Journal of Computing & Biomedical Informatics
ISSN: 2710 - 1606

ICASET
2024

Review Article
Collection: Intelligent Computing of Applied Sciences and Emerging Trends

Systematic Review: Machine Learning and Deep Learning based Prostate Cancer Prediction

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Academic Editor: Salman Qadri **Published:** April 01, 2024

Abstract: The purpose of this study focuses on using various computer models and imaging systems to diagnose prostate cancer, a major cause of cancer-related deaths globally. These models analyze patient samples using tools and advanced algorithms like DL (Deep Learning) to spot tumors and predict critical symptoms using methods such as AH or UNet. AI models like RNN and CNN help predict and detect prostate cancer, reducing risks. By employing SOM (Self-Organizing Maps) based on deep learning, they enhanced accuracy in disease detection, extracting parameters from CT scans for better treatment. Using DL and ML for prediction and classification, they observed improvements in computer-aided diagnosis. Techniques like KNN or SVM, along with multitask learning, helped in therapy reporting and optimizing prostate cancer assessments. AI-based clinical tools and technologies improved patient outcomes, utilizing biopsies and MRI scans for disease detection. The study explores various AI models such as Machine Learning and Deep Learning (like RNN, CNN, KNN, SVM, random forest, logistics regression) for detecting, predicting, diagnosing, and classifying prostate cancer. These models have used publicly available datasets from different websites, demonstrating their high performance in improving the treatment of prostate cancer.

Keywords: Prostate Cancer Prediction; Machine Learning Applications; Deep Learning Techniques; Diagnostic Models; Systematic Review.

1. Introduction

One kind of cancer that arises in the prostate gland, a tiny gland found in males beneath the bladder, is called prostate cancer. Sperm are fed and transported by seminal fluid, which is produced by the prostate gland. Vin its early stages, prostate cancer may not exhibit any noticeable signs and usually progresses slowly. However, if the cancer spreads, it may result in symptoms including erectile dysfunction, blood in the urine, trouble urinating, lower back or pelvic pain, and other urinary symptoms. Although the precise origin of prostate cancer is unknown, a number of risk factors, such as age (since the disease tends to worsen with age), a family history of the condition, race (African American males are more likely to get prostate cancer), and certain lifestyle factors.

A digital rectal exam (DRE), a prostate-specific antigen (PSA) blood test, and imaging tests like ultrasound, MRI, or biopsy are commonly used to identify prostate cancer. Prostate cancer treatment options are contingent upon a number of criteria, including the patient's general health, the tumor's aggressiveness, and the cancer's stage. Treatment options include surgery, radiation therapy, hormone therapy, chemotherapy, active surveillance (monitoring without prompt treatment), or a combination of these. Patients with prostate cancer can greatly improve their prognosis with early detection and therapy.

Estimated cases of prostate cancer in 2023 are 288,300 whereas estimated deaths in 2023 34,700 with the percentage of 5.7% of all cancer deaths. [50]

Figure 1. Chart of people affected by prostate cancer and death rate from 1992-2020

Talking about tools used, MRI scans help assess and suggest better diagnostic methods using AI, improving accuracy. Research indicates that 75% of diagnosed cases receive treatment. Models like RNN and UNet are used alongside frameworks like SHAP to understand and communicate about prostate cancer.

Machine Learning (ML) [50-53] and Deep Learning (DL) specifically study imaging features to create predictive models. Treatments like VMAT, common for prostate cancer patients, use advanced 3D methods for better quality. AI, in conjunction with imaging, helps analyze shapes and sizes using CNN to classify and treat nodules. Evaluating AI's role shows potential for improvement, especially in identifying prostate cancer. Models like SVM and KNN perform well in diagnosing using labeled and unlabeled data. Technologies like ResNetV2 and SVM enhance predicting unseen data. Developing countries are adopting efficient AI tools to identify prostate cancer, shaping future strategies.

DL studies on the Cox model help guide complex patient data. Organizations like the American Cancer Society and European counterparts follow updated cancer guidelines, promising better assessments in the years ahead. Safety in clinical features and computer-based decisions tied to PSA levels are being emphasized. This study aims to detect and classify prostate cancer using AI methods, improving both performance and clinical approaches. It seeks better diagnoses for improved quality of life through accurate studies.

In recent years, deep learning has revolutionized the area of medical imaging by playing a vital role in a variety of activities and applications. Deep learning plays multiple important roles in medical imaging, such as:

Image Classification: Through the use of deep learning models, medical pictures can be put into groups depending on whether they show tumors, certain kinds of pathology, or are normal.

For this purpose, CNN is commonly used as a tool.

Object Detection: Within medical images, Deep-Learning models have the capacity to identify and point out specific structures or anomalies. This means pointing out and defining structure, lesions, and cancer and supporting with examples. Medical imaging often uses methods like single shooters or region-based CNNs to carry out object detection.

Image Reconstruction: Deep learning algorithms are employed for further enhancement and reconstruction of medical images from erroneous or absent information. These involve procedures that may improve the clarity and accuracy of diagnosis, with denoising, super-resolution, and algorithm that can fill gaps in images being among them.

Image Registration: Aligning and registering medical images from several modalities or time points is made easier by deep learning. In order to combine data from several photos for diagnosis, therapy planning, and illness progression tracking, registration is necessary.

Quantitative Analysis: Deep learning makes it possible to quantify features in medical pictures automatically and accurately. Examples of these features include tracking changes over time, evaluating tissue properties, and determining the size or volume of tumors. This facilitates monitoring therapy response and making decisions with objectivity.

2. Literature Review and Background Study

In this study, Prostate cancer detection by AI methods clinically with a CNN model. The performance of these methods against disease measures diagnosis outcomes to operate area with specificity. Predictive modeling accuracy is near to 89% to conduct external purpose datasets. If we talk about expert level in prostate cancer the assessment are accessible with different experiences. In this report researchers also narrate some highlighted predictive models. The quality of evolution in DL models is clinically useful for PCa with time saving effects for crucial diagnosis. [1]

According to the proposed study, DL based model for detection of prostate cancer. The MRI algorithms are scanners used for testing. These architectures are trained to detect positive predicted values. AHNet model are comparing for the detection of the PCa patients. The range of result is 70.9% of positive datasets. [2]

In this article, imaging resonance in AI for diagnosis prostate cancer is being detected. ML and DL in AI provide tools to improve the identification of PCa and theses implementations on computer based decide and interprets the data. Also the researchers use logistic regression (LR) model to assign specific results and also analyze data properties used for imaging system to predict prostate cancer and identify features for desired output. The accuracy of this study is 90% because they combine MRI the imaging system for recognition AI approaches and models for prostate classifications. [3]

The aim of this study predicting some significant of prostate cancer with DL approaches. The study of DL models like RNN with MRI imaging process diagnosis prostate cancer and classifiers their images using independent cohorts. It is necessary to train the models for diagnose PCa. Further researcher eliminate some training models in multicenter for validation. [4]

The proposed study, AI evidence and MR imaging in prostate cancer. The aim is improve accuracy to diagnose prostate cancer. Many male patients in different cities are highly affected but now some recent years many countries control the risk of this disease with affiliated hospitals by using many technologies. In this article, researchers used CNN model. The flowchart of the model to specifying maligned lesion. They assets some images in effected area which are useful for best prediction and clinically resolve. [5]

According to the researchers, they have designed DL models and clinical parameters for long term survival in prostate cancer disease. They aimed some biochemical resources to predict models like MLIPs and perform better. So individually used medical images for patients to achieve better care of prostate cancer patient. The accuracy was 88%. Patient selection, protocols, model construction and some clinical review are performed for better prediction and diagnosis. [6]

The aim of this study subtitle DL and ML models for predict prostate cancer. The vision transformer algorithms for prostate tumors across multiple biopsies and also show pattern of tumor nodule. AH model used in this study and importantly DL algorithms used for prostate tumors are tested clinically for prediction. [7]

The study aim localized prostate cancer for treatments and decision parameters of ML models. Researchers notified the new diagnosed criteria and treatment therapy. Each feature is presented some outcomes for affected decisions. The study shows the decision prediction machine and models like Naïve bayes (NB) for decision and for patient access. It also makes data tables that remain PCa factors to localize the treatment of complex decision. The accuracy of learning model of ML is about 99%. [8]

In this article, the study prediction models that are based on ML for prostate cancer to visualize disease. Researchers basically use some datasets for visual interpretations and with model of ANN. When the disease analyze some patients are with incomplete data points are excluded. Models were train and test some datasets for final outcomes test. The models in these articles are predictive for classification of prostate cancer. [9]

The study is detected and predicts the prostate cancer by ML models. Logistic regression and CT scans are used in this. The sample of patients is design with limited number of data. The models analyzed features of patient diagnosis in various aspects. Researchers ensure that features extraction are finding across different strategies in future. KNN model is used in this article with accuracy of 79%. [10]

Risk factors and methods for prostate cancer features are discussed in this study. The model used is CNN that is most similar model. Researchers perform test stages with imaging techniques and this test indicates the patient surgical therapies. The methods define PCa stages and also guide the management for feature extraction. So it is very suitable to diagnose the disease that screening the cancer detection. [11]

The study shows 3D prediction by DL for the diagnosis of prostate cancer in therapy. The model used in this article is RNN and approached some methods for three dimensional to predict prostate cancer patients. Researchers also compare some models to trained and show the result in different maps for testing patient. [12]

The aim of this study is basically based on diagnosis of prostate cancer by MRI and deep learning radiomics. As it is known that MRI is an imaging processing system which detect the affected area and quickly just add some new DL algorithms that works on tissue to diagnosis prostate cancer and also extract the information of tumors with high radiomics. The model MILPs used in it to provide some significant detect prostate disease with 55% accuracy. [13]

In this study, the significant scanner and DBN model clinically detect prostate cancer. Researchers also use KNN model in machine learning which trained the classifiers and predict features with biopsy. These systems track all lesion impact on men with single time and provide the care academic services to prevent peaceful environment for patient and then detect all clinical parameters for PCa. [14]

This study elaborates some medical images that are based on ML for diagnosis prostate cancer. SVM model is used in this article. In addition, some ML algorithms like MRI for diagnosis PCa were discussed. These algorithms are used to extract some features regions present in prostate and each feature assign to map out the classifiers matrix and also highlight small dataset which often cause poor image quality, but to solve this, used some special methods like GAN that improves the image and rise DL networks that detect prostate cancer. [15]

In this article, this study is about supervised machine learning methods [53-55] for the detection of the prostate cancer. This article also used SVM model and also LR model that performs reports for patient datasets based on accuracy of 83.2% for diagnoses PCa. But, according to our study it shows that the performance of RF model is best as compared to other ML models. This will help to improve the accuracy and provide useful features to detect problem. These studies introduce the high resolution and high detection of prostate cancer as compared to others. [16]

This study shows Deep transfer learning based approaches that predict the prostate cancer. As we know that prostate cancer is a dangerous disease which causes a lot of deaths in men. This research classify CNN that train the datasets in high quality also and this architecture use images slides for identifying the prostate cancer tumors or tissues for best accuracy and improve efficiency. [17]

The aim of this study is using deep learning algorithms with MRI that classifies the prostate cancer. The author proposed the model MILPs for diagnosis PCa and imaging system that classify them. The study shows the pre-processing approaches that separate images and then feature extraction that optimized the training datasets and then PCa detection. And for the classification of prostate cancer they have also use SVM method to improve classification process. The accuracy of this model is 91.32%. [18]

This study shows ML and DL models for diagnosis prostate cancer using medical images. The model gives accurate and efficient significance for system detection in prostate cancer and these services some clinical decisions. RNN and KNN is the best model for decision making and accurate efficiency. They have accomplish some datasets that build complex features for complex tumor issues in PCa. So deep and machine learning are real impact of prostate cancer that diagnosis disease and also show some treatments workflows and clinically healthcare system. [19]

The use of AI for prostate cancer is the purpose of this study. The screening diagnosis and imaging for prostate and collect some information for low or high risk to detect disease. Accuracy will be notifies about 76%. The challenging tasks of AI are increased and attempts overcome sensitive cancerous diseases. The use of naive byes (NB) model is localizing clinical diagnosis and detecting prostate. [20]

In this article, the study shows the treatment therapy for prostate cancer patients and their benefits. We need some rapid and accurate techniques for critical situations. The model used is RNN and also uses some imaging system. The VMIT therapy for better diagnosis and reduce spreading risks. The beneficial part is these guidelines for the PCa detection are increased with aging modern. So they study different algorithms and provide the best accuracy 88% for prognosis prostate cancer. [21]

The aim of this study, some machine learning models and some external metastasis for the prediction of prostate cancer. The risk of cancer is increasingly spread all over the world so here it allows some surgeons that perform best for patients. The model also predicts that risk by machine learning model KNN, CNN that also avoid some side effects. [22]

The study indicates some highly predictive models radiomics for prostate cancer. The model include like MILPs that are trained for the prediction. They also used some radiomics models like CNN which perform multiple tasks for training against PCa disease. This will improve the patients' healthcare and helps clinicians for better diagnosis. [23]

This study used some advanced level of imaging process of prostate cancer. The criteria show some frameworks that are used to response high reports about PCa detection. The frameworks also measures and detect tumors to enhance some risky criteria. RNN are used in this study and provide accuracy of 77% with best performance. Researchers also fix some threshold problems in this article which can cause sometimes damage routine and low performance. [24]

The paper discussed medical therapies with DL models for high-risky prostate cancer. The therapy like pathologies improve surgical outcome in which patients are in high risk disease. Models are DBNs is required for several results and follow-up treatment efficacy. The multicenter prospective is groups that treat small number of patients in PCa. These are non-high-risk categories identify the test records of patients and detect. [25]

In this study the role of ML features for localized prostate cancer. The body images and clinical features are predicted for recur and assists accuracy. The study shows model training to indicate resources for patient survival. The researchers' preferred SVM and CNN for this assessment which is effected for long-term treatment. Prostate cancer patients are offering by medical healthcare's in the field of computer aided detection. [26]

In this study, the new eras of AI and ML techniques that perform pattern algorithms and imaging for complex tasks. Computer based decisions on ML the AH are assigned to improve diagnosis accuracy and shows 99% results. These clinical treatments are helpful for the management of the prostate cancer. The CT scans used to perform low-level imaging for different tasks and their prediction in prostate detection. [27]

This study shows the role of MRI for detect the prostate gland tissues. The finding tumors are targeted and identifies with diagnosis tool for prostate cancer patients. The computer vision technologies are using AI for large image datasets and they also improve clinical workflows. These techniques with different models ANN and SVM improve quality of images and features of PCa detection. [28]

The aim of this study is classify some deep learning structure for prostate cancer that are challenging tasks and have high dependencies. Researchers compared some DL architectures that are model trained RNN, LR by using method called transfer vision with 91% accuracy. This study also classifies features extraction and models tools to provide and improves decision. [29]

The proposed article about computer aided prostate cancer diagnosis system. Researchers provide a method and detail approaches of CAD that identify the PCa they also introduced some fuzzy models like CNN, SVM, and KNN. The software tools are used to extract some medical images for prostate cancer. The accuracy is 99.9%. They also developed algorithms for prostate tumor detection by MRI and enhance some results for diagnosis. They select some biopsy that is helpful for opinion in replace of doctors. [30]

The study integrates two different Models like Artificial Intelligence and Machine Learning. The authors used Random Forest (RF) model and SHAP as a framework. Designing drugs for prostate cancer is challenging and costly. The data for machine learning is collected from the CHEMBL database. This model achieved an accuracy of 89.9%. There are Limited diagnosis models for prostate cancer. The dataset use for training is from Cancer Genome Atlas (TCGA) and for validation is from Memorial Sloan Kettering Cancer Center (MSKCC) and GSE70769. [31]

In this Study researchers used 3D U-net which is a type of Convolutional Neural Network (CNN) use to designed image segmentation tasks in computer vision. Researchers need advanced tech, like SAM-UNETR, to make the process better and faster for detecting prostate cancer. And in many cases the availability of advanced tech is not possible. In this study 158 patients are analyzed as a dataset. They also used U-net Architecture which is a type of Convolutional Neural Network (CNN) that use to 2D tumor segmentation from the PET images. The CNNs are trained and tested multiple times by using a data set. [32]

The aim of this study is Artificial Neural Networks (ANNs) which is used to identify ATP5J and ALDH1A2 combination in RNA-sequencing data as a potential diagnostic biomarker in prostate cancer. But more research and validation are needed. The data sets are obtained from the GEO database. We need more tests to check if the acetylation-related gene signature works for different prostate cancers in real medical situations. [33]

In this article, they used Random Forest (RF) and developed a new combination of textural and clinical features to improve the diagnosis of the prostate cancer. The main problem with it is reliability problem which is needed to be solving as soon as possible. This model achieved an accuracy of 83.5%. Random Forest Algorithm of machine learning model and multipara metric MRI and radiomics to detect prostate cancer. The study found a computer model that can predict serious prostate cancer well, using four MRI features. The model requires more real-world testing and validation to ensure its reliability. [34]

The aim of this study in which it used R-CNN and Inception-v3 and develop the model helps with common problems in ultrasound images, like noise and a weak signal, making them better. The data set based on random 1200 images from the data of prostate ultrasound images. The accuracy rate of this framework is 81%. The model used is Logistic Regression, K-Nearest Neighbors (KNN), Cat Boost, Extreme Gradient Boosting (Boost) for clinical trials for prostate cancer. Challenges may arise in applying these models and further refinement is needed. [35]

In this study the authors conducted A Narrative Review of The Use of Artificial Intelligence in Prostate Cancer. In this article they used dataset of 409 prostate cancer patients. The Study Found That AI Has the Potential to Improve the Accuracy of Cancer Diagnosis and Treatment using Radiomics, CNN and DCNN models. [36]

In this study, A Machine Learning Model for Prostate Cancer Detection and Analysis models are LG, Decision tree, Random Forest ,SVM and CNN. In this article the use dataset of 200 prostate cancer patient. The Model Used Advanced Machine Learning Techniques. In prostate cancer 98 patients are used in data set. The Study Found That Healthcare Professionals Believe on AI Can Improve Cancer Care by Providing More Accurate Diagnoses and Make Treatment Plans. The Accuracy rate of this study is 95%. [37]

In this study researchers developed A Machine Learning Model for Transitional Zone Prostate Cancer Detection and models are LG, SVM, and Random Forest. In this article used dataset of 361 prostate cancer patients. The Model Used Texture-Based Machine Learning and Image- Based Deep Learning. The Accuracy rate of this study is 89%. [38]

In this study using Boost developed A Machine Learning-Based Prediction Model for Prostate Cancer. In this article they used dataset of 823 patience of BCP and 1092 patience of PCa. The article uses a dataset of 100 prostate cancer patients, models used are ML model CNN and a deep learning algorithm. [39]

Developed an 18-Gene Algorithm Urine Test for Predicting Prostate Cancer. This article uses a dataset of 505 prostate cancer patients. The Study Used Random Forest Machine Learning Algorithm Screening to Develop. This article use a dataset of prostate cancer cells shows effective classification performance They Accuracy of this model was 82.5%. [40]

In this study, they used multiple ML and DL models like CNN, KNN, and UNet for detecting the prostate cancer and classify it stages. They used the dataset from a public repository on Kaggle. This study presents a deep learning-based artificial intelligence model for prostate cancer detection at parametric MRI. The model uses a convolutional neural network to extract features from the MRI images. The article shows potential of applying artificial intelligence to prostate cancer diagnosis. [41]

This study applies integrated machine learning to identify cell marker genes in prostate cancer. The article uses a multi-omits dataset of 1,000 prostate cancer patients and a random forest algorithm with Cox Boost. This model achieved an accuracy of 91.1%. The article suggests that these genes could be used as biomarkers for prostate cancer. [42]

This study detects the prostate cancer prognosis using CNN and artificial neural network. The article uses a dataset of 1,500 prostate cancer patients and CNN, artificial neural network. The model achieves an accuracy of 86.7% showing the power of the proposed method. [43]

This study uses machine learning and radiomics in predicting prostate cancer. The article uses a dataset of 200 prostate cancer patients and a support vector machine to classify the patients. The article shows that the machine learning and radiomics. [44]

This study applies an extreme gradient boosting machine learning algorithm to identify genome-wide relevant in prostate cancer risk prediction. The article uses a dataset of 2,000 prostate cancer cases prostate cancer and Logistic regression, Boost Model. The model achieves an accuracy of 89.2%. [45]

This study uses tumor infiltrating lymphocytes (TILs) prostate cancer. The article uses a dataset of 100 prostate cancer patients, ML model CNN and a deep learning algorithm to segment TILs. The model has an accuracy of 81.3%. [46]

This study classifies the prostate MRI into clinical-genomic risk groups of prostate cancer. The article uses a dataset of 300 prostate cancer patients and a logistic regression model. The model achieves an accuracy of 87.3%. [47]

This study analyzes the metabolomics of prostate cancer Gleason score in tumor tissue and serum. The article uses a dataset of 100 prostate cancer patients and ML models like Logistic regression, Support vector classifiers (SVC) and Random Forest. The article finds that the tumor tissue and serum metabolomics profiles are distinct and reflect the aggressiveness of prostate cancer. [48]

This study predicts the grade of prostate cancer based on a parametric MRI radiomics. The article uses a dataset of 150 prostate cancer patients, support vector machine and a random forest algorithm. The model achieves an accuracy of 90.7%. The study says that the parametric MRI radiomics can be used as prostate cancer grading. [49]

Table 1. Systematic Literature Review Table

Author Name	Year	Models	Accuracy	Goals	Findings
Michael yeung	2023	CNN	89%	ML and DL significant methods for PCa	Disruptive potential for PCa diagnosis.
Bradford Wood	2022	AHNet, UNet	70.9%	False positive predictive scenario	Utilize tools for radiologist
Arkadiusz Miernik	2022	LR, Naïve byes	90%	AI for PCa detection	Classification and identification PCa.
Yueyue Zhang	2023	RNN	87%	DL models and multicenter data	Data usage and images of patient
Marc. Kohli	2023	CNN, ANN	98%	AI tools and detection by models	MRI imaging and localization of PCa
Claire de la Calle	2023	MILPs	45.85%	Diagnose tumor by DL algorithms	Predictive therapy and PCA prognosis.
Matthew.Cooperberg	2023	AH, LR	88%	Treatment of localized prostate cancer	AUC multi classes and databases
Gang Chen	2023	Naïve byes	68%	ML techniques PCa detection	Clinical database for prostate cancer

Hey won Lee	2023	ANN	89%	Retrospective design value	AI hub and ICT foundation
Bruno beomonte zobel	2023	KNN,SVM	99%	Clinical improve models for patient	DS resources and data curation
Ferdinand Pereira	2023	CNN, DT	92.45%	PSA test for diagnosis PCa	Acknowledgment of effectiveness
Hideki Takegawa	2023	RNN, UNet	60%	3D and DL based methods for patients	JSPS KAKENHI supported work
Yang Zhang	2023	MILPs	55%	MRI protocol and DCE	AUC radiomics and kinetic information
H Huisman	2022	KNN	77.1%	AC setting and PCa lesion	Performance of AI for PCa detection images
Yuke Wu	2023	SVM, ANN	89%	Alignment of prostate cancer images	Poor image quality and GAN network
Maryam Maleki	2023	SVM, RF	83.2%	Biopsy side effects in PCa diagnosis	High frequency, ultrasound images
Prabu Kanna	2023	CNN, ResNet	78%	DL classifiers diagnosis methods	CNN architectures and training datasets
Faris kateb	2023	MILPs, SVM	91.32%	PCa detection and classification of MRI	Ensemblance of diffusion model
Manuel Mazzara	2023	RNN, KNN	92%	Complex nature risk PCa disease	Risk of overfitting

Arnav Rashid	2023	Naïve byes	76%	Screening PCa detection	DCNN algorithms false positivity
Tsuyoshi Suga	2023	RNN	88%	Prognostic factors in PCa therapy	Predictive factors and targeted agent
Ali Sabbagh	2023	KNN, CNN	96.55%	Risk of complicated procedures in PCa	Threshold, optimal risk
Sarah Alessi	2023	CNN, MILPs	98%	ML against regular training datasets	GBTDs target across multitasks.
Steven P. Rowe MD	2023	RNN	77%	Frameworks to integrate tumors	RECIP and thresholding
Takuya koie	2023	DBNS	35.23%	UFT in patient with high risk PCa	Non-high risk and efficiency of diagnosis.
Chia-Hung Kao	2023	SVM, CNN	79%	Racial groups for finding PCa prediction	Survival outcomes, treatment of PCa
G. Muhiuddin	2022	ML, AH	99%	Algorithms for PCa detection	CDA system and earlier diagnosis
Romain Matheiu	2023	ANN, SVM	93.87%	DL methodologies in prostate cancer	Cancer detection and Gleason grading
Bernhard Breil	2022	LR, RNN	91%	MRI and identifying PCa	Detection of PCa to avoid biopsies
Candice Jia Xin	2023	CNN, SVM, KNN	99.9%	MRI analysis with ML for prostate	Enhance the TW2 images results.

				cancer	
Ishfaq et al.	2023	Random forest, LASSO-COX	89%	Designing for PCa challenging & cost	Advancing drug discovery PCa
Alzate-Grisales et al	2023	UNet	77%	Process better and faster for prostate	By designing makes better.
Sokhangouy et al.	2023	ANNs	92%	More research validation needed	Showing substantiality
Patel at Al	2023	CNN, KNN, SVM, LF, RF	99%	Using ML algorithms	Logistic accuracy of PCa treatment
Hesso Et Al	2023	KNN, LR	81%	Common prb in ultrasound images	Refinement is needed
Lee at AI	2023	CNN, DCNN	89%	Texture-based machine learning	Emulative elusive transition
Chen AT AI	2023	CNN, SVM, Random forest	95%	Early detection of aggressive	Predict the risk of PCa
Gua AT AI	2023	LG, SVM	89%	Risk group classification MRI	Identification with low decipherer
Mehralivand	2022	CNN	94%	Biparameters in MRI for PCa	AI model diagnosis prostate
Yu, J. at Al	2023	RF, KNN, LR	82.5%	Prostate cancer detection by SVM	Effective perform classification

Chia, D	2022	CNN, UNet, KNN	91.4%	Use ML and DL models detection	Segmentation, cancer detection
Huang, J	2023	Random forest COX Boost	91.1%	Epithetical cell marker genes	ML approaches for identification
Wang, Y. D	2023	Logistic regression	86.7%	Locally advanced prostate cancer	Potential ML radiomics for PCa
Osamor, V	2023	Logistic regression	89.72%	XG Boost genome-wide	ML models algorithm for PCa
Sheen C	2023	Random forest , LR	81.3%	Detection of tumors TILs	Prove ML model using CNN
Zavala-Romero	2023	Random forest SVC	87.3%	Risk groups classification MRI	Low NCCN risk
Rosenthal, J	2021	Logistic regression, SVC	82%	Gleason scores in tumor tissue	Tools for diagnosis PCa
Tang, M	2021	SVM, RF, LR	90.7%	Predicting PCa Biparameters MRI	BPMRI radiomics for prediction

2.1. Comparative Analysis

Many of the papers on deep learning and machine learning methods in prostate cancer detection reflect positive findings from their study. From the analysis of the mentioned studies, it is clearly evidenced that machine learning and deep learning algorithms have achieved a high level of accuracy in the correct identification of prostate cancer using medical imaging data. A number of applications of these algorithms outrank the traditional techniques on account of their higher sensitivity, specificity, and diagnostic accuracy.

To be specific, convolutional neural networks, which are deep learning models, have demonstrated to be highly efficient in tasks like segmentation, object detection, image reconstruction, and image classification in relation to prostate cancer diagnosis. The ones have been shown to be able to locate and detect these anomalies, for example, cancers and lesions, in prostate imaging data. However, deep learning-based techniques have simplified the process of measuring and characterizing prostate cancer features, thus, leading to effective treatment planning and monitoring.

The capacity of deep learning and machine learning skill in successfully identify prostate cancer gives insight into the future of healthcare whereby such evaluations of imaging data can be quicker, more precise, and unbiased. These intelligent surgical tools allow healthcare providers to refine treatment decisions, diagnose early, and increase favorable results in androgen-dependent prostate cancer patients. To ensure the neutrality of the algorithms and to handle the issues regarding the explainability, generalizability, and regulatory compliance, more investigation plus incorporation into clinical practices are needed. As a whole, the results surveyed in these articles suggest that deep learning and machine learning can play a significant role in the history of prostate cancer detection and treatment.

2.2. Limitations

Especially, most operations such as medical imaging interpretation, genetic data annotation, and clinical decision support have proved to the effectiveness for the detection of prostate cancer via machine learning and deep learning approaches. Notwithstanding this, however, such models are still associated with particular imperfections.

The caliber and volume of training data greatly influences how well machine learning models function. Obtaining high-quality data, particularly labeled data (such histopathology photos or medical records), can be difficult when it comes to the identification of prostate cancer because of problems like data imbalance, inaccurate labeling, and inter-observer variability.

Biases present in the training data, such as demographic biases or biases introduced during data collection processes, can lead to biased predictions by the model. This can result in inaccurate or unfair predictions, particularly for underrepresented groups.

Deep learning models, especially deep neural networks, are often considered as "black boxes" due to their complex architectures and large numbers of parameters. The main principle of model explanations is the trust of health professionals and patients by observing the logic underlying the model's predictions, especially when a model is used to opt for a sequel in critical medical cases like cancer detection. Non-transparency issue of the models might get in the way of their integration into clinical routines.

A model can be very good in training data, but it may not work well when new data is tested, especially the data from groups that are different or from the environments it has not been trained on. Because of the fact that demographics of patients, characteristics of diseases, and the type of imaging could be different for one data source than another, the models made by using the data of a specific institution or cohorts of patients might have a worse performance when such models are applied to data from the other sources.

Machine learning models generally times come up with point forecasts, but the doubt surrounding such predictions is seldom measured in quantitative terms. To enable clinical decision-making and to determine the reliability of output strength of the model in medical solutions such as detection and staging of cancers uncertainty assessment of the model's predictions is an utmost necessity.

A lot of ethical and legal issues, among others patient privacy, informed consent and responsibility of human actors in case of model failure or error, are raised by the use of the machine learning and algorithms in practice medicine.

It is crucial to be in alignment with the laws and regulations including the GDPR (Data protection Act) and HIPAA (Accountability and Portability Act).

To advance the diagnostic machine learning for prostate cancer which will be reliable and with the highest clinical standards, researchers must be supported by the healthcare practitioners, ethicists and public policymakers in tackling these difficult issues.

3. Conclusion and Future Work

3.1. Conclusion

In conclusion, AI and machine learning techniques are reshaping prostate cancer care worldwide. They improve diagnosis accuracy, reduce unnecessary biopsies, and predict cancer risks effectively. These advanced methods, incorporating AI and deep learning, enhance treatment strategies and improve survival predictions.

Cutting-edge technologies like VMAT use AI for detailed analysis of medical images, while fusion and pre-trained models improve cancer detection accuracy by reducing data needs. Decision-making systems are evolving for better treatment selection, and traditional images aid long-term disease trials.

Overall, these studies emphasize AI's promising role, showcasing models with accuracy rates ranging from 76% to 99%. They highlight AI's potential to revolutionize cancer care by enhancing precision and efficiency in detecting and managing prostate cancer during the fourth industrial revolution.

Furthermore, as some models predicted the good accuracy so it is also possible that the report generation with the algorithms of Natural language processing according to the medical reports.

3.2. Future work

In the future, a number of machine learning and deep learning techniques might develop the detection of prostate cancer and report generation. Here are some motivating techniques:

Multimodal Data Fusion technique can provide a more comprehensive picture for the diagnosis of prostate cancer by combining information from multiple sources, such as genetics, clinical data, and medical images (such as MRIs and ultrasounds). Combining data from many modalities utilizing fusion techniques, like early and late fusion procedures, can improve the performance of predictive models.

The process of adapting knowledge gained from one task or domain to another that is similar is known as transfer learning. For the purpose of detecting prostate cancer, pre-trained deep learning models—such as transformer-based or convolutional neural networks (CNNs)—that were trained on extensive datasets can be improved upon using smaller, task-specific datasets. Transfer learning can enhance model generalization and lessen the requirement for substantial volumes of labeled data.

Attention processes enable models to ignore unimportant information and concentrate on pertinent portions of the input data. Attention mechanisms can be used in medical imaging tasks to identify regions of interest in pictures, which can help identify anomalies linked to prostate cancer. In a variety of medical imaging applications, models like transformer structures with self-attention processes have demonstrated potential.

Based on the results of histology or medical imaging, structured reports for radiology or pathology can be automatically generated using natural language processing (NLP) techniques. NLP algorithms can produce clear, accurate summaries by extracting pertinent information from medical pictures or textual reports. This helps radiologists and pathologists make decisions and document their findings.

Future improvements in prostate cancer detection and report creation have the potential to enhance diagnostic accuracy, efficiency, and patient outcomes in clinical practice by utilizing these cutting-edge machine learning and deep learning techniques. To achieve these breakthroughs, computer scientists, physicians, and other healthcare stakeholders must continue their research, validate their findings, and work together.

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