

Deep Learning Methods in the Medical Device Industry: An Overview

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Abstract: We frequently come across a deep learning-based artificial intelligence product or service that has become the center of attention worldwide almost wherever we go. This demonstrates the rapid advancement of deep learning algorithms and the sectors in which they are applied. Face identification, speech recognition, self-driving cars, the military and security industries, and a variety of other fields can all be used as examples. In this study, we conducted a literature evaluation that was separated into classes based on the domains in which deep learning methods are utilized in the medical device business, as well as an examination of the article distribution by year. Healthcare, big data and wearable technologies, biomedical signal, image processing, diagnostics, and Internet of medical things are among the six categories. As a result, deep learning approaches have gained traction in the medical device business in recent years, with the majority of studies focusing on diagnosis and image processing.

Keywords: Deep learning; Medical device; Artificial intelligence; Neural networks; Internet of medical things

Introduction

People's health concerns are developing in tandem with the world's growing population. This issue demonstrates that there is an ever-increasing necessity for medical gadget utilization. Furthermore, persons with Covid-19 have been exposed to viruses and germs that have never been seen in humans before, and the pandemic is predicted to continue. Covid-19 breathing (ventilator) is medical equipment used in the treatment of pandemic devices, and it demonstrates how vital it is to your health in such epidemics.

Medical equipment business is worth 2.6 billion dollars. Imported items account for 85% of this total, while domestically produced medical equipment account for 15%. There is a 1% share of the medical device market (Zli, 2020). In 2018, the global medical device market was valued at 425.5 billion dollars, growing at a rate of 5.4 percent through 2025. Fortune Business Insights estimates that it will be worth billions of dollars in 2019.

Medical equipment is becoming increasingly technologically advanced. Co-treatment is now available for diseases that were previously difficult to treat or conditions that were thought to be impossible to treat. This technical advancement is one of the most crucial aspects of the development of learning applications in medical devices. Deep learning is a type of machine learning that uses a multi-layer neural network topology. It's a type of machine learning that's used for things like categorization and phenotyping novel diseases. It is a promising medical machine branch (Krittanawong et al., 2019).

We focused on medical gadgets that have been released in recent years in our study. Deep learning methods were utilized in the studies, which were examined by breaking them into classes based on the domains they covered. The year-by-year distribution of studies is presented.

Methods

"(Deep learning) and (medical device)" are significant terms in PubMed, the world's biggest medical database. A total of 620 publications were scanned, and the terms were discovered. 2018's biggest jump was achieved with 128 publications. Then, in 2019, 200 publications were created, and in 2020, 155 publications were made. Figure 1 shows the publications. The year-by-year distribution is displayed.

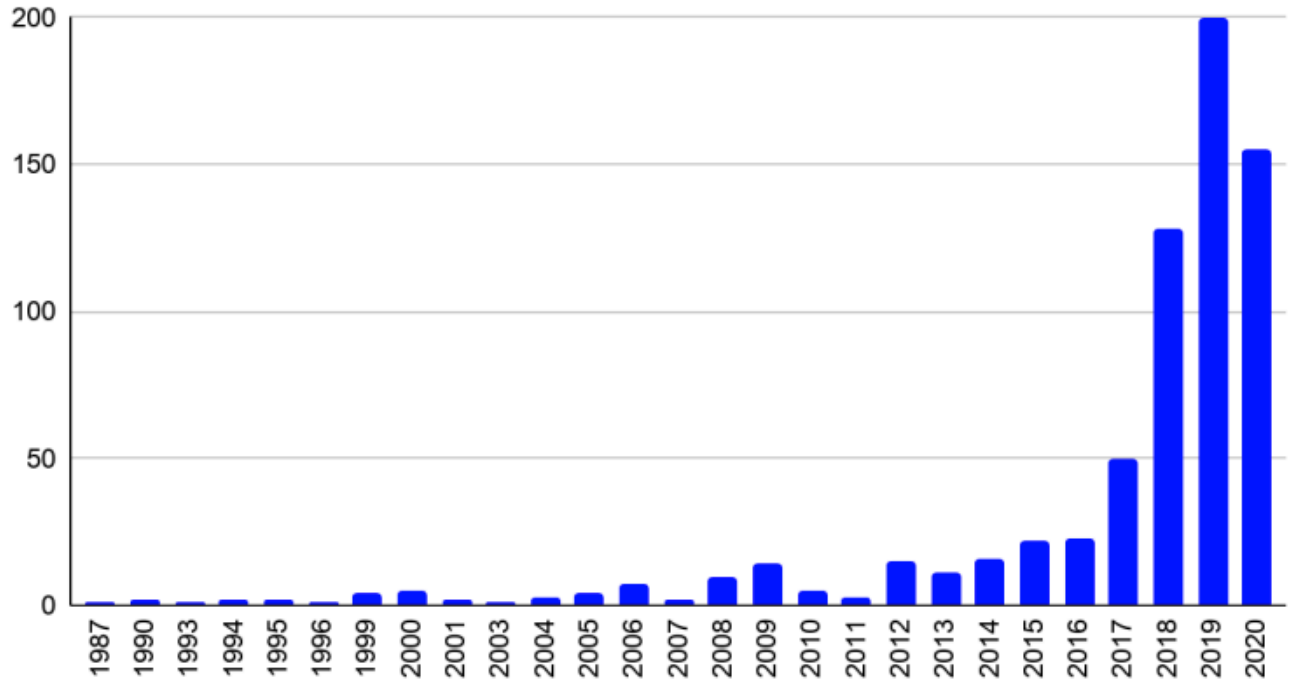


Figure 1: Search result with deep learning and medical device keywords in PubMed

In the same source, we look for the "(deep learning) AND (device)" key. There are 1,396 publications identified while searching with the term. The largest jump may be seen in the graph below as shown in Figure 2. Following that, 417 publications were made in 2019 and 529 publications were published in 2020. As can be observed in both graphs, the number of medical device deep learning applications is growing.

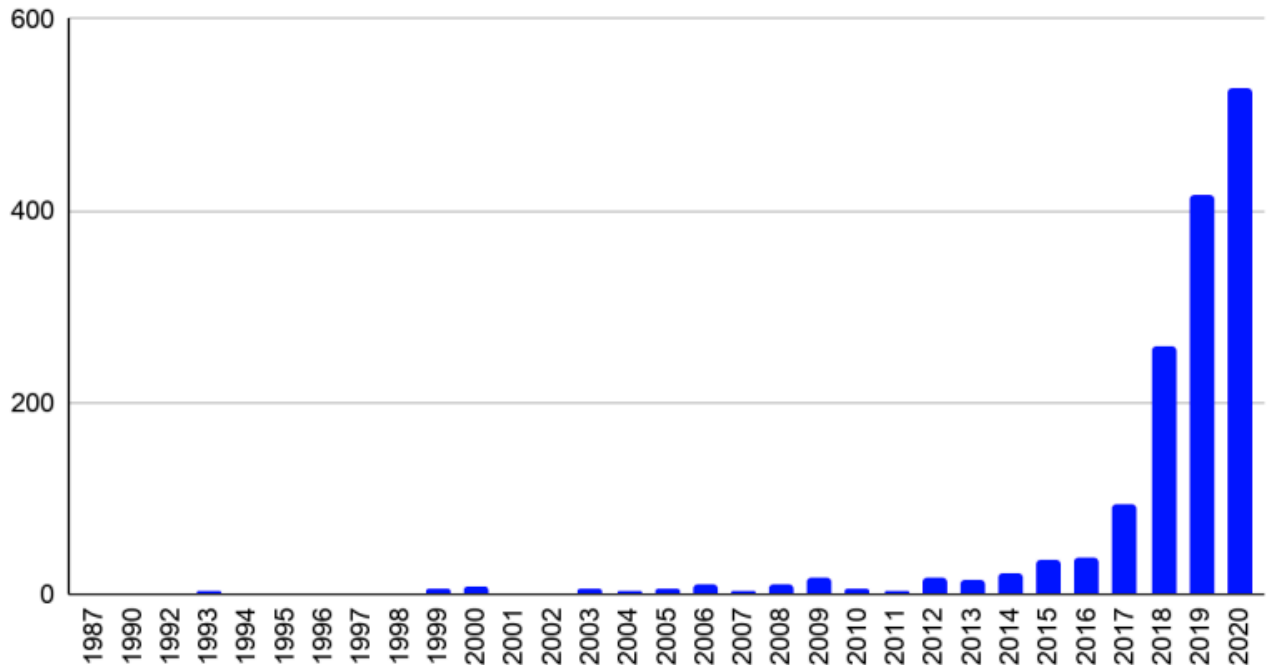


Figure 2: Search result on PubMed with keywords deep learning and device.

Because Pubmed is a worldwide database, comprehensive scans of the database have been performed for each field. As a consequence, in the realm of big data and wearable technology, health services have a 95 percent success rate. 190 articles in the field of biomedical signal, 8 publications in the field of biomedical signal, 282 publications in the processing area, 714 publications in the diagnostic area, and 6 publications in the field of the Internet of medical things. Publications in these fields are many. When all of the information is gathered, 1,295 publications are received.

Conclusion and Recommendations

There are 29 publications that have been discarded based on the content of the detected publications. These articles are grouped and examined based on the major subject. Medical apparatus one of the industries in which deep learning is applied 7. Healthcare-related big data and wearable's 2 on technology, 5 on biological signals, 6 on image processing, 5 on diagnosis and medical treatment. We looked at four publications about the Internet of Things.

Health Service

There are 29 publications that have been discarded based on the content of the detected publications. These articles are grouped and examined based on the major subject. Medical apparatus 7 big data and healthcare services via "Healthcare" PubMed are two domains where deep learning is employed in the market. In terms of the number of publications in scans, it has a share of 7.3 percent. While healthcare resources are limited, smartphone devices are becoming more widely available across the world; therefore improving healthcare learning practices on welfare and the economy has the potential to have a significant impact. TensorFlow, Deng created all MXNet, Mobile AI Compute Engine (MACE), and Paddle-mobile deep learning. The platform's industrial level is investigated (Deng, 2019).

Amota et al. established a deep learning and big data online medical health counseling system in another investigation (Amato et al., 2019). In their evaluation of health machine learning algorithms utilized in services, Ngiam and Khor provided examples (Ngiam and Khor, 2019). Estava and his colleagues investigated deep learning, computer vision, natural language processing, reinforcement learning, and other generic approaches for health services in their work (Esteva et al., 2019). Ali et al. built a healthcare system employing a collective deep learning method and a feature fusion strategy to create an intelligent tool for predicting heart disease. Sensors and electronic medical data were used to create a feature fusion approach to provide useful health data by combining factors. This system has a greater accuracy rate (98.5%) than previous methods (Ali et al., 2020). Others they've done for the human body in health care in research diabetes and abnormally utilized blood pressure parameters are two prevalent and hazardous diseases. This measure, as well as the risk of cardiovascular disease, rises. Ali et al use advanced technologies, data mining, cloud servers, big data, ontologies, and deep learning for chronic patients. A new integrated health monitoring system has been designed (Ali et al., 2021).

Miotto et al. recently released a paper on the deployment of deep learning technology. They compiled the material. Deep learning techniques using massive biomedical data as a tool to contribute to an enhanced human health system were shown to be achievable as a consequence of this work (Mitto et al., 2017).

Big Data and Wearable Technologies

Sensor technology, particularly wearable's, has evolved tremendously in terms of technology and size. Kwon et al. used deep learning analysis to connect PPG data to electrocardiography with a wearable device, without successfully diagnosing fibrillation (Kwon et al., 2020). Haghi et al. looked at wearable health care devices in both scientific journals and commercial activities in another research. Wearable gadgets, thanks to advances in technology, have become far more dependable and long-term instruments for health monitoring systems. It has been accepted.

These are the many health monitoring indicators, vital signs, and fitness levels that are utilised to keep track of the condition. Wearable gadgets are now accessible for a variety of medical monitoring applications. The most crucial need for data collecting is that it be done in a timely manner. The sensor is one of the components. Semiconductors have become increasingly popular in recent years. Sensors are becoming a reality as technology improves. Our study will be able to follow a set of criteria considerably more carefully (Haghi et al., 2017).

Biomedical Signal

The number of research in the medical device business using deep learning is 0.6 percent. This is the case with this field's deep learning. The development of apps has just recently begun. It might be as a result of it. Signals in the human body were evaluated and researched. Craik et al., in their review, task type, EEG preprocessing techniques, input type, and learning architecture were all depth studied (Craik and et al., 2019). Heart rate (HR) and oxygen saturation (SpO2) signals from sleep or waking stages of sleep, which is a specific sort of DNN/RNN in The GRU classification, were employed in another study (Casal et al., 2021).

Alhussein et al. suggested an automated learning-based electroencephalogram (EEG) disease identification system in their study. Brain signals can be influenced by a variety of conditions. As a result, brain impulses collected in the form of EEG waves can reveal whether or not a person is suffering from disease. A convolutional neural network (CNN) was deployed, and a multilayer perceptron-based fusion technique was also examined. The suggested method obtained 87.96 percent accuracy using a deep CNN model and fusion (Alhussein et al., 2019). In an-

other work by Dose et al., an electroencephalogram (EEG)-based Motor Image (MI) Brain-Computer Interface (BCI) Deep Learning (DL) technique was used for the system to enhance rehabilitation procedures (Dose et al., 2018). Other research has used a convolutional neural network (CNN) to analyze EEG data. A Parkinson's disease (PD) automated detection method has been proposed. The slow loss of motor function in the brain is referred to as PH. The abnormalities of (EEG) signals in PD illness brain electroencephalogram are typically regarded for early identification. Twenty PD and twenty normal participants' EEG data were utilized. The use of a thirteen-layer CNN architecture was used. The developed model achieved performance values of 88.25 percent accuracy, 84.71 percent sensitivity, and 91.77 percent specificity. Before clinical usage, an improved categorization model was frequently utilized ready to be used by the general public (Oh et al., 2018).

Image processing

With 21.8% using deep learning methods, It has the second largest broadcast rate. Medical artificial intelligence (AI) in imaging, potentially devastating is a technology. Radiomic, artificial neural networks, machine learning and principles of deep learning and understanding of practices, ethical and regulatory design solutions that meet the requirements, knitting and artificial intelligence that improves results, quality and efficiency provides the basis for building algorithms based on et al., 2019). The most common operation in orthopedic surgery is the rotator cuff muscle rupture, which is one of the causes. In their research, who and what convolutional neural networks were used. They used an algorithm to quantitatively estimate the fossa and muscle area in the supraspinatus fossa to determine the supraspinatus muscle invasion rate (Kim et al., 2019). In another work, Balu et al. employed a deep learning-based analysis-based deep learning algorithm to estimate the deformation of bio prosthetic heart valves (Balu et al., 2019).

Yi et al. set out to determine whether or not arthroplasty was present in single-compartment knees with total knee arthroplasty. To design and evaluate the system's performance, Yi et al. (2020) used deep learning to classify arthroplasty. The hand and wrist were automatically sensing and segmenting pictures as a baseline using a pre-processing engine, fine automatic bone age estimate using a tailored CNN completely automated deep learning system was produced in another study (Lee et al., 2017). Ni and his colleagues used 14 different IVC filters on photos in their research profound understanding. The model was constructed and assessed using CNN classification for identification. As a consequence, deep learning to reliably detect distinct IVC filter types in radiographs was automated, demonstrating the CNN classification model's usefulness (Ni et al., 2020).

Diagnosis

In our work, deep learning is employed to diagnose disease/ailment, and in their investigation, 14,884 heterogeneous three-dimensional optical coherence tomography images were utilized. A vision-threatening array of retinas can be trained once. Obtaining the advise of illness specialists or achieving a performance that exceeded (De Fauw et al., 2018). ResNet architecture based on a deep convolutional neural network (CNN) was used to train and evaluate the computer assisted diagnostic (CAD) system by Ebigo et al. in another study. Barrett's esophagus (IE) disease and early cancer were investigated using two databases. As a result, the accuracy of identifying Barrett's esophageal illness is very high. They were able to get a rough map of the tumor location, and segmentation was shown automatically (Ebigo et al., 2018).

Khonsari and Fourcade "A third eye for doctors": "Deep in medical image analysis learning" "Deep for image recognition learning algorithms might enhance visual diagnosis in medicine, is it?" they ask in their collection of papers. They looked up the question in the current literature and scanned it. CNNs for physicians aren't a perfect answer, but streamlining doctors' everyday chores can help and have a good influence on their practice. Fourcade and Khonsari (2019) found that it would have an impact. With deep learning applications in cardiovascular medicine, Krittanawong and colleagues demonstrated its use in a compilation study on methods of ischemic and structural heart disease imaging, heart failure prediction, and heart rhythm disorder (arrhythmia) detection and phnotyping (Krittanawong et al., 2019). "PAIP 2019: Liver cancer," Kim et al. (2021). More high-quality pathologies would give more accessibility to generate a learning dataset, according to their study titled "difficulty of segmentation."

Medical Internet of Things

Sensor technology is part of the Internet of Things (IoT) movement, but to a lesser extent than others. It also has an impact on medical gadgets. The Internet of Things (IoT) has grown in popularity. The pace of their work is obvious when medical devices become deep learning in the realm of the Internet of Things (IoT). IoT for surgery, Ushimaru and colleagues' work. The surgical procedure may be visualized utilizing it. This would promote surgi-

cal safety through viewing and follow-up analysis, optimal use of surgical instruments, electro cautery appropriate usage, and surgical processes, as proven in standardization studies (Ushimaru et al., 2019). In another work, deep learning algorithms were utilized to encrypt and decode medical pictures (Ding et al., 2020).

Uncertainty in Internet and Big Data Services for Medical Objects Using Intelligence and Deep Learning" Al Turjman et al. take into consideration dynamic uncertainty elements such as presenting data through the cloud in their study on network structure, transmit/receive energy, node load and power, and computation. The price model was explored (Al-Turjman and et al., 2019). The worldwide challenge conceptual radio (CR)-based IoT's medical field-specific and Cognitive Medical Things Its novel application dubbed the Internet (CIoMT) was investigated in another research. As a result, the virus is spread through CIoMT quick diagnosis without spreading, dynamic monitoring and monitoring, and improved monitoring and monitoring. It is a potential therapy and control technique. Swayamsiddha and Mohanty (Swayamsiddha and Mohanty, 2020).

Argument

Deep learning in the medical device business is the subject of this research. The methods have been investigated in publications, and they have been grouped into divisions based on the areas in which they are employed. Deep learning has a high number of publications in the areas, according to the number of publications in the fields. The most popular and least popular sections were selected. The most common deep learning study is diagnosis. It has been the most widely utilized and published in this field. Second, deep learning approaches for image processing are being researched. Object detection, particularly in the realm of radiography, is the focus of these investigations. It's all about object categorization and segmentation. Last but not least, there's the field of the Internet of Medical Things.

When looking at the articles, it is clear that deep learning approaches are gaining popularity in the medical device business. Deep learning looks to be having a disruptive / revolutionary influence in the medical device sector, as it has in many other industries. Deep learning algorithms will be implemented in gadgets as decision assistance rather than a replacement for his vocation. According to the findings, medical equipment are the last to gain internet access, and deep learning technologies are more widespread in this field.

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