Indian J Microbiol (Apr–June 2018) 58(2):252–255
https://doi.org/10.1007/s12088-018-0708-2

OPINION ARTICLE

Integrated Artificial Intelligence Approaches for Disease Diagnostics

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Received: 28 November 2017 / Accepted: 6 January 2018 / Published online: 6 February 2018

Abstract Mechanocomputational techniques in conjunction with artificial intelligence (AI) are revolutionizing the interpretations of the crucial information from the medical data and converting it into optimized and organized information for diagnostics. It is possible due to valuable perfection in artificial intelligence, computer aided diagnostics, virtual assistant, robotic surgery, augmented reality and genome editing (based on AI) technologies. Such techniques are serving as the products for diagnosing emerging microbial or non microbial diseases. This article represents a combinatory approach of using such approaches and providing therapeutic solutions towards utilizing these techniques in disease diagnostics.

Keywords Artificial intelligence · Computer aided diagnostics · Mechanobiology · Robotic surgery

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Introduction

Computational and artificial intelligence (AI) based tools are proven to assist medical professionals to understand the disease by comparing the different cases of a disease in a single platform. Such tools are helpful in detecting and diagnosing the disease at early stages of development; arrive at the solutions of complex problems in an easy, precise and faster way and overall accurate analysis to know the futuristic style of the specific disease. This finally enables healthcare professionals to opt for surgical or diagnostic options in an accurate manner by using time and motion study. These computational tools also help in optimizing the parameters by which a root cause of a disease can be cognized. On the nanoscale, genes formulates the DNA, which corresponds as the building block of the body and responsible for hereditical transfer of characteristics from one generation to the other. Thus, any impurity in the genome transfers disease from one generation to the other. But with the help of recently evolving technique like targeted geneome editing via CRISPR-Cas9 tool the above can be prevented [1]. Also dysfunction in the metabolism due to internal or external factors causes the propagation of diseases that causes disturbance among the chemical, mechanical and electrical forces. Moreover, mechanobiology, which considers the interaction of these forces at micro and nano level by estimating physical properties of cellular components, enables us to cure diseases at their initial level of prominence [2]. The data obtained from all sources of detection of diseases can be commuted into the interoperable rapports by using indispensable computational techniques in the form of machine learning, artificial intelligence, bioinformatics and optimization algorithms.

Neurological disorders like Alzheimer's, Parkinson's, and epilepsy are very difficult to treat and almost 7 million people die annually due to them. Diagnose of these diseases can be performed by generating data in the form of scans like, computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), electroencephalography (EEG), electromyography (EMG), arteriogram and single photon emission computed tomography (SPECT). Treatment via such complex data requires expertise, resources and time, but the introduction of computer aided diagnostics (CAD), in which deep learning algorithms are used to aid the medical practitioner, makes the job more comfortable. Interpretation of this medical big data (MBD) is performed via a chain process in which initial data in the form of the image is preprocessed, registered and segmented, for segmentation computational tools like mevislab is used, then features are extracted from the image to train the classifiers like support vector machines (SVM), k-means algorithm, neural networks (NN) etc. followed by testing and validation [3]. As feature extraction is itself a very complex phenomenon for these types of images, therefore pre-trained convolutional neural networks and deep learning platforms like alexnet, googlenet are used to make the process fast and less tedious. Also the detection of cancerous nodules in the modalities of breast and lung via ultrasound, detection of glaucoma in the retina and classification of infected and non infected blood smears are processed in the same way via digital image processing as in neurological disorders. For the chronic diseases like atherosclerosis, diabetes, and hypertension in which effective monitoring of the patient is required, tools like vitual assistant (VA) and point of care (POC) are used for diagnosing along with the biosensors and biomarkers [4]. Mechanobiology has contributed significantly in the development of these biosensors and POC diagnostics in which, biophysical characteristics and dynamics of the cells are looked after, which includes, alteration in their shape, size and stiffness upon interaction with the external stimulus (that could be a physical force or micro level bacteria in the context of various diseases), micro electro mechanical systems (MEMS) uses the concept of force spectroscopy in which the analyte upon binding with the cantilever either produces the deflection or mediate resonant frequency that confirms its presence [5]. Moreover, from the microbiological points of view, there are very few diagnostic approaches which are reported by various authors. These reports show that AI based techniques can also be applied in case of bacterial and viral diseases. The brief description of these techniques is reported in Table 1 [6–11].

Mass spectrometry data of protein profiles are used for detection of cancer via neural networks in which patient with and without diseases are distinguished on the basis of serum proteomic pattern. Surface enhanced laser desorption and ionization (SELDI) of protein mixture in mass spectrometry is used for profile pattern generation [12]. This spectrometry data can be made into a tabulated form, which is preprocessed in the diverse statistical tools (design expert) through response surface methodology that can be clustered using ANN and SVM in order to be easily optimized for effective analysis by using optimization methods such as genetic algorithm, particle swarm optimization and hybrid optimization (GA-RSM, GA-ANN) [13–15].

As genomics has revealed that cancer differs from one patient-to-patient therefore orthodox cancer diagnosis fit poorly with genomic reality. Identification of drugs for individual cases can be a very complex task; hence precision medicine will be the better way to solve the purpose of drug development via 3-d printing for a particular, instead of manufacturing it for the masses [16, 17]. In the near future, it is plausible that printing of vital organs can be done to change the shape of medicine and drug delivery. Another AI tool for diagnostics is robotic surgery supported by augmented reality in which data are obtained via finite element analysis by generating a mesh for soft tissues like brain followed by training an optimized NN and SVM classifier to predict the deformations in order to train a robot to perform the complex surgical operations in which typical hand–eye–coordination and a vast surgical experience is required [18]. There are some interesting reports on quorum sensing, biomarkers discovery and rapid identification of pathogens that are quite beneficial to evolve a multidisciplinary strategy for applying artificial intelligence approach in these areas [19–21].

The traditional approaches for disease detection were very time consuming and costly as these require highly

Table 1 Application of AI based approaches in prominent diseases

S. No.	Name of disease	AI approaches	References
1.	Rotavirus	Image processing	[6]
2.	Swine flu	POC	[7]
3.	Optimal drugs and doses for HIV	Big data interpretation	[8]
4.	Zika virus	Fog computing	[9]
5.	Tuberculosis	POC	[10]
6.	Hepatitis b	ANN	[11]

POC Point of care; *ANN* Artificial Neural Network expert professionals, continuous monitoring and observations. Moreover, disease detection at early stages was very tedious and almost impossible with these approaches. Now, the existing techniques developed using advanced computational tools made possible to detect the disease smartly in early stages of development that is shown in Fig. 1. These

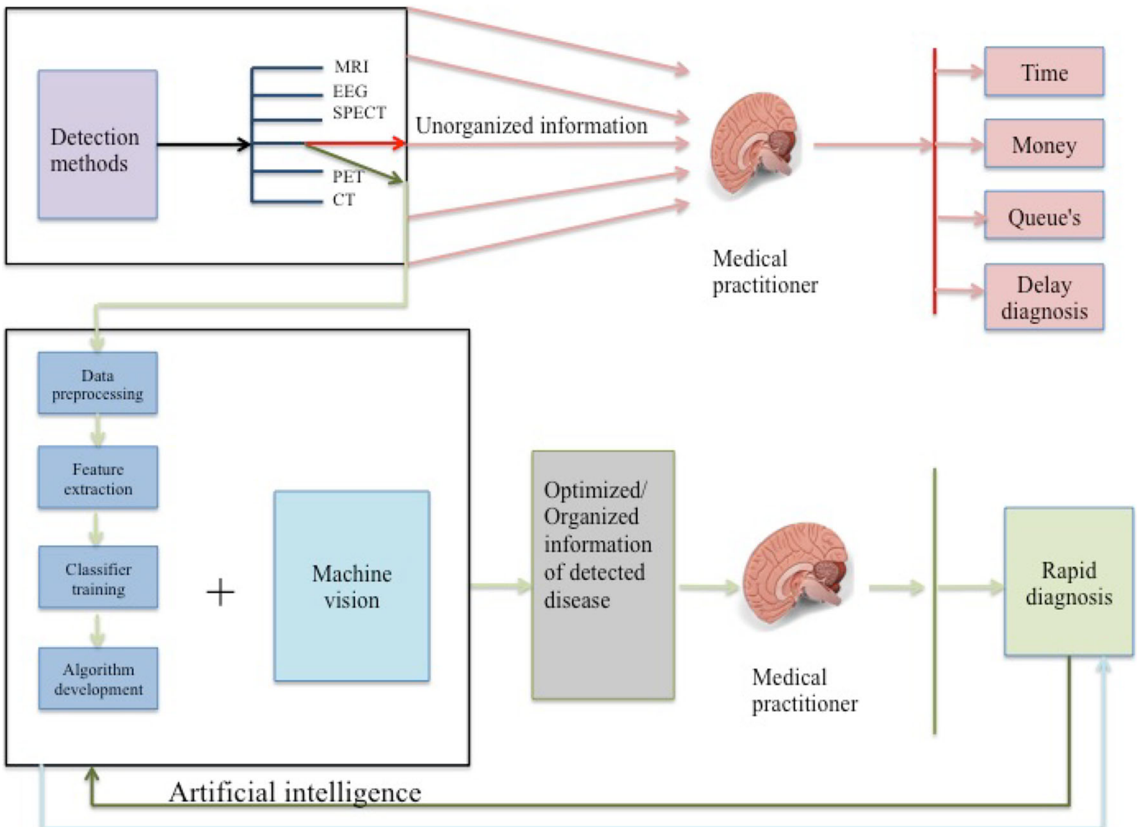

Fig. 1 A scaffold of comparative overview of computational tools in disease diagnostics. *CT* Computerized tomography CT, *MRI* magnetic resonance imaging, *PET* positron emission tomography, *EEG* electroencephalography, *EMG* electromyography, *SPECT* single photon emission computed tomography

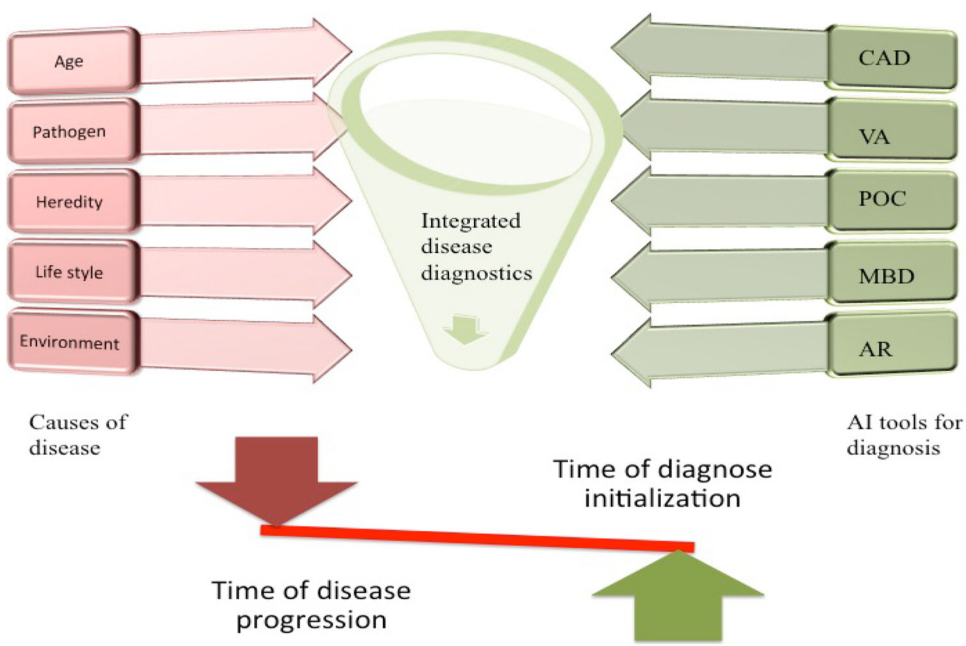

Fig. 2 An overview of integrated artificial intelligence tools, *CAD* Computer aided diagnostics, *VA* virtual assistant, *RS* robotic surgery, *AR* augmented reality, *GE* genome editing, *POC* Point of Care, *MBD* Medical big data

techniques have utilized various image processing methods followed by computer vision algorithms. Segmentation of images, extraction of features, classification and identification of diseases has been efficiently done by using these machines-learning practices. After detection of diseases at early stages, these computational tools has also been assisting in precise diagnostics of disease like virtual assistance, robotic surgery, POC etc. to enhance the time of diagnostics as shown in Fig. 2.

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