRICAL SCIENCE ASSOCIATION

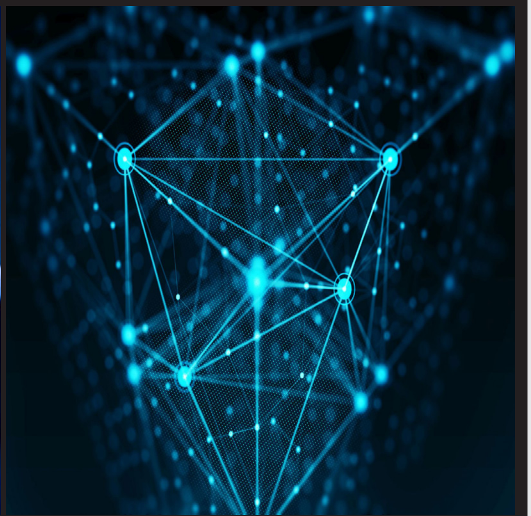
Electrical Engineering Magazine

PPPC

September 2022 // Vol. 17

THE ONLY FULL ENGLISH PUBLICATION OF TECHNICAL ENGINEERING FACULTIES OF SHAHID BEHESHTI UNIVERSITY

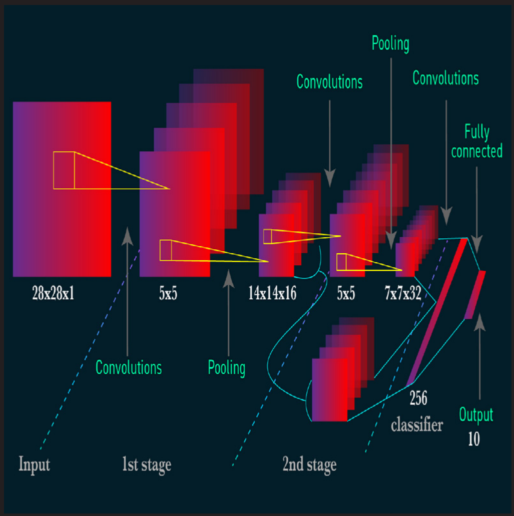
NEW RELEASE



With the increasing progress of technology, new cases and definitions are created that are important for today's world. One of these definitions that we want to examine is the science of image processing.

Robotic surgery (also called robotic-assisted surgery) is perhaps the most cutting-edge medical technology of modern times. In the following article, we are going to analyze how robotic surgery works.

Blockchain is a new and special type of Internet network in which different information is classified as identical blocks. If we want to explain more clearly the main difference between this particular type



A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image.

Industrial networks used in enterprises are known as enterprise networks or corporate networks. They include LANs and WANs to transfer data between various systems in the same building.

POET: Training Neural Networks on Tiny Devices with Integrated Rematerialization and Paging, We Can Now Train Big Neural Networks on Small Devices A new method could keep your private data local

Editor's

Publisher: AESA PWUT
Editor: Fatemeh Sharifzadeh
Designer: Seyed Mohammad Shobeiry

PPPC

Electrical Engineering

"In this regard, we are very happy and proud to introduce the latest in the electrical and computer industry that are offered by knowledge-based companies based at Shahid Beheshti University in the next issues (in the form of job and product advertisement)."

In the era we live in, due to the strange speed of technology and the nature of the field of electricity and computer, we have to run so that we can always innovate and move on the edge of science.

Between all kinds of new hot topics about bitcoin, digital currency, metaverse, artificial intelligence, electric car, data mining, etc. that you need to know to use them for your new thesis idea and project, everyone's first priority is "time" and how It is planned.

Therefore, it is necessary to use the right and appropriate resources that have been prepared and adjusted carefully and by people (who have sufficient knowledge and information in the above subjects.

My friends in PPPC group have tried their best to present quality and useful articles according to the most up-to-date topics. I request you to carefully and patiently follow the results of our work and be diligent in publishing the maximum knowledge and awareness.

Please share your criticisms and suggestions with us and help us improve the quality of the next issues of the magazine.

Finally, thank you for the patient cooperation of my friends who worked hard in this issue of the magazine.

Best regards

Fatemeh Sharifzadeh
Editorial Board Chairman

BLOCKCHAIN TECHNOLOGY

Blockchain is a new and special type of Internet network in which different information is classified as identical blocks. If we want to explain more clearly the main difference between this particular type of interconnected network and a normal Internet network, we must mention how information is stored. This means that the information exchanged on a normal Internet network is stored centrally on a main server that can be accessed and tracked by hackers and related entities, while the information transmitted on the Blockchain network are not given to any institution or natural or legal person. Blockchains are typically managed by a peer-to-peer network for use as a publicly distributed ledger, where nodes collectively adhere to a protocol to communicate and validate new blocks. Although blockchain records are not unalterable as forks are possible, blockchains may be considered secure by design and exemplify a distributed computing system with high Byzantine fault tolerance.

1. Introduction

1.1 Overview

Blockchain has been first introduced to the public along with the emergence of Bitcoin in 2008. It is widely known as a decentralized and tamper-resistant ledger technique that is maintained by a group of users with specific purposes. Considering the scenario of Bitcoin, such a ledger keeps records of all transactions e.g., financial deals, supply chain information, and copyright ownership After the smart contract was introduced by Ethereum, blockchain was considered a breakthrough technical concept that fitted in a broad scope of implications and applications.[10]

1.2 Blockchain

Blockchain is a distributed ledger a chain of blocks, which stores transactions by peaking them into blocks in a chain. The chain links blocks with a cryptographic hash chain, which keeps growing as long as new blocks are created and maintained. [1]

Characteristics of Blockchain

One of the representative characteristics of blockchain, normally speaking, is decentralized computing with a tamper-resistant feature. The reason for having this characteristic is that no central authority is configured in a blockchain system. A blockchain system is maintained by communications between miners in a distributed network. Data stored in blockchain somehow provides anonymity in a sense where miners can choose multiple public keys to generate identities and participate in blockchain mining. [5]

1.4 Classification of Blockchain Systems

Blockchain systems can be categorized into three fundamental types, involving public,sortium, and private blockchain systems. These three types of blockchain systems are used in various implementation scenarios, depending on a network scale, miner invitation rule, and security level. [3]

1.4.1 Public Blockchain

In general, public blockchain offers a pure decentralized computing environment; thus, public blockchain is extensively implemented in general-purpose financial systems, e.g., Bitcoin blockchain. It has a low requirement for the miner. [3]

1.4.2 Private Blockchain

Private blockchain resides within a single institution, even though it abandons a full decentralized computing setting. It has been widely believed that private blockchain is a type of centralized computing approach. [3]

1.4.3 Consortium Blockchain

Consortium blockchain fits in compact cooperation between enterprises and organizations, as it arranges the mechanism between public and private blockchain systems. [3]

2. Technical Dismensions of Blockchain

2.1 User and Miner

There are two basic roles in public blockchain : user and miners.

A "User" is a person or an organization , which conducts financial transactions with each other.

Users transform their financial transactions into blockchain-designed transactions and upload them to the blockchain via sending/broadcasting them to miners. A "Miner" is a machine equipped with blockchain software whose main task is maintaining the blockchain. Miners validate all transactions on the blockchain and compete to become a winning Miner in each time period, relying on the consensus mechanism. A winning miner packs a certain number of transactions to create a block and appends it to the blockchain. Specifically, Miners have to invest their own resources, (computational power, electricity, storage) in mining operations. [2]

2.2 Block

Typically, a Block consists of the "Block Header" and "Block Body". [2]

2.2.1 Block Header

A " Block Header " includes :

2.2.1.1 Block Version : States a set of block validation rules.

2.2.1.2 Block Hash : A 256-bit hash value of the previous Block Header.

2.2.1.3 Market root : A hash value of all the transactions in the block.

2.2.1.4 Timestamp : Instant Timestamp as seconds.

2.2.1.5 nBits : A hashing target indicating the difficulty of mining.

2.2.1.6 Nonce : A 4-Byte number status with 0 and increases for every hash calculation.

2.2.2 Block Body

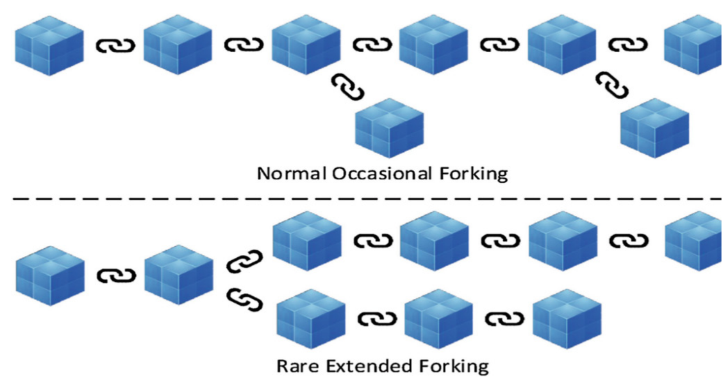
A " Block Body " includes a transaction counter and transactions. The transaction counter indicates the number of transactions that a block can contain and it depends on block size as well as the size of a transaction. [2]

2.3 Chain and Height

A chain is a virtual string that links a growing set of blocks with cryptographic hashes.A chain is a virtual string that links a growing set of blocks with cryptographic hashes. As long as blockchain is up and running, the chain will keep growing with new blocks appended in the end. Blocks in the chain are usually addressed by their block height which is a sequence of numbers starting with 0 for the first block, i.e… genesis block. [7]

2.4 Fork

When two or more miners concurrently create a block, these blocks will have the same block height. This produces a "fork" in the blockchain. Forking can be classified into normal occasional forking and rarely extended forking as depicted in Fig. [9]



BLOCKCHAIN INDUSTRY IN THE FUTURE

Originally , blockchain is not designed for storage digital files , but business solutions favor data sharing to a great degree. These digital files are of large size and various types , and their amount is growing expontially over time. Since most blockchain systems utilize a key-value data model with limited storage space, bandwidth and transaction throughput , novel methods and approaches are called for supporting multiple types of data and large digital files in the near future. [10]

2.5 Smart Contract

In the blockchain, smart contracts are programable electronic scripts that are typically deployed on the blockchain. Each smart contract has a unique address. A smart contract is triggered by addressing a transaction to it. Then the smart contract self-executes on every node in the blockchain network based on specific codes and data in the triggering transaction, independently and automatically. In another word, the smart contract program logic lies within a "Block" that is a software-generated container. The "Block" bonds message is pertinent to a specific smart contract. The messages act as inputs or outputs of the contract. [6]

2.5.1 Smart Contract performance

a smart contract-based blockchain supports multistep processes between parties who do not trust each other. The transacting parties can review the contract code and predict its outcomes before interacting with the smart contract ; (1) have certainty of the contract execution because the code is made public on the network ; (2) have verifiability over the outcome because they are signed.

Smart contracts can be applied in many scenarios, such as digital identity records, security, trade finance, derivatives, financial data recording, and clinical trials. For instance, smart contracts can offer visibility for food supply at every step. [6]

2.6 key Characteristic

blockchain has four key characteristics :

2.6.1 Decentralization

In traditional centralized online business systems, transactions have to be verified by a centralized server, such as a bank. This approach inevitably leads to performance bottlenecks of communication overhead for the whole system and computational cost for the centralized server. A blockchain network is built on a P2P network and transactions can be conducted between any two entities without the participation of the centralized server. In this way, blockchain greatly slashes the cost of the server and mitigates the performance bottlenecks. [10]

2.6.2 Persistency

Since all broadcasted transactions in blockchain are validated and then recorded in blocks, it is difficult to falsify them. Moreover, blocks are verified by other miners, it is also nearly impossible to tamper with them. [10]

2.6.3 Auditability

Given that all transactions in blockchain are signed by their sender and then recorded in a block with a timestamp, users can trace and validate the information in the transactions. Additionally, each transaction is linked to a previous transaction iteratively which enables sources traceability and data transparency. [10]

2.6.4 Anonymity

each user holds a self-generated address to interact which the blockchain every time. Additionally, the user can generate a set of addresses in advance just to keep her/his identity anonymous. Since there is no longer a centralized role to keep a list of users' real identities, the risk of identity exposure is highly reduced. By doing so, blockchain protects user privacy to a certain degree. [10]

3. Applications of Blockchain

3.1 Public Applications

There are various blockchain applications in the literature. These applications include vehicular networks, food supply chains, commercial businesses, and industry. Most of them leverage the decentralization and persistency of blockchain and apply it in their scenarios with specific features and requirements. [8]

3.2 Application of Blokchain in the electrical industry

Vehicle-to-grid (V2G) networks, including electric vehicles (EV), are gradually developing as an essential enhancement for smart grids. In the V2G network, two-way electricity transmissions create a huge number of electricity usage payment records. These records can be used to provide valuable services, such as electricity usage forecasting, electricity price estimation, and optimal electricity scheduling. To put the benefits aside, the sharing of payment records will incur privacy concerns because sensitive information may be leaked such information include real identities, current location, and charging/discharging volumes. [8].

REFRENCES

Blockchain technology applications for Industry 4.0: A literature-based review Javaid – Haleen – Singh – Khan – suman – Journal Pre-Proof – Elsevier- 2021.

2. NutBaaS: A Blockchain-as-a-Service Platform Zheng – Chen – Dai – Li – Chen – Zheng – Journal IEEE Transaction – 2016.

3. On Consortium Blockchain Consistency:A Queueing Network Model Approach Meng – Zheo – Wolter – Xu – Publish IEEE.Explor – 2021.

4. A Blockchained Federated Learning Framework for Cognitive Computing in Industry 4.0 Networks. Qu – Pokhral – Gao – Journal IEEE Transaction – 2020.

5. Blockchain-enabled fog resources access and granting Liu – Wu – Wang - Publish IEEE.Explor -2021.

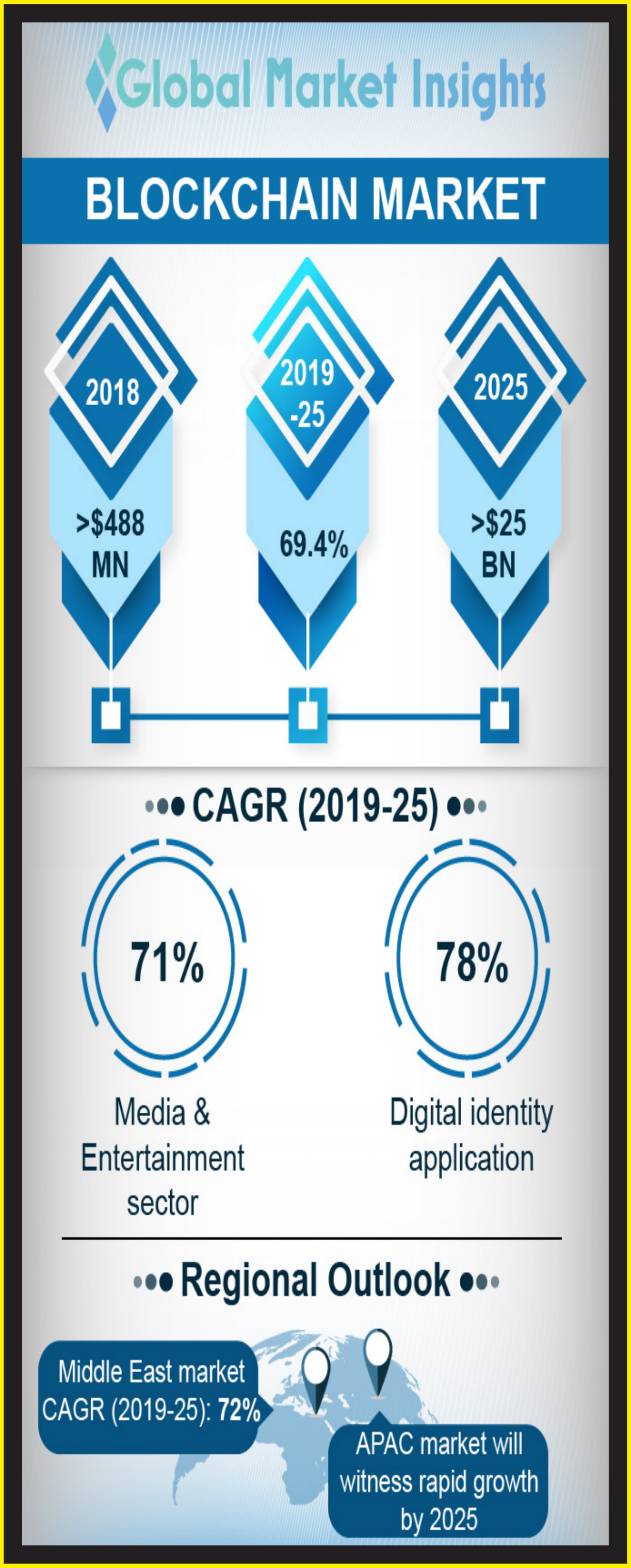
6. Electronic Voting Using Blockchain And Smart Contracts: Proof Of Concept Grialdo – Barbosa – Carlos - Publish IEEE.Explor -2020.

7. A Survey on the Adoption of Blockchain in IoT: Challenges and Solutions Uddin – Strsnieri – Gondol – Venki - Journal Pre-Proof – Elsevier- 2021.

8. Applications of Blockchain Technology in marketing systematic review of marketing technology companies Stallone – Wetzels – Klass - Journal Pre-Proof – Elsevier- 2021.

9. Performance evaluation of permissioned blockchains for financial applications: The ConsenSys Quorum case study Mazzoni – Corrod – Nicola - Journal Pre-Proof – Elsevier- 2021.

10. Blockchin Technology in Internet of Things Zho – Gai – Li – Book – 2019.



Mersad Pourahmadi

Filed : Electrical Power Engineering
MSc : Shahid Beheshti University
Research Field : Optimization and Operation of power system

AI-EMPOWERED ROBOTIC SURGERY

Robotic surgery (also called robotic-assisted surgery) is perhaps the most cutting-edge medical technology of modern times. In the following article, we are going to analyze how robotic surgery works and its advantages over other minimally invasive surgeries. Then we will discuss the classification of various robotic systems applied in medicine; thereafter, we will analyze how virtual reality simulators assist robotic surgeries and compare some of the available virtual reality simulators for robotic surgery. Finally, we will deeply explore the role of AI in robotic surgeries, and a fascinating robotic surgery system, called the BATS, will be studied by the end of this article.

I. Introduction

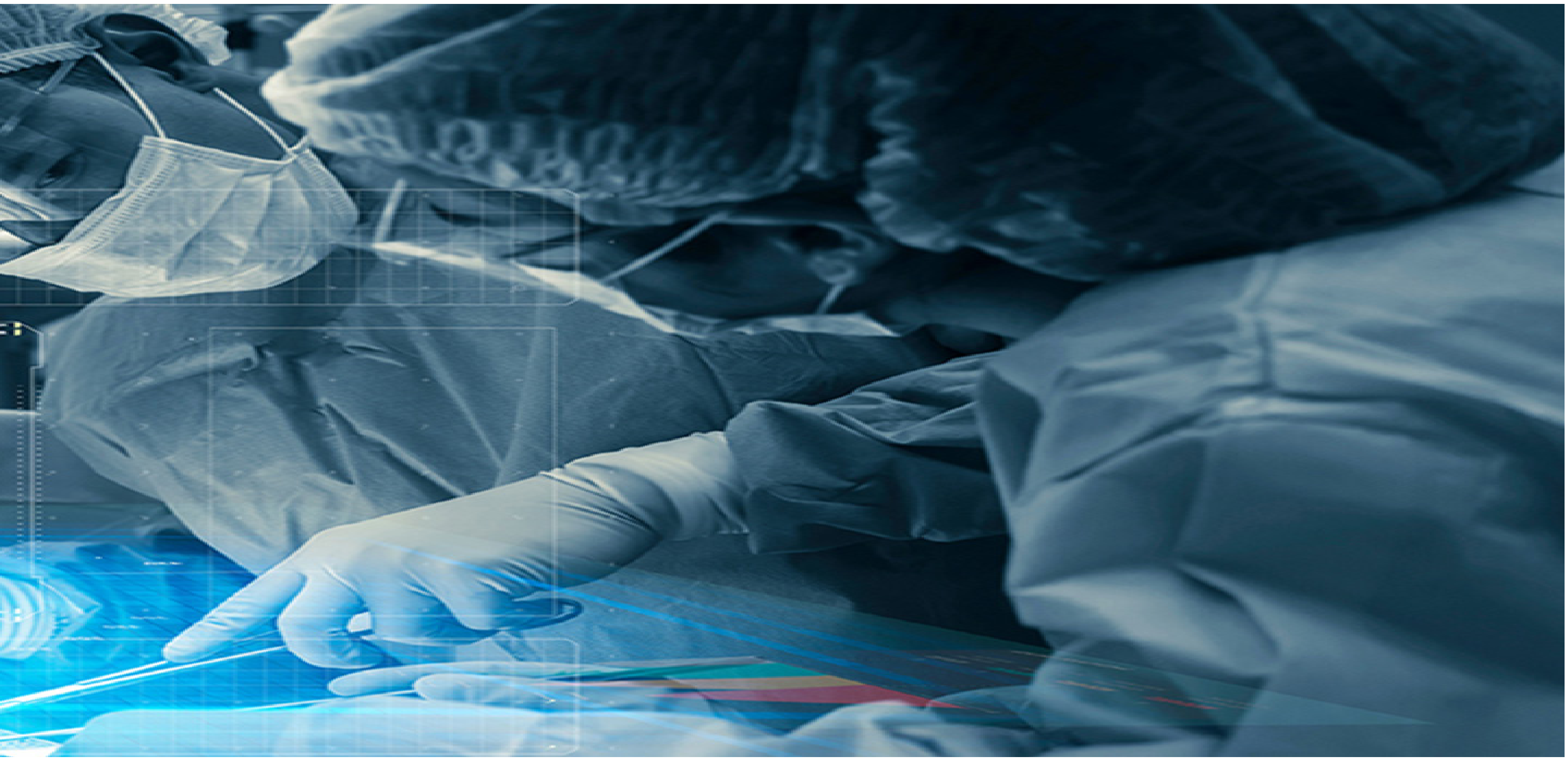
Who knew technology would reach such heights someday that robot-assisted surgery would be a possibility? Advances in technology and Artificial Intelligence have brought robots into the operating room (OR), assisting surgeons while they perform surgery. Robotic surgery is a revolutionary concept which essentially integrates the expertise of skilled surgeons with advanced computer technology. In order to better understand how robots are performing surgeries and why they can be an asset in the operating room, we will first define what robotic surgery is.

What is robotic surgery?

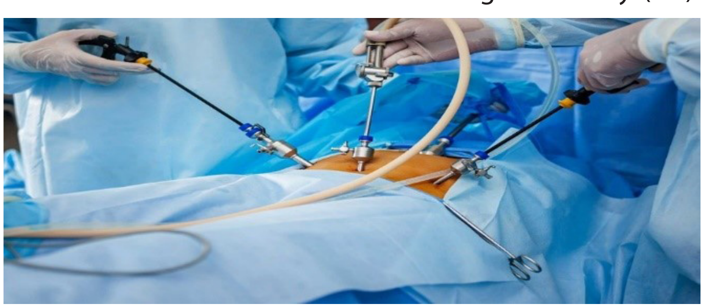
Robotic surgery is a form of laparoscopy. Laparoscopy is minimally invasive surgery, usually performed in an outpatient setting. Small incisions about a half inch each are made in the abdomen that allow a surgeon to place a laparoscope (lighted camera) and surgical instruments through surgical incisions below the belly button. The laparoscope then goes inside the abdomen or pelvis in order to perform surgery. In traditional laparoscopy, a surgeon holds those instruments and directly places them through the incisions. The instruments can move forward and backward and can be opened and closed. In robotic surgery, the same incisions are made and instruments are placed, but the instruments are usually held in place by "robotic arms." The surgeon controls the robotic arms and instruments from a control center or "console" several feet away from the patient but in the same operating room. The console can also be controlled from a remote location [1].

What are the advantages of robotic surgery compared to traditional laparoscopy?

Figure 1 presents a laparoscopic surgery setup, and figure 2 represents a robotic surgery setup. Compared to traditional laparoscopy, robotic surgery has several advantages. First of all, the console uses high-definition cameras so the surgeon's view inside the abdomen and pelvis is clearer.



Also, the surgeon's depth perception is better during surgery because the view is 3-dimensional as opposed to traditional laparoscopy, which is 2-dimensional. Control of the instruments in robotic surgery is better than in traditional laparoscopy because the instruments in robotic surgery can move in any direction that the surgeon's hand can move. This better control means the surgeon can perform more precise movements and speed up or slow down hand movements, and it allows for easy suturing (sewing) and knot tying [1]. In [2] Takahiro Kinoshita et al. analyzed data of patients with primary gastric cancer undergoing either robotic or laparoscopic radical gastrectomy from June 2014 to June 2020. In this study surgical outcomes were compared between the two groups, and multivariable analyses were performed to elucidate the relevant factors for postoperative complications in several subgroups. A total of 1172 patients were divided into those who underwent Robotic gastrectomy (RG) (n=152) and those who underwent laparoscopic gastrectomy (LG) (n=1020). Results of the aforementioned study indicates that RG reduces the incidence of postoperative complications compared with conventional LG and this tendency may be enhanced in technically complicated procedures with demanding anastomosis or D2 lymphadenectomy. Patients requiring such procedures would most benefit from Robotic gastrectomy (RG).



II. Classification of robotic systems applied in medicine

The classification of robotic systems depends on the actual point of view one takes. There are multiple classifications of robotic systems applied in medicine, with some being more preferable. A first high-level classification was proposed by Taylor and Stoianovici [3], in which they divided surgical robots into two broad categories, surgical computer-aided design/manufacturing (CAD/CAM) systems and surgical assistants.

Surgical CAD/CAM systems are designed to assist in planning and intraoperative navigation through reconstruction of preoperative images and formation of three-dimensional (3D) models, registration of this data to the patient in the operating room, and use of robots and image overlay displays to assist in the accurate execution of the planned interventions.

Surgical assistant systems are further divided into two classes: surgical extenders, which are operated directly by the surgeon and essentially extend human capabilities in carrying out a variety of surgical tasks, with emphasis on intraoperative decision support and skill enhancement; and auxiliary surgical supports, which work side-by-side with the surgeon and provide support functions, such as holding an endoscope.

Artificial Intelligence (AI) is an indispensable factor when it comes to the evolution of robotic surgery. AI-based algorithms combined with the precision and control of surgical robots are revolutionizing the way we look at surgeries in this age. It has the power to simplify the medium of interactions between surgical robots and surgeons, with the help of deep machine learning data. For instance, it can recognize and determine the movements and patterns of a surgeon during surgery and then convert them into actionable commands for the robot. Thus, AI collects data over time by watching surgeons perform. With the help of all the collected data and algorithms, AI assists surgical robots with reasoning and performance of cognitive functions like decision-making, problem-solving, speech-recognition, and more. AI and surgical robots also help analyze scans and surgeries, detect cancers, and facilitate instrument positioning or transferring equipment.

Complementary to the previous classification, Wolf and Shoham [4] summarize a division according to autonomous function. They present four categories for medical robots, passive robots, semi-active robots, active robots and remote manipulators. Loosely correlating the two classifications, one could say that passive, semi-active and active robots fall under the surgical CAD/CAM and auxiliary surgical support categories, while the remote manipulators are identified to the surgical extender class [5].

Passive robots provide support actions in surgery and do not perform any autonomous or active actions. Typical examples include the Acrobot [6], the Arthrobot [7] and the MAKO system [8]. Semiactive robots are closely related to the surgical assistant class and perform similar operations, viz. support tasks such as holding a tool or automated stereotaxy, e.g. the NeuroMate stereotactic robot. On the contrary, active robots exhibit autonomous behaviour and operate without direct interaction with the surgeon. Prominent examples include the CyberKnife (Accuray Inc., Sunnyvale, CA, USA) and RoboDoc (Curexo Technology Corp., Fremont, CA, USA) [9].

Remote manipulators, or surgical extenders, are probably the most common surgical robots in use today. One of the most successful commercial robots in this class is the da Vinci robot (Intuitive Surgical, Sunnyvale, CA, USA), which was originally implemented for heart surgery [10].

In this master–slave telemanipulator system the surgeon sits at a master console next to the patient, who is operated on by the slave arms (Figure 3). The surgeon views the internal organs through an endoscope and, by moving the master manipulator, can adjust the position of the slave robot. The surgeon compensates for any soft-tissue motion, thus closing the servo-control loop by visual feedback. The high-definition 3D images and micromanipulation ability of the robot make it ideal for transpubic radical prostatectomy, with reduced risk of incontinence and impotence [11].

A more recent telesurgery robot is the MiroSurge system [12] (Figure 4), developed by the German Aerospace Centre (DLR). The system consists of a master–slave platform, with the slave platform involving three robotic manipulators (MIRO surgical robots; see Figure 5), two carrying surgical tools and one carrying an endoscope.

Remote manipulators belong to a broad field of robotics called telerobotics. Niemeyer et al. [13] present a more engineering-orientated classification of telerobots with respect to control architecture and user interaction. However, this classification holds true for surgical telemanipulators as well. Depending on the degree of user interaction, three categories are defined, direct or manual control, shared control and supervisory control robotic systems.

In direct control the surgeon operates the slave robot directly through the master console. This involves no autonomy on the slave end and the robot mirrors the surgeon's movements (although some filtering may take place, e.g. tremor reduction and movement scaling). Apparently, this mode has the most surgeon involvement. At the other end, in supervisory control the procedure is executed solely by the robot, which acts according to a computer program that the surgeon inputs into it prior to the procedure. The surgeon (supervisor) gives high-level directives and the robot has to operate autonomously in order to carry them out, closing the loop locally. The surgeon is still indispensable in planning the procedure and overseeing the operation, but does not partake directly. Because the robot performs the entire procedure, it must be individually programmed for the surgery. Finally, in shared control the surgeon and the controller share the command of the manipulator and work together in order to carry out a task. This means that the human and the robot share the same resources, e.g. the manipulators. A prominent technique in shared control is the use of virtual fixtures [14]. Virtual fixtures are invisible 'rulers' that constrain the surgeon's movements. When the surgeon drives the manipulator towards the fixture, the controller starts to apply a deterrent force on the master console (force feedback), pushing the surgeon away from this location (passive assistance). Conversely, the controller can apply an assistive force to help the surgeon move towards a correct path (active assistance). Other applications of shared control include motion compensation (e.g. compensation of the motion of a beating heart) and obstacle avoidance. Obviously, shared control combines the intelligence of the surgeon and the robot, thus the robot presents a limited autonomy. From the previous classifications, it is clear that robots may have varying levels of autonomy. Autonomous or semi-autonomous modes have already been incorporated into medical robotics; however, most of them belong to the surgical CAD/CAM class. Autonomic performance of specific tasks can lessen the workload for the surgeon and potentially speed up the operation time. 'Smart tools' with a degree of intelligence seem to be more in favour of modern surgeons than fully-automated systems, which replace the surgeon's role by using imaging and robotics technology [15]. An example of the technological opportunities and the clinical dismay is the Minerva system for neurosurgery [16]. In [5] G. P. Moustris et al. have analyzed the autonomy of various robotic systems that are involved in medical practice.

III. AI-enabled robotic surgery

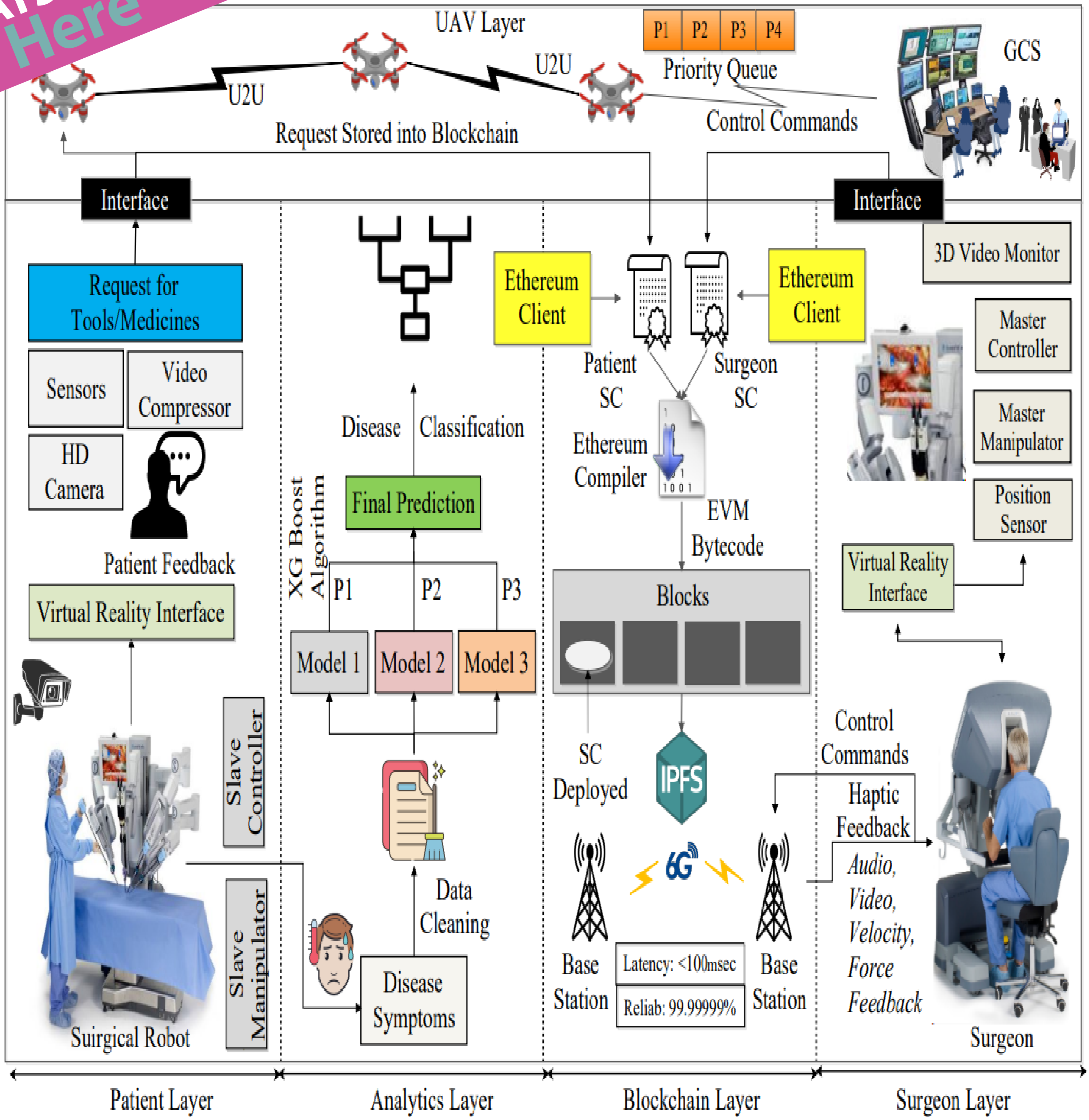
Artificial Intelligence (AI) is an indispensable factor when it comes to the evolution of robotic surgery. AI-based algorithms combined with the precision and control of surgical robots are revolutionizing the way we look at surgeries in this age. It has the power to simplify the medium of interactions between surgical robots and surgeons, with the help of deep machine learning data. For instance, it can recognize and determine the movements and patterns of a surgeon during surgery and then convert them into actionable commands for the robot. Thus, AI collects data over time by watching surgeons perform. With the help of all the collected data and algorithms, AI assists surgical robots with reasoning and performance of cognitive functions like decision-making, problem-solving, speech-recognition, and more. AI and surgical robots also help analyze scans and surgeries, detect cancers, and facilitate instrument positioning or transferring equipment.

BATS : A Blockchain and AI-empowered Drone-assisted Telesurgery System towards 6G

One of the most interesting AI-enabled robotic surgery systems has been proposed by Rajesh Gupta, Arpit Shukla, and Dr. Sudeep Tanwar [24]. They have proposed a blockchain and AI-empowered telesurgery system towards 6G called BATS, which is a self-manageable, secure, transparent, and trustable system with massive Ultra-Reliable Low-Latency Communication (mURLLC). BATS uses AI algorithms such as eXtreme Gradient Boosting (XGBoost) to classify the disease with their criticality score ranging from 0 to 1. Moreover, BATS uses UAVs to transport light-weight healthcare items such as medicines and surgical tools in an emergent situation (during surgical procedures) to avoid road-traffic congestions.

Figure 7 presents the proposed blockchain and AI-based UAVassisted secure, precise, and intelligent telesurgery system underlying a 6G environment called BATS.

BATS Here



The AI algorithm called XGBoost is used to classify the disease and assign a probability value, which decides its criticality. In contrast, UAVs are used to assist indispensable tools/medicines transportation needed during the telesurgery procedure. The BATS is virtually ramified into five distinct layers, such as (i) patient layer, (ii) analytics layer, (iii) blockchain layer, (iv) surgeon layer, and (v) UAV layer. The elucidation of each layer is as follows.

A Blockchain and AI-empowered Drone-assisted Telesurgery System towards 6G

BATS

A. Patient Layer

It has a teleoperator, also called a surgical robot that executes the real-time operational commands received from the remote surgeons. This layer has caregivers to assist the surgical robot during the telesurgery procedure. A surgical robot is also called a slave because it follows the instructions given by the remote surgeons. It uses haptic devices to exchange real-time haptic data, i.e., touch sensing and feeling. This layer comprises of various components such as sensors/actuators, video compressor (to save bandwidth), highdefinition camera, Virtual Reality (VR) interface (to make surgeons feel like a physical surgical procedure with the 3D view), slave controller, and slave manipulator. In BATS, the patients and caregivers can give their feedback in the form of a questionnaire for the surgeons just after the completion of the telesurgery procedure and calculate the surgeon's new performance rating (PRatings), which assists other patients in selecting the surgeon for their surgery.

Based on ratings (stored in the blockchain) and wallet balance, the patients can request the required surgeon to the hospital for their surgical procedures. Further, the hospital will look for the availability of a remote surgeon. Once the surgical procedure has been started (patients share their IPFS hash keys with the surgeons) and the emergent requirement of any medicine or lightweight surgery tools can be requested to the nearby warehouse via blockchain.

B. Analytics Layer

This layer is used to predict and classify the disease with assigned priorities. It accepts symptoms as an input from the patient layer that could be fever, cough, high pulse, high blood pressure, and high heart rate. The received data is passed to the cleaning process such as noise removal, outliers removal, and normalization, to increase the prediction accuracy in disease classification. Once the data cleaning is accomplished, it will be passed to the XGBoost algorithm for disease prediction and classification. Algorithm 1 presents the steps to classify the disease and score them. XGBoost is an ensemble AI algorithm that yields superior and optimized results with fewer resources and time. It optimizes the results by parallelizing the tree implementation, tree pruning, hardware optimization (for efficient use of resources), and algorithmic improvements [26]. Finally, we then assign a score to the predicted diseases, i.e., score based on the surgery's criticality. The heart surgery will be given a high score over the knee surgery. These scores will be used by the UAV layer while dispatching and shipping the medicines/tools.

C. Blockchain Layer

BATS considers the public block chain, i.e., Ethereum, a distributed ledger and is entirely decentralized. It ensures secure and trustworthy communication between the entities involved in the tele surgery procedure.

Blockchain stores the transaction/data into the chain of immutable blocks (not modifiable) and are cryptographically secure with the public-private key pair. Blockchain's smart contract eradicates the need for trusted third-party systems to preserve the trust between the participating entities. A smart contract is a code in a specific programming language like solidity and is self-executable on the encounter of particular conditions. It also helps in designing real-world decentralized solutions efficiently. Ethereum smart contract involves complex operations to manage the multi-party transactions from the surgeons across the world, which require a careful, complete, and security bug-free development [27].

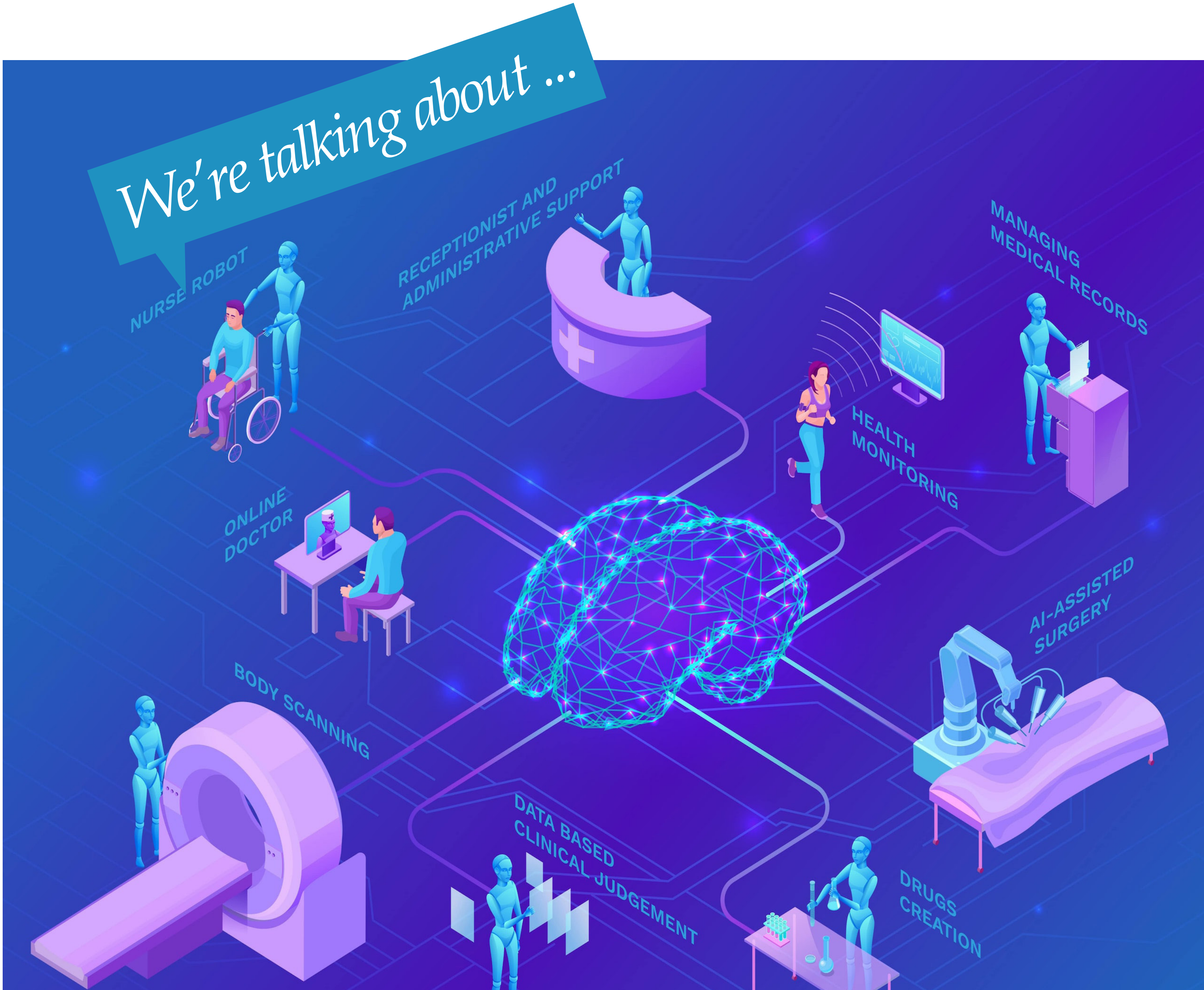
As discussed above, the BATS has multiple entities associated with the Ethereum smart contract. Surgeons need to register themselves with the network authority (ENA) via blockchain network and verify their credentials before the initiation of surgical procedure. The smart contract also ensures that whether the surgery is required or not. This is to be predicted at the analytic layer with the symptoms identified. After the successful completion of the surgical procedure, the payment can be exchanged between the surgeons and the hospital administration via Ethereum wallet.

D. Surgeon Layer

It comprises multiple surgeons connected remotely to the surgical robot at the hospital administration to execute telesurgery procedures via a 6G communication network. Surgeons must be registered with the hospital administration before the initiation of any surgical procedure and the registration agreement is stored in the blockchain network. The main components of the surgeon layer that assist telesurgery procedures are VR interface (3D and close view of the surgery area), master controller & manipulator (that controls the surgical robot), position sensor, video monitor, video decompressor, and speakers. The commands to control the surgical robot are exchanged via the blockchain network in a secure manner. Fig. 4 shows the structure of a block having transactions as the commands given by the surgeons. Surgeons also receive haptic feedback from the patient layer to feel the surgical procedure. The haptic feedback is in the form of audio, video, velocity, and force applied. Once the telesurgery procedure is completed, surgeons will receive the ratings from the patients and the caregivers.

E. UAV Layer

This layer consists of healthcare UAVs (carries medicines and surgical tools) and the Ground Control Station (GCS). The patient layer stores its request for a medicine/tool into the blockchain network and immediately, the request will be received by the surgeons and pharmacy [28]. The surgeon verifies the request and the pharmacy uses their air vehicles such as UAVs to deliver the items on an urgent basis [29]. Multiple surgeons are executing remote surgeries at a time, and their request for medicines/tools can be approved based on the priority value assigned to the type of surgery in the disease classification step of the analytic layer. Based on a priority queue, the UAV schedules the delivery.



V.Conclusion

As depicted by the progress reviewed here, robotic technology is going to change the face of surgery in the near future. Robots are expected to become the standard modality for many common procedures. As a result, surgeons have to become familiar with technology, and technology should come closer to the everyday needs of a surgical team.

Autonomous and semi-autonomous modes are increasingly being investigated and implemented in surgical procedures, automating various phases of the operation. The complexity of these tasks is also shifting from the low-level automation early medical robots to high-level autonomous features, such as complex laparoscopic surgical manoeuvers and shared-control approaches in stabilized image-guided beating-heart surgery.

Future progress will require a continuous interdisciplinary work, with breakthroughs such as nanorobots entering the spotlight. Autonomous robotic surgery is a fascinating field of research involving progress in artificial intelligence technology. However, it should always be faced with caution and never allow the exclusion of human supervision and intervention.

REFERENCES

[1] robotic_surgery_factsheet.pdf (reproductivefacts.org)
[2] Reduction in postoperative complications by robotic surgery: a case–control study of robotic versus conventional laparoscopic surgery for gastric cancer
[3] Taylor RH, Stoianovici D. Medical robotics in computer-integrated surgery. IEEE Trans Robotics Autom 2003; 19(5): 765–781.
[4] Wolf A, Shoham M. Medical automation and robotics. In Springer Handbook of Automation. Springer: Berlin, 2009; 1397–1407.
[5] Moustris GP, Hiridis SC, Deliparaschos KM, Konstantinidis KM. Evolution of autonomous and semi-autonomous robotic surgical systems: a review of the literature. Int J Med Robot. 2011 Dec;7(4):375-92.
[6] Jakopec M, Rodriguez y Baena F, Harris SJ, et al. The hands-on orthopaedic robot 'acrobot': early clinical trials of total knee replacement surgery. IEEE Trans Robotics Autom 2003; 19(5): 902–911.
[7] Kwon D-S, Lee J-J, Yoon Y-S, et al. The mechanism and registration method of a surgical robot for hip arthroplasty. In Proceedings of IEEE International Conference on Robotics and Automation 2002 (ICRA '02), vol. 2, Washington, DC, 2002; 1889–1894.
[8] Lonner JH, John TK, Conditt MA. Robotic arm-assisted UKA improves tibial component alignment: a pilot study. Clin Orthop Relat Res 2010; 468(1): 141–146.
[9] Taylor RH, Mittelstadt BD, Paul HA, et al. An image-directed robotic system for precise orthopaedic surgery. IEEE Trans Robotics Autom 1994; 10(3): 261–275.
[10] Guthart GS, Salisbury JK. The Intuitive telesurgery system: overview and application. In IEEE International Conference on Robotics and Automation (ICRA '00), vol. 1, 2000; 618–621.
[11] Dasgupta P, Jones A, Gill IS. Robotic urological surgery: a perspective. BJU Int 2005; 95(1): 20–23.
[12] Hagn U, Konietschke R, Tobergte A, et al. DLR MiroSurge: a versatile system for research in endoscopic telesurgery. Int J Comput Assist Radiol Surg 2010; 5(2): 183–193.
[13] Niemeyer G, Preusche C, Hirzinger G. Telerobotics. In Springer Handbook of Robotics. Springer: Berlin, 2008; 741–757.
[14] O'Malley MK, Gupta A. Passive and active assistance for human performance of a simulated underactuated dynamic task. In 11th Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (HAPTICS 2003); 348–355.
[15] Tavakoli M, Patel RV, Moallem M. Haptics for Teleoperated Surgical Robotic Systems. World Scientific: Singapore, 2008.
[16] Dario P, Hannaford B, Menciassi A. Smart surgical tools and augmenting devices. IEEE Trans Robotics Autom 2003; 19(5): 782–792.
[17] A. Chellali, L. Zhang, G. Sankaranarayanan, V. S. Arikatla, W. Ahn, A. Derevianko, S. D. Schwaitzberg, D. B. Jones, M. DeMoya, and C. G. L. Cao, "Validation of the VBLaST peg transfer task: a first step toward an alternate training standard," Surgical Endoscopy, vol. 28, pp. 2856–2862, Oct. 2014.
[18] R. Korets, A. C. Mues, J. A. Graversen, M. Gupta, M. C. Benson, K. L. Cooper, J. Landman, and K. K. Badani, "Validating the Use of the Mimic dV-trainer for Robotic Surgery Skill Acquisition Among Urology Residents," Urology, vol. 78, pp. 1326–1330, Dec. 2011.
[19] Naveen Madapana, Md Masudur Rahman, Natalia Sanchez-Tamayo, Mythra V. Balakuntala, Glebys Gonzalez, Jyothsna Padmakumar Bindu , L. N. Vishnunandan Venkatesh , Xingguang Zhang, Juan Barragan Noguera , Thomas Low , Richard M. Voyles , Yexiang Xue , and Juan Wachs, "DESK: A Robotic Activity Dataset for Dexterous Surgical Skills Transfer to Medical Robots," 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 6928-6934, 2019.
[20] X. B. Peng, M. Andrychowicz, W. Zaremba, and P. Abbeel, "Sim-to-Real Transfer of Robotic Control with Dynamics Randomization," in 2018 IEEE International Conference on Robotics and Automation (ICRA), pp. 1–8, May 2018.
[21] J. Tobin, R. Fong, A. Ray, J. Schneider, W. Zaremba, and P. Abbeel, "Domain randomization for transferring deep neural networks from simulation to the real world," in 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 23–30, Sept. 2017.
[22] Wang RS, Ambani SN. Robotic Surgery Training: Current Trends and Future Directions. Urol Clin North Am. 2021
[23] Hung AJ, Jayaratna IS, Teruya K, et al. Comparative assessment of three standardized robotic surgery training methods. BJU Int 2013; 112(6):864-71.
[24] R. Gupta, A. Shukla and S. Tanwar, "BATS: A Blockchain and AI-Empowered Drone-Assisted Telesurgery System Towards 6G," in IEEE Transactions on Network Science and Engineering, vol. 8, no. 4, pp. 2958-2967, 1 Oct.-Dec. 2021.
[25] N. Joshi, "What impact will blockchain have on robotics?." https://www.allerin.com/blog/what-impact-will-blockchain-have-on-robotics.
[26] V. Morde, "Xgboost algorithm: Long may she reign!." https://towardsdatascience.com/https-medium-com-vishalmordexgboost-algorithm-long-she-may-rein-edd9f99be63d#:□: text=XGBoost%20is%20a%20decision%2Dtree,all%20other% 20algorithms%20or%20frameworks. Accessed: 2019.
[27] "Security considerations." https://solidity.readthedocs.io/en/v0.7.0/security-considerations.html. Online; Accessed: 2020.
[28] R. Gupta, A. Shukla, P. Mehta, P. Bhattacharya, S. Tanwar, S. Tyagi, and N. Kumar, "Vahak: A blockchain-based outdoor delivery scheme using uav for healthcare 4.0 services," in IEEE INFOCOM 2020 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), pp. 255–260, 2020.
[29] M. B. Mollah, J. Zhao, D. Niyato, Y. L. Guan, C. Yuen, S. Sun, K.-Y. Lam, and L. H. Koh, "Blockchain for the internet of vehicles towards intelligent transportation systems: A survey," IEEE Internet of Things Journal, p. 11, 2020.

Negin Heidari

Filed : Electrical Engineering
BSc : Shahid Beheshti University
Research Field : Artificial intelligence & Machine learning

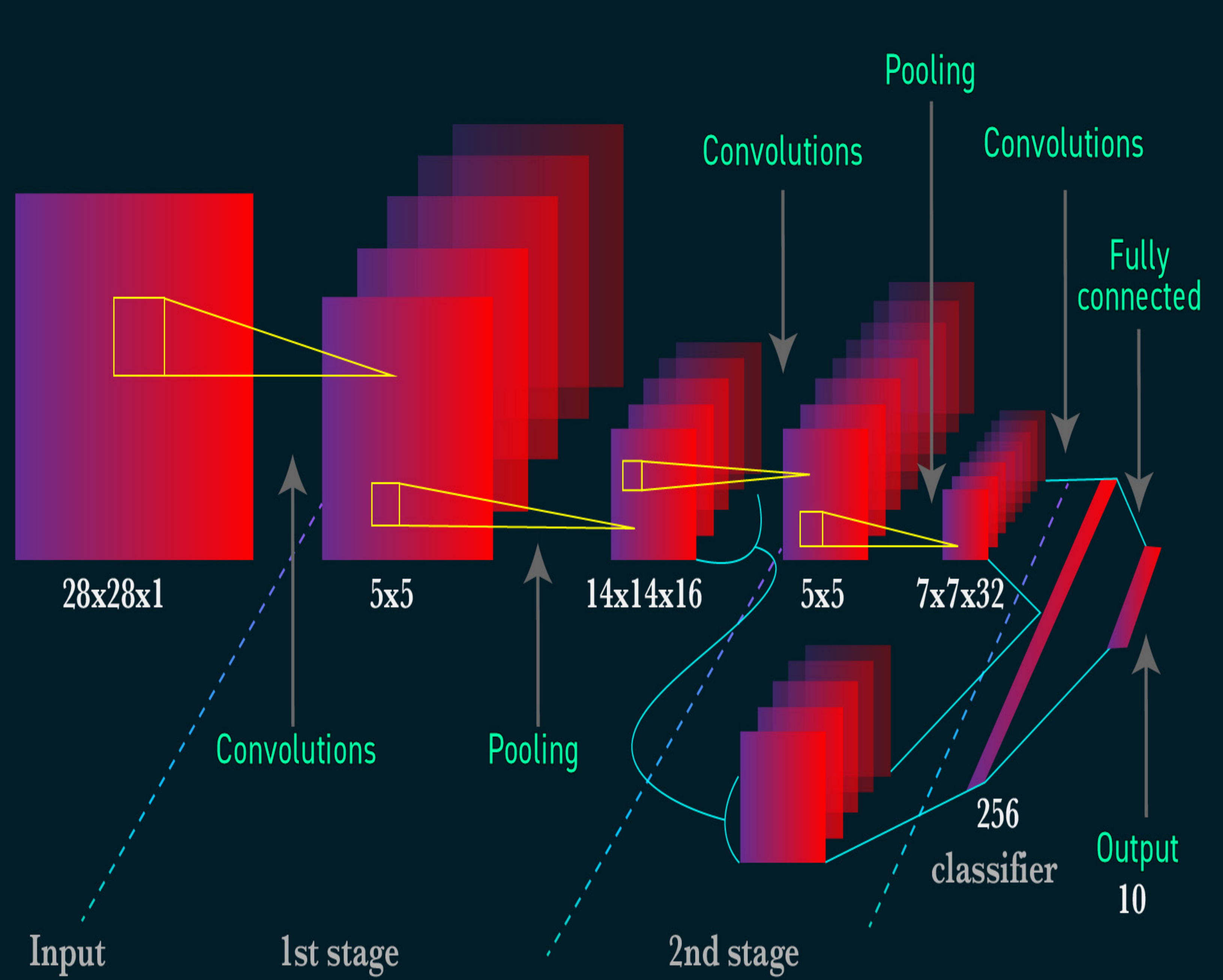


IMAGE PROCESSING

USING A CONVOLUTIONAL NEURAL NETWORKWORK

1. Abstract

You may have already heard about artificial intelligence (AI) and the utilization of neural networks in facilitating human applications. Nowadays owing to the exponential growth of CPU's process speed and on the other hand, the ubiquity of cameras, we are given this opportunity to be the first generation of humans who can explore and investigate high-resolution images using computers, namely due to the advent and advancement of deep and machine learning.

and investigate high-resolution images using computers, namely due to the advent and advancement of deep and machine learning. Currently, one can manifestly see how artificial intelligence is expanding into various subjects including biology, astronomy, geology, and so forth. Gone are the days when computers were confined to computer engineers and scientists. Knowing the importance of artificial intelligence, this article aims to briefly explore some of the applications of deep learning and specifically convolutional neural network (CNN) to give the reader a foretaste of what people are trying to do in this discipline.

2. What is AI?

According to the Cambridge dictionary, it is "the use of computer programs that have some of the qualities of the human mind, such as the ability to understand language, recognize pictures, and learn from experience". As set forth, one of the main branches of AI is recognizing pictures using computers.

3. What is image processing?

An image may be defined as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the intensity values of f are all finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to processing digital images using a digital computer. Note that a digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are called picture elements, image elements, panels, and pixels. Pixel is the term used most widely to denote the elements of a digital image. [1]

4. What are deep Learning and Machine learning?

Nowadays, one of the most vital parts of employing AI in human applications is with using machine learning and deep learning. Machine Learning is a branch of data analysis that has soared its popularity in the last few decades. Firstly, it was born from pattern recognition and the theory that computers can learn without being programmed to perform a specific task. Generally, when you want something from the computer you should let them know what you want exactly. For instance, I want this dataset to be oriented in another way. You programmed a computer specifically for a task and it would do it for you. Yet, if you wanted to give the computer another task you should modify your code so that it could perform that task specifically. Nevertheless, what if we could teach computers how to do it for themselves?

We can start by asking how we, as humans, perceive our surroundings for the first time. When we were born, we did not know anything about cars or motorcycles. Further, in life, our parents and teachers taught us that for example, this thing is a car and that is a motorcycle. After watching countless examples of cars and motorcycles, we were able to comprehend the next one. This is the exact concept that AI specialists are trying to do with computers. Just by giving thousands of examples of cars, we want our AI to guess the next car that it sees. The way it functions is like the human brain. The human brain has a biological neural network that has billions of interconnections. As the brain learns, these connections are either formed, changed, or removed, similar to how an artificial neural network adjusts its weights to account for a new training example. The most obvious similarity between a neural network and the brain is the presence of neurons as the most basic unit of the nervous system. However, how neurons take input in both cases is different. In our understanding of the biological neural network, we know that input is taken in from dendrites and output through the axon. These have significantly different ways of processing input.

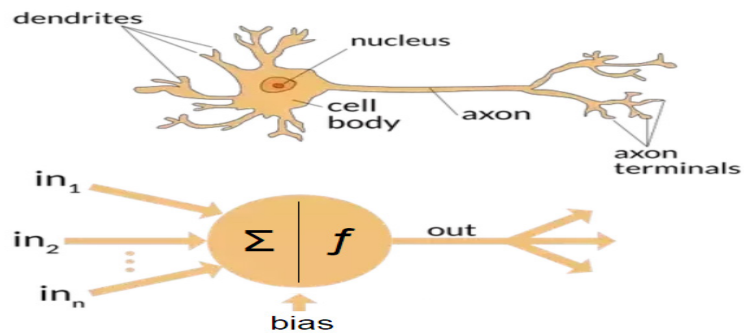
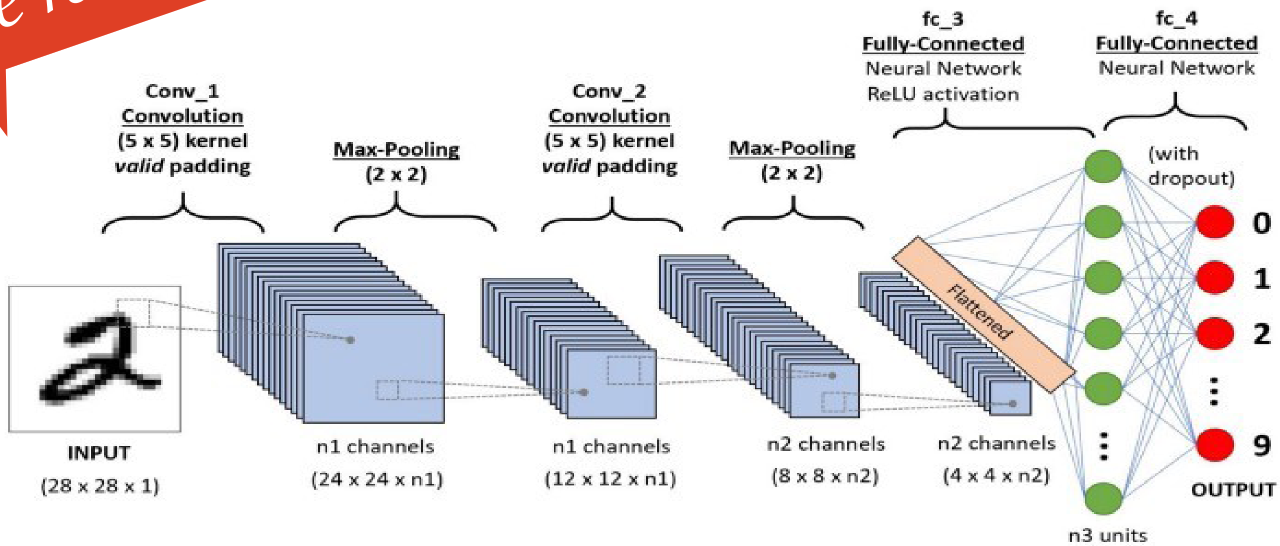


FIG1- THE STRUCTURE OF THE NEURAL NETWORK

I believe one of the compelling indications that how fast image processing is going forward is the ImageNet challenge. Thanks to Prof. Li Fei-Fei who created a database of 1.2 million human-labeled images, which at the time was the largest labeled image dataset ever constructed. From 2010 to 2017 ImageNet ran an annual contest (the ImageNet large-scale Visual Recognition Challenge) in which participants competed to correctly detect and classify images. Images were classified into 1000 different categories including 90 different dog breeds. Each Neural Network should have 1000 different outputs each for a corresponding object. The way that they assess each algorithm was by seeing how often the five highest neuron activations do not include the correct category. This was the so-called top-5 error rate. In 2010, the top-5 rate was 28.2% achieved by NEC, in 2011, 25.8% by XRCE, and in 2012, AlexNet achieved an impressive number. AlexNet reached a 16.4% top-5 error rate. Further in the competition, in 2015 ResNet reached a 3.6% top-5 error rate which is better than the human performance on the task. The ResNet comprises 100 layers of neurons which involves a huge amount of computation. Patently, these computations were conducted on GPUs which are not meant to do these computations. The main reason that the top-5 error rate plummeted in that competition was due to the rise of the number of neural layers. The more layers you have, the more precise you become. Although algorithms play a vital role in how efficiently your AI works, nevertheless, we cannot ignore the time that those hundreds of millions of computations could take. Considering Moore's law this may become an important question in the future. how can we increase the speed of computation by acknowledging the fact we are reaching the limits of transistors? Perhaps we should rethink about digital computing and reconsider using analog or quantum computers in conjunction with digital ones.

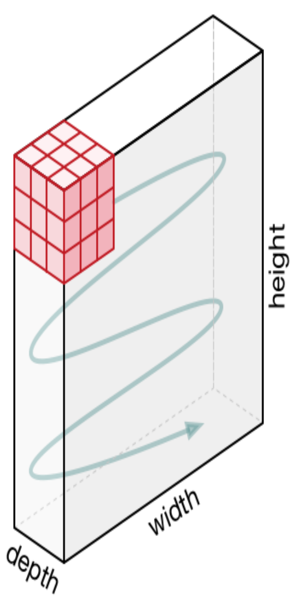
We're talking about ...

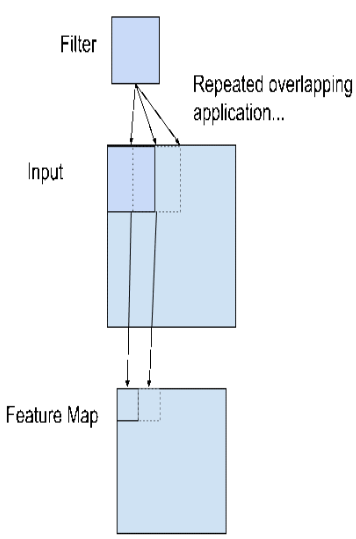


CONVOLUTIONAL NEURAL NETWORKS

5. What are convolutional neural networks?

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image, and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets can learn these filters/characteristics.





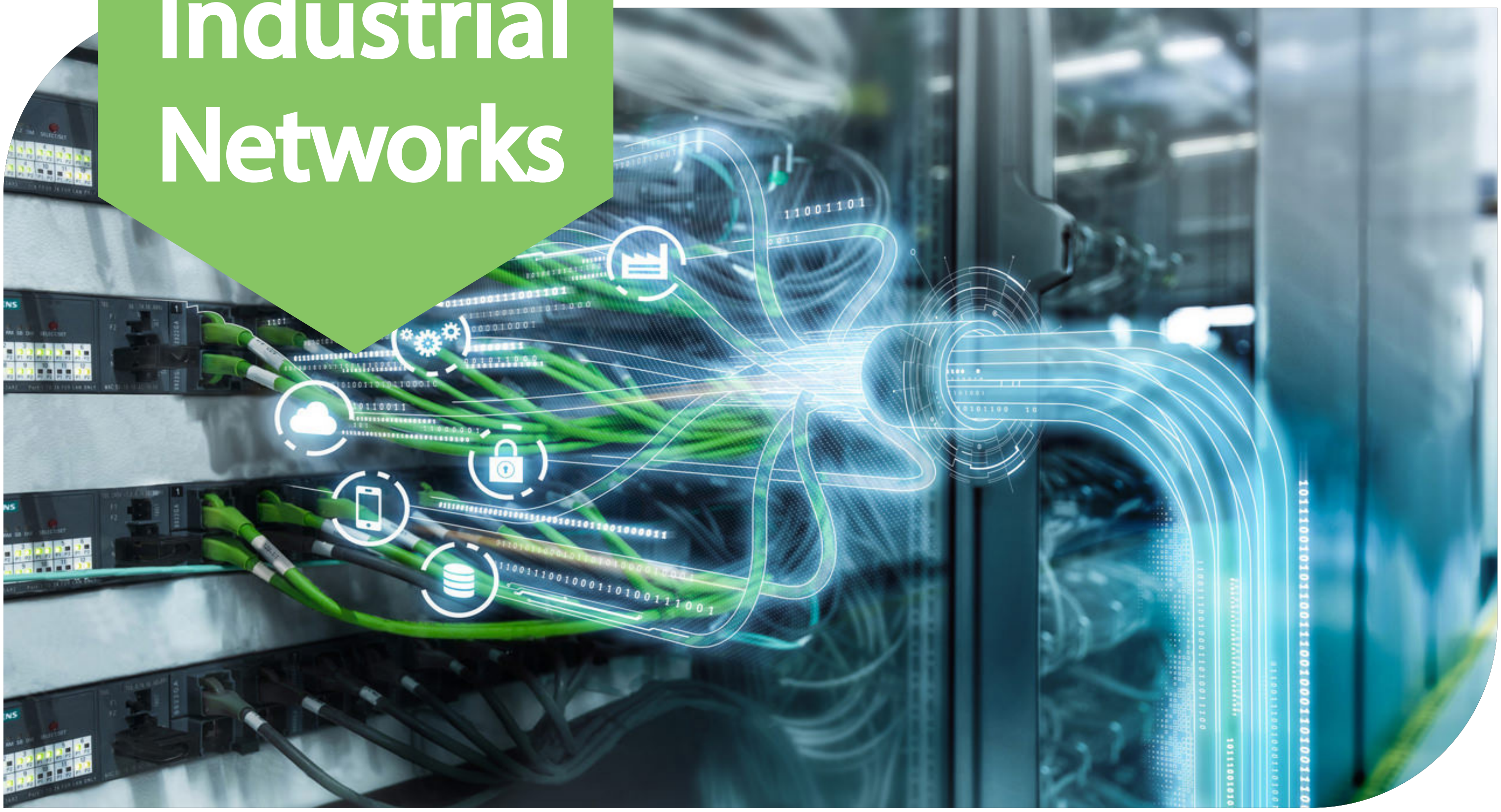
In the context of a convolutional neural network, convolution is a linear operation that involves the multiplication of a set of weights with the input, much like a traditional neural network. Given that the technique was designed for two-dimensional input, the multiplication is performed between an array of input data and a two-dimensional array of weights, called a filter or a kernel.

Reference

1. Gonzalez, Rafael (2018). Digital image processing. New York, NY: Pearson. ISBN 978-0-13-335672-4. OCLC 966609831.

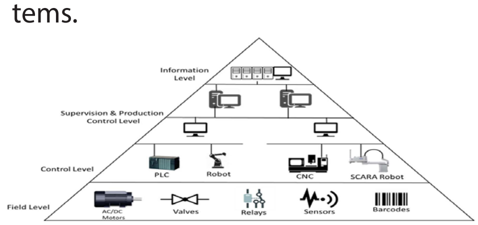
I am Arian Komaei. I am a senior student at Shahid Beheshti university in the field of Electrical Engineering. I am interested in solving computer vision and image processing problems using artificial intelligence, machine learning, and different algorithms.

Industrial Networks



What is an industrial network?

Industrial networks are used to share information and facilities between controllers and equipment. The industrial network creates a route or bus for data exchange. This path is like a road for cars to pass, with the difference that data is exchanged in the industrial network. The protocol of a network specifies how data is coded and how to send and receive and other things related to it. Before the invention of industrial networks, information from sensors and actuators was transferred to the controller by direct wiring, but with the invention of industrial networks and their use, it became possible for electrical signals to be first converted into data and this data to be transferred to the controller through industrial networks. Imagine, in an industrial unit, there are several production lines and these lines need to transfer information between other controllers (for example, PLCs) and monitoring systems.



Types of industrial networks

Industrial networks are progressing day by day, and we will continue to introduce each industrial network.

1. Modbus network

The ModBus network is an open source communication protocol that was released in 1979 by Modicon. The initial idea of this protocol was to be used in PLCs, but it was gradually accepted as a communication standard nd many automation equipment manufacturers supported it. In this way, Modbus was released as an open standard, so that products from different manufacturers could easily communicate with each other through this protocol. Manufacturers of small devices also preferred to use this network with RS232 or RS485 connection on their devices so that they can be used in large projects.

2. Profibus network

Profibus is a communication standard in industrial automation that is used for digital and analog automation processes (Factory Automation and Process Automation). This method of communication is flexible, stable and cheap in relation to its performance. Profibus is designed based on RS-485 serial communication technology, and nowadays all kinds of PLCs, HMI/SCADA, sensors, drives, servos and even HART equipment are also able to connect to the Profibus network. The main reason for the acceptance of Profibus is the significant reduction in the volume of wiring for connecting all types of field equipment to the control system.

Alireza Heydari kamalabadi
Filed : Electrical Engineering
BSc : Shahid Beheshti University
Research Field : Industrial automation

Image data processing

Abstract

With the increasing progress of technology, new cases and definitions are created that are important for today's world. One of these definitions that we want to examine is the science of image processing. The first question that arises is what is image processing? The process of converting a photo into digital form and applying specific operations to extract information from it is called image processing. Usually, the image processing process treats all images as two-dimensional signals and applies predefined signal processing methods to them. After this initial definition of image processing, different questions arise, such as what is the application of image processing? Where did this science come from? In this article, we try to answer the complete questions and also examine this science from different perspectives.

Introduction

One of the first uses of the digital image was in the newspaper industry, when the image was first sent by submarine cable between London and New York. With the introduction of the Barrett Line cable image transmission system in the early 1920s, it reduced the time required to transmit an image across the Atlantic from a week or more to three hours a day. Specialized printing equipment for cable transmission encoded the images and then reconstructed them at the end. Some of the initial problems in improving the visual quality of these early digital images were related to the choice of print manufacturers and intensity level distribution. In fact, digital images require a lot of storage and computing power, so that progress in the field of digital image processing depends on the development of digital computers and supporting technologies such as data storage, display, and transmission.[4]

Digital image processing involves the manipulation of images using digital computers. In the past decades, its use has increased exponentially. Applications of digital image processing range from medicine to entertainment and remote sensing. The field of digital image processing is a broad field that includes digital signal processing techniques as well as image specific techniques.[1]

The five main types of image processing are:

• Visualization: Finding objects that cannot be seen in the image.

• Recognition: distinguishing and identifying objects in the image.

• Sharpen and Restore: Create an improved image from the original image.

• Pattern recognition: measuring different patterns around the objects in the photo.

• Retrieval: Searching for photos from a vast database of digital photos that are similar to the original photo.

Why do we need digital image processing?

Let us explain the importance of image processing with an example. As we know, the satellite is a more useful tool to get information about the world as well as the planet earth. Many decisions are made; There are decisions that are not directly made with presuppositions; They were taken by us using satellite images. But satellite images are in RGB form; Therefore, we have to convert these images into a suitable color combination as well as a suitable format for image processing. The satellites transmit these images or any digital data that is processed by a computer.[2]

Image processing steps

What are the stages of Image Processing? Digital image processing includes a wide range of hardware, software and theoretical foundations. Image processing methods originate from two main application areas:

• Improving image data for human interpretation

• Image data processing for machine understanding

In a complete Image Processing operation, from the initial stage when the image is entered into a software system to the last stage where a label is assigned to each specific object in the image; It consists of several steps.[2]

Image preprocessing stage or enhancement of image data

• Image acquisition

The first step in the image processing process is to acquire the image. It is also called as pre-processing stage. This step includes receiving a photo from a software source.

To do this, an imaging sensor and the ability to digitize the signal produced by the sensor are needed. The sensor can be monochrome, color TV, or linear scanner camera. If the output of the imaging camera is not a digital image; An analog-to-digital converter digitizes it.[2]

• Image enhancement correction

Image enhancement is actually the process of extracting and highlighting some desired features from a blurry image. Correction and improvement is a function that can somehow increase the chances of success of other image processing processes. Image correction and enhancement with techniques to increase contrast, remove noise, and isolate regions whose structure is likely to represent numerical information; He has a job.[2]

• Image restoration

The process of improving the appearance of an image is called image restoration. While the image restoration process, unlike the image enhancement process, uses specific mathematical models and probabilities.[3]

• Image color processing

Image color processing includes color modeling techniques in the digital medium. This stage has gained a significant advantage due to the significant use of digital images in the Internet space.

• Multiple wavelets and resolutions

Wavelets are used to express different degrees of resolution in images. Images are divided into wavelets or smaller regions for information compression and also for pyramidal representation.

• Compression

A process that reduces the space required to store the image or the bandwidth required to transmit it; It is called compression. This is especially the case when the image is used for uploading to the Internet.[2 ,3]

• Morphological or morphological processing

Morphological processing is a set of image processing operations that transforms images step by step based on their shape.[2]

Image preprocessing stage or enhancement of image data

• Classification

Segmentation is one of the most difficult image processing steps. This process involves dividing an image into its components.

A robust segmentation method drives the process towards the successful solution of an imaging problem. Poor or irregular segmentation algorithms almost always fail. The key role of segmentation is to extract individual characters and words from the background.

• Display and description

After the image is divided into specific parts in the segmentation stage; Each part is described and presented in a way that is suitable for computer processing in the next steps. A method for describing the data should be specified so that the desired features are revealed. Annotation by extracting quantitative information that helps distinguish between categories of objects; deals with

• Diagnosis

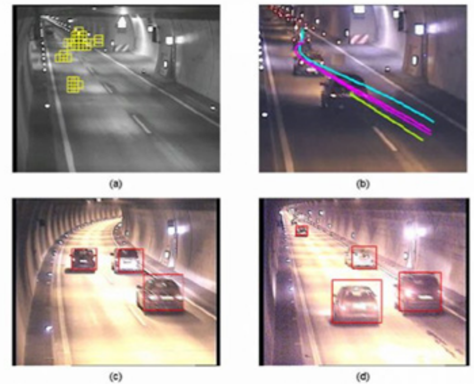
At this stage, a method for describing the data should be specified so that the desired features are visible. Then it assigns a label to each object according to its description.

Some important issues in image processing

• Image zoning

Image zoning is the separation of image pixels into separate areas that are the same in terms of characteristics such as light intensity, texture, or color, or are correlated as much as possible. Image segmentation is a necessary and important need to start processing in many processing cases such as image therapy, machine vision, image compression, and object science.[3]Object recognition

The object recognition process, from the simplest analysis to the most advanced possible analysis, is done by seeing an image. Such as recognizing various natural and artificial objects, recognizing the weather, diagnosing diseases and treatment methods, recognizing a person's face, recognizing the state of a person's body parts, etc., all of which can be deduced from images. (Figure 1) [3]



It is one of several biometric methods that is highly accurate and unlike other validation methods, the user can enter the validation process very easily with his own face. Face recognition is widely used in robotics. (Figure 2) [3]

• Image edge detection

The edge detection process is one of the most efficient and useful techniques in image processing, especially in separating and identifying the main frame of the image. There are different ways to reveal the edge in an image, which face problems such as the loss of the original image data and the inability to find the edge at different angles. The purpose of edge detection is to identify boundaries of objects in an image, which are the basis of image analysis and machine vision.[3]

The main applications of image processing are in artificial intelligence and machine vision, but since each of them has its own complexity, here we will discuss the applications of image processing in everyday life.[2]

• Medical image restoration

Digital image processing is especially used in medical research and has made access to more useful and accurate treatment solutions. For example, advanced medical image processing algorithms help in the detection of small cancerous glands and ultimately in the early detection of breast cancer.

• Industrial image processing

Advances in industrial image processing technology have led to prosperity and production quality in most of its industrial applications. For example, monitoring some environmental conditions in the aerospace or manufacturing industries can be difficult or dangerous. Machine vision can be a good substitute for human inspection. Since it is necessary to use advanced image processing in medical applications; Medical image data require accurate and specialized evaluation and measurement.

• Traffic measurement technology

The video image processing system or VIPS is used in the traffic camera system. This system includes the following:

A system for recording images, Remote communication system, Image processing system

During video recording, the Image Processing system is made up of different parts that send the "on" signal to the output of the system when each vehicle enters the image, and send the "off" signal to the output when the vehicle leaves the image. The detector segments can be configured with multiple lenses and used to evaluate the traffic at a specific location.

On the other hand, this system can automatically record the number plates of cars, distinguish between different types of vehicles, check the speed of cars, and also have many other uses.

• Image reconstruction

Digital image processing can be useful in recovering and restoring lost parts of images. For this purpose, image processing systems that are trained with existing image databases are needed to create newer versions of old and damaged images.

Lorem ipsum eu nec everti indoctum at mei meis denique legendos. Ut nec sint utinam, ea pri tation mollis similique? Per et option sapientem, ad meliore eleifend sea, eius consequat percipitur cu pro? Cu sed molestiae moderatius delicatissimi, an eos feugiat oporteat? Te est sale utamur, vel menandri ocurreret te. Lorem ipsum eu nec everti indoctum at mei meis denique legendos. Ut nec sint utinam, ea pri tation mollis similique? Per et option sapientem, ad meliore eleifend sea, eius consequat percipitur cu pro? Cu sed molestiae moderatius delicatissimi, an eos feugiat oporteat? Te est sale utamur, vel menandri ocurreret te. Qui eros vivendum ne. Ad vidit blandit mentitum ius. An populo qualisque ullamcorper est, cu pri vidisse aliquam consequuntur! Velit debitis vivendum est in, pri ut dicit feugait, ne etiam tincidunt eos.

• Face Recognition

One of the most common applications of image processing that is used today; Face recognition. This process follows deep learning algorithms, in the beginning, the computer gets to know the characteristics of the human face, such as the shape of the face, the distance between the two eyes, etc.

Conclusion: The growth of deep learning technologies has led to the rapid acceleration of computer vision in open source projects, which has increased the need for image processing tools. Because artificial intelligence is progressing every day and with the predictions made by scientists and enthusiasts in this field, in the next few years we will see fundamental changes in the world related to this science. Image processing is closely related to artificial intelligence. It is not far from expectation if image processing is observed in other styles and sciences at the same time as artificial intelligence. As it was said in the article, image processing is also widely used in medical science and it has caused the diagnosis of cancerous glands, which is very important in medicine, so this science with high efficiency will surely solve many problems in various sciences and industries.

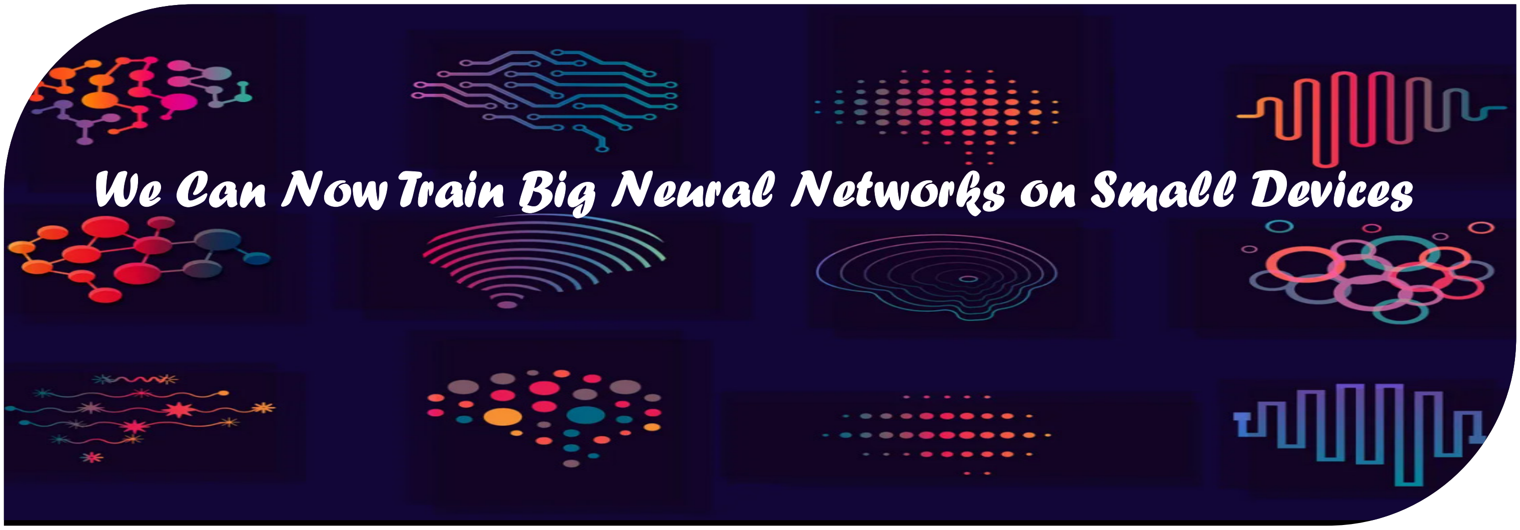
Samira Safari Najafabadi

Filed : Electrical Engineering
BSc : Malayer University
Research Field : AI & image processing

Seyed Amir Khoshrou

Filed : Electrical Engineering
BSc : Malayer University
Research Field : AI & image processing

We Can Now Train Big Neural Networks on Small Devices



The gadgets around us are constantly learning about our lives. Smartwatches pick up on our vital signs to track our health. Home speakers listen to our conversations to recognize our voices. Smartphones play grammarian, watching what we write in order to fix our idiosyncratic typos. We appreciate these conveniences, but the information we share with our gadgets isn't always kept between us and our electronic minders. Machine learning can require heavy hardware, so "edge" devices like phones often send raw data to central servers, which then return trained algorithms. Some people would like that training to happen locally. A new AI training method expands the training capabilities of smaller devices, potentially helping to preserve privacy.

The most powerful machine-learning systems use neural networks, complex functions filled with tunable parameters. During training, a network receives an input (such as a set of pixels), generates an output (such as the label "cat"), compares its output with the correct answer, and adjusts its parameters to do better next time. To know how to tune each of those internal knobs, the network needs to remember the effect of each one, but they regularly number in the millions or even billions. That requires a lot of memory. Training a neural network can require hundreds of times the memory called upon when merely using one (also called "inference"). In the latter case, the memory is allowed to forget what each layer of the network did as soon as it passes information to the next layer.

To reduce the memory demanded during the training phase, researchers have employed a few tricks. In one, called paging or offloading, the machine moves those activations from short-term memory to a slower but more abundant type of memory such as flash or an SD card, then brings it back when needed. In another, called rematerialization, the machine deletes the activations, then computes them again later. Heretofore, memory-reduction systems used one of those two tricks or, says Shishir Patil, a computer scientist at the University of California, Berkeley, and the lead author of the paper describing the innovation, they were combined using "heuristics" that are "suboptimal," often requiring a lot of energy. The innovation reported by Patil and his collaborators formalizes the combination of paging and rematerialization.

"Taking these two techniques, combining them well into this optimization problem, and then solving it—that's really nice," says Jiasi Chen, a computer scientist at the University of California, Riverside, who works on edge computing but was not involved in the work.

In July, Patil presented his system, called POET (private optimal energy training), at the International Conference on Machine Learning, in Baltimore. He first gives POET a device's technical details and information about the architecture of a neural network he wants it to train. He specifies a memory budget and a time budget. He then asks it to create a training process that minimizes energy usage. The process might decide to page certain activations that would be inefficient to recompute but rematerialize others that are simple to redo but require a lot of memory to store.

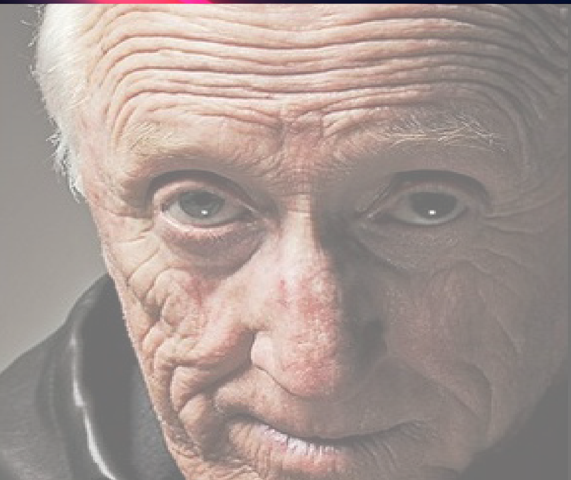
One of the keys to the breakthrough was to define the problem as a mixed integer linear programming (MILP) puzzle, a set of constraints and relationships between variables. For each device and network architecture, POET plugs its variables into Patil's hand-crafted MILP program, then finds the optimal solution. "A main challenge is actually formulating that problem in a nice way so that you can input it into a solver," Chen says. "So, you capture all of the realistic system dynamics, like energy, latency, and memory."

Seyed Mohammad Shobeiry was born in 1997 in Tehran, Iran. He received the M. Sc. degree in electrical engineering from Shahid Beheshti University, Tehran, Iran, in 2021. At present, he is an electrical engineering Ph. D. student at Shahid Beheshti University, Tehran, Iran. He is also a research assistant at Electricity Network Research Institute, Shahid Beheshti University, Tehran, Iran. His research interests include power systems operation and dispatching and load forecasting.

PPPC

Publisher: AESA PWUT
Editor: Fatemeh Sharifzadeh
Designer: Seyed Mohammad Shobeiry

THE FUTURE IS HERE



Once a new technology rolls over you, if you're not part of the steamroller, you're part of the road.

— Stewart Brand —