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Deep Learning Based Multimodal Ensemble Classification of Breast Cancer as A Prognosis

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ABSTRACT: Suspicious or doubtful women may visit the hospital for doing a prognosis check for cancer. Normally patients would be subjected to take X-ray for any physical pain, which may lead to generation of cancer cells or tumor. In existing system, a machine learning algorithm is proposed for the prediction of the breast lesion using microwave signals. This model performs well on the training data but fails to generalize effectively to new, unseen data and it may not capture complex relationships in the data as effectively as more sophisticated models. Hence we propose to use Ultrasound for screening the problem, which would avoid formation of cancer cells due to Xray exposure. Captured ultrasound images were given to the preprocessing unit of convolutional neural network layer. This layer operates by applying convolutional filters to input data, systematically scanning through the data to extract features and detect patterns such as edges, textures, or more complex structures within the input. Preprocessing unit has Bidirectional Long Short Term Memory Network algorithm. This algorithm is one of the Deep Learning Technique. It is employed to process sequential data, particularly the histopathological images. Its ability to capture temporal dependencies makes it well-suited for this task. Using this technique, feature extraction will be obtained at a faster rate than the existing algorithms. The extracted feature will be sent to the Microcontroller through UART because it transfer the data quickly. The microcontroller will predict the presence of tumor or not and the same will be indicated to the physician through a Buzzer or displayed in the LCD screen. IoT is also part of this project, which is used to either store the data or send it to the end user.

KEYWORDS: Breast Cancer, Deep learning, Convolution Neural Network, Benign cancer and Malignant cancer, Etc.

I. INTRODUCTION

Breast cancer (BC) is a frequent cancer that poses significant risks to women's lives globally. Correct diagnosis and early identification are critical in improving patient outcomes. According to the WHO's IARC, BC has overtaken lung cancer as the most prominent cancer form in terms of new cases recorded, with 2.26 million (11.7%) unique patients reported compared to 2.2 million (11.4%) instances of lung cancer. By the end of 2020, BC is expected to officially become the most prevalent cancer worldwide, highlighting the urgent need for increased awareness and comprehensive efforts to combat this disease. The continuous decrease in the cancer mortality rate since 1991, marking a 33% overall reduction and preventing approximately 3.8 million deaths, is attributed to declines in smoking, increased screening for breast, colorectal, and prostate cancers, and advancements in treatments such as adjuvant chemotherapies for colon and breast cancer (BC). The 2022-2024 BC Facts & Figures report shows a slight decrease in the incidence of newly diagnosed cancer cases of invasive BC in the US, with an estimated 287,850 cases in 2022 and 44,130 deaths. The 5-year relative survival rate is 90.5%, with a favorable prognosis for women diagnosed, with age playing a significant role. The estimation of the incidence of melanoma in situ and ductal carcinoma in situ of the female breast in 2023 was based on annual age specific incidence rates. In 2023, the "American (ACS) Cancer Society" projects 1,958,310 new cancer cases and 609,820 deaths in the USA. In 2023, BC is estimated to Account for 300,590 incidences of newly diagnosed cancer Cases in the US. Among these, 2800 cases are projected in Males, while the majority, 297,790 patients, are expected in Females. The estimated deaths related to BC for the same year are 43,700, with 530 occurring in males and 43,170 in female scan have a mammogram every two years instead of every year. Screening should be continued if a woman is healthy and expects to live for at least ten years.

All women need to understand the known benefits, limitations, and Potential drawbacks of breast Cancer screening. BC Originates from the lobules lining cells or ducts lining cells In the breast's Glandular tissue, with most cases (85%) Found in the ducts. During the early stages, cancer Remains confined within the lobule or duct, termed "in situ," Showing limited potential for spreading to other body Parts(metastasis) and often presenting no noticeable symptoms. Recently, special computer techniques called DL models have proven they can be good at studying US breast (BIs) images to find and understand breast cancer. This note looks closer at how we can use DL to study BIs for BC. High frequency sound waves are used in US imaging to obtain comprehensive images of breast tissue. It is non-invasive, Inexpensive, and does not entail ionizing radiation exposure. The US can assist in identifying breast anomalies, guiding Biopsies, and diagnosing and staging BC.

II. LITERATURE SURVEY

Abdullah-Al Nahid, Aaron Mikaelian and Yinan Kong(2018),"Histopathological Breast-image classification with restricted Boltzmann machine along with back propagation" deaths due to cancer have increased rapidly in recent years. Among all the cancer diseases, breast cancer causes many deaths in women. A digital medical photography technique has been used for the detection of breast cancer by physicians and doctors, however, they need to give more attention and spend more time to reliably detect the cancer information from the images. Doctors are heavily reliant upon Computer Aided Diagnosis (CAD) for cancer detection and monitoring of cancer. Because of the dependence on CAD for cancer diagnosis, researchers always pay extra attention to designing an automatic CAD system for the identification and monitoring of cancer.

Various methods have been used for the breast-cancer image-classification task, however, state-of-the-art deep learning techniques have been utilised for cancer image classification with success due to its self-learning and hierarchical feature extraction ability. In this paper we have developed a Deep Neural Network (DNN) model utilising a restricted Boltzmann machine with "scaled conjugate gradient" backpropagation to classify a set of Histopathological breast-cancer images. Our experiments have been conducted on the Histopathological images collected from the Break Hisdataset. Many patients in the world suffer from cancer. There are different kinds of cancer, Among them Breast Cancer (BC) is a prominent one, and is specifically a serious health threat to women. As a case study shows the death statistics due to BC in Australia for the last 5 years. This shows that the death trend due to BC increased every year at an alarming rate in Australia. This might be considered as an example of the BC situation throughout the world. Obviously this causes a serious human and social impact. Proper and timely detection of BC can save or at least improve the condition of susceptible people. Along with other conditions, the detection of BC largely depends on investigation of biomedical images captured by different imaging techniques such as XRays, mammogram, magnetic resonance, histopathological images, etc. For perfect diagnosis of BC, a biopsy can produce reliable results with confidence. Histopathological images are used as a standard image for cancer diagnosis. However, their analysis is very time- consuming and needs extra attention for the perfect diagnosis along with the expertise of H.K.Chethan et al.,(2023),"Machine Learning Techniques for the Classification and Detection of Breast Cancer from Medical Images" cancer is an incurable disease based on unregulated cell division. Breast cancer is the most prevalent cancer in women worldwide, and early detection can lower death rates.

Medical images can be used to find important information for locating and diagnosing breast cancer. The best information for identifying and diagnosing breast cancer comes from medical pictures. This paper reviews the history of the discipline and examines how deep learning and machine learning are applied to detect breast cancer. The classification of breast cancer, using several medical imaging modalities, is covered in this paper. Numerous medical imaging modalities' classification systems for tumors, non-tumors, and dense masses are thoroughly explained. The differences between various medical image types are initially examined using a variety of study datasets. Following that numerous machine learning and deep learning methods exist for diagnosing and classifying breast cancer. Finally, this review addressed the challenges of categorization and detection and the best results of different approaches. The second-leading cause of mortality is breast cancer, which is the cancer type that is most frequently diagnosed.

In 2020, more than 2 million new cases of breast cancer were discovered, making it the most diagnosed disease in the world, according to the World Health Organization (WHO). A total of 626,700 women lose their lives to cancer-related conditions every year. Breast cancer is the most common malignancy in women and the second leading cause of death, and if it is not caught early enough, it can be fatal.

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If the cancer is found before it expands to a size of 10 mm, the patient has an 85% probability of going into complete remission. Cohort studies show that 30% of breast cancer cases are identified when the tumor is 30 mm. Breast cancer is usually detected during screening when the tumor is at least 20 mm in size. Therefore, encouraging early diagnosis of breast cancer is crucial.

A positive clinical breast examination (CBE) and breast self-examination (BSE) may warrant early intervention. Healthcare professionals conduct a CBE as part of routine medical examinations to look for breast lesions. BSE also includes a patient physical examination to look for any physical changes and breast appearance. Women may take charge of their health thanks to the BSE technique. The World Health Organization recommends that at-risk women learn more about BSE. Screening procedures are used to create medical images of the breasts. Professionals with human skills, such as radiologists and doctors, typically interpret these images. Medical imaging's poor diagnostic accuracy is caused by a lack of technological expertise and expertise in analyzing such images.

III. METHODOLOGY

Suspicious or doubtful women may visit the hospital for doing a prognosis check for cancer. Normally patients would be subjected to take X-ray for any physical pain, which may lead to generation of cancer cells or tumor. In existing system, a machine learning algorithm is proposed for the prediction of the Breast lesion using microwave signals. This model performs well on the training data but fails to generalize effectively to new, unseen data and it may not capture complex relationships in the data as effectively as more sophisticated models. Hence we propose to use Ultrasound for screening the problem, which would avoid formation of cancer cells due to X-ray exposure. Captured ultrasound images were given to the preprocessing unit of convolutional neural network layer. This layer operates by applying convolutional filters to input data, systematically scanning through the data to extract features and detect patterns such as edges, textures, or more complex stuctures within the input. Preprocessing unit has Bidirectional Long Short Term Memory network algorithm.

This algorithm is one of the Deep Learning Technique. It is employed to process sequential data, particularly the histopathological images. Its ability to capture temporal dependencies makes it well-suited for this task. Using this technique, feature extraction will be obtained at a faster rate than the existing algorithms. The extracted feature will be sent to the Microcontroller through UART because it transfer the data quickly. The microcontroller will predict the presence of tumor or not and the same will be indicated to the physician through a Buzzer or displayed in the LCD screen. IoT is also part of this project, which is used to either store the data or send it to the end user.

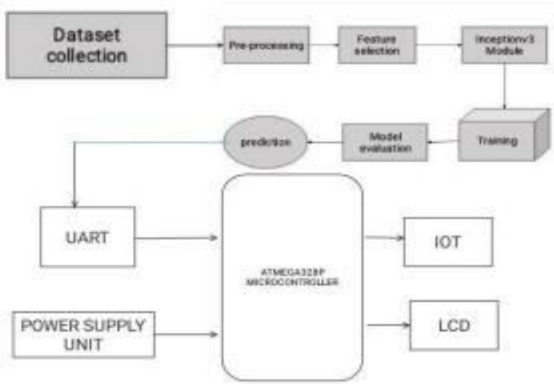

Fig. 1. Proposed Block Diagram

MACHINE LEARNING

Machine learning (ML) is a field of study in artificial intelligence concerned with the development and study of statistical algorithms that can learn from data and generalize to un-seen data, and thus perform tasks without explicit instructions. Recently, generative artificial neural networks have been able to surpass many previous approaches in performance. Machine Learning approaches have been applied to many fields including large language models, computer vision, speech recognition, email filtering, agriculture, and medicine, where it is too costly to develop algorithms to perform the needed tasks. ML is known in its application across business problems under the name predictive analytics. Although not all machine learning is statistically based, computational statistics is an important source of the field's methods. The Mathematical foundations of

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ML are provided by mathematical optimization (mathematical programming) methods. Data mining is a related (parallel) field of study, focusing on exploratory data analysis through unsupervised learning. [7][8] From a theoretical point of view Probably approximately correct learning provides a framework

Working:

1.A Decision Process: In general, machine learning algorithms are used to make a pre-diction or classification. Based on some input data, which can labeled or unlabeled, your algorithm will produce an estimate about a pattern in the data.

2.An Error Function: An error function evaluates the prediction of the model. If there are known examples, an error function can make a comparison to assess the accuracy of the model.

3. Model Optimization Process: If the model can fit better to the data points in the training set, then weights are adjusted to reduce the discrepancy between the known example and the model estimate. The algorithm will repeat this iterative "evaluate and optimize" process, updating weights autonomously until a threshold of accuracy has been met. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, and to uncover insights in data mining projects. These insights subsequently drive decision making within applications and businesses, ideally impacting key growth metrics. As big data continues to expand and grow, the market demand for new data scientists will increase. They will be required to help identify the most relevant business questions and the data to answer them. Machine learning models fall into three primary categories: supervised machine learning supervised learning, also known as supervised machine learning, is defined by its use of labeled datasets to train algorithms to classify data or predict outcomes accurately. As input data is fed into the model, the model adjusts its weights until it has been fitted appropriately.

This occurs as part of the cross validation process to ensure that the model avoids overfitting or underfitting. Supervised learning helps organizations solve a variety of real-world problems at scale, such as classifying spam in a separate folder from your inbox. Some methods used in supervised learning include neural networks, naïve bayes, linear regression, logistic regression, random forest, and support vector machine (SVM). Unsupervised machine learning unsupervised learning, also known as unsupervised machine learning, uses machine learning algorithms to analyze and cluster unlabeled datasets (subsets called clusters). Human intervention. This method's ability to discover similarities and differences in information make it ideal For exploratory data analysis, cross-selling strategies, customer segmentation, and image and pattern recognition. It's also used to reduce the number of features in a model through the process of dimensionality reduction. Principal component analysis (PCA) and singular value decomposition (SVD) are two common approaches for this. Other algorithms used in unsupervised learning include neural networks, k-means clustering, and

probabilistic clustering

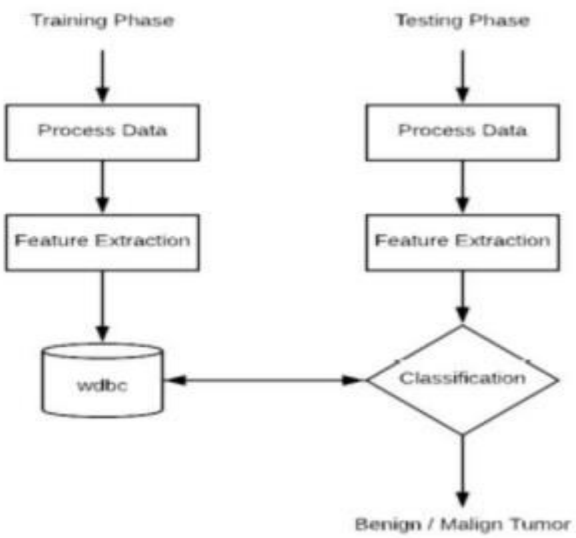

Fig. 2. Flow chart for the proposed method

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IV. HARDWARE AND SOFTWARE IMPLEMENTATION

A. Image Acquisition

An image dataset is a collection of images that are used for various purposes such as training machine learning models, computer vision applications, and more. Creating a high-quality image dataset is a crucial part of many computer vision tasks, and it requires careful planning and execution. There are several approaches to collecting image datasets. One way is to take images manually by capturing photos or videos using cameras or mobile devices. Another way is to download publicly available datasets, either for free or for a fee, from various sources such as academic institutions, government organizations, and private companies. However, building a high-quality image dataset from scratch can be time-consuming and resource-intensive.

Therefore, it is essential to carefully plan the dataset's design, including its scope, size, and labeling requirements, and consider the ethical implications of collecting and using the images. Additionally, it is crucial to ensure the data's quality, which can be achieved through quality control procedures and validation methods. In summary, image dataset collection is an important step in computer vision tasks, and it requires careful planning, execution, and quality control procedures[7]

A. Image Processing

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. Image processing basically includes the following three steps:

Importing the image via image acquisition tools; Analysing and manipulating the image; Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

In this lecture we will talk about a few fundamental definitions such as image, digital image, and digital image processing. Different sources of digital images will be discussed and examples for each source will be provided. The continuum from image processing to computer vision will be covered in this lecture. Finally we will talk about image acquisition and different types of image sensors.

A. System Architecture

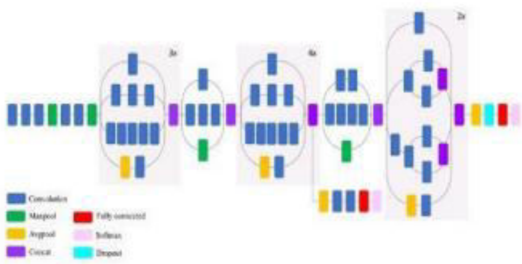

Fig.3 Convolution Neural Network

A. Data set collection:
The first step in our proposed system involves the collection of a comprehensive dataset comprising various types of breast cancer-related data. This dataset will include genetic profiles, histopathological images, clinical records, and any other relevant information that can contribute to the analysis. The collection process will ensure that the dataset is representative of different demographics and disease stages, thereby enhancing the generalizability of the models developed.

C. Pre-processing:
The dataset is collected, the next module involves pre-processing the data to ensure its quality and consistency. This step may include tasks such as data cleaning to remove any inconsistencies or errors, data normalization to bring all features to a similar scale, and data augmentation to increase the diversity of the dataset. Additionally, any missing values or outliers may be handled during this phase to ensure the integrity of the data for subsequent analysis.

D. Features Extraction:
Following pre-processing, the features extraction module aims to identify and extract relevant features from the dataset that are predictive of breast cancer prognosis. This step may involve techniques such as dimensionality reduction to reduce the complexity of the data while retaining important information, as well as feature selection to identify the most informative features for model training. Feature extraction plays a crucial role in improving the efficiency and effectiveness of the subsequent modelling stages.

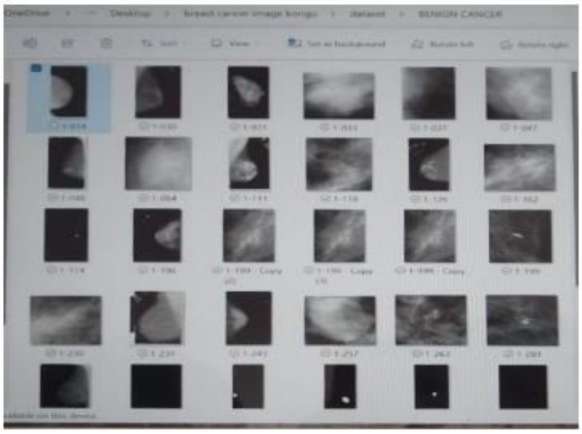

Fig.4 Image for Processing

E. Model Training:
The relevant features are extracted, the dataset is used to train machine learning models for breast cancer prognosis. This module involves selecting appropriate algorithms, such as deep learning models like InceptionV3, and training them on the pre-processed dataset. The goal of model training is to develop predictive models that can accurately classify breast cancer cases and provide valuable insights into prognosis. Training may involve iterative processes to optimize model parameters and improve performance.

F. Model Evaluation:
The trained models are evaluated using separate validation datasets to assess their performance and generalization ability. This module involves metrics such as accuracy, precision, recall, and F1-score to evaluate the model's predictive performance. Additionally, techniques such as cross-validation may be employed to ensure robustness and reliability of the evaluation results. The model evaluation phase provides valuable feedback on the effectiveness of the proposed system and guides further refinement or optimization if necessary.

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V. RESULT

The proposed system represents a cuttingedge approach to Breast Cancer detection and treatment, leveraging the power of deep learning, embedded systems, IoT, and sensor technologies. By employing convolutional neural networks (CNNs), the system extracts intricate features from medical images of the breast, enabling precise classification of BCD. This advanced image analysis capability facilitates early detection of breast cancer, a critical factor in preventing complications such as infections and tissue damage that could lead to amputation. Furthermore, the integration of IoT-enabled sensors allows for real-time monitoring and analysis of breast health, providing healthcare professionals with valuable insights into the risk of Breast Cancer development for individuals. Upon identifying a Breast Cancer, the system initiates therapy using Peltier crystal technology embedded within the system. This innovative treatment approach aims to mitigate the progression of breast cancer, thereby improving patient outcomes and reducing the need for more invasive and costly interventions

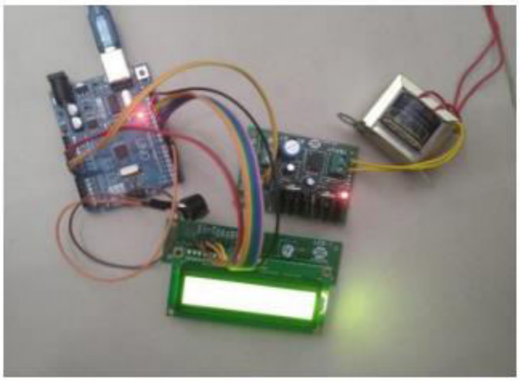

Fig.5 Hardware Output

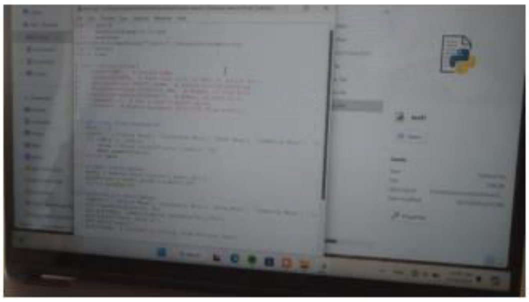

Fig.6 Program for Diagnosis

Fig.7 Detection of Breast Cancer

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By combining early detection with targeted therapeutic interventions, the proposed system has the potential to significantly improve the management of DFUs, leading to better patient care and reduced healthcare burdens. Moreover, the integration of deep learning techniques with embedded systems and IoT not only enhances the accuracy of DFU detection but also lays the groundwork for future advancements in diabetic care and remote monitoring technologies.

VI. CONCLUSION

In conclusion, the integration of advanced data mining techniques with deep learning methodologies, particularly utilizing the InceptionV3 neural network architecture, represents a significant advancement in breast cancer research and clinical practice. By amalgamating diverse data sources, including genetic, clinical, and imaging data, this approach enables a more comprehensive assessment of breast cancer prognosis, leading to more informed and personalized treatment decisions. The development of a practical framework demonstrated through the utilization of UART communication for data transfer to the LCD showcases the potential for real-world implementation, with the prospect of streamlining diagnostic processes and improving patient outcomes. Moving forward, further research and development in this field hold immense promise for enhancing our understanding of breast cancer biology, refining prognostic models, and optimizing therapeutic interventions. Continued collaboration between medical professionals, data scientists, and computational researchers will be crucial in harnessing the full potential of advanced computational techniques for breast cancer analysis. By leveraging the power of data-driven approaches and cutting-edge technology, we can strive towards more effective strategies for early detection, accurate prognosis, and personalized treatment of breast cancer, ultimately contributing to improved patient survival and quality of life

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