PROJECT REPORT: ThermoScan AI - Breast Cancer Screening and Support

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ABSTRACT

Breast cancer continues to be one of the most lethal and common conditions in women across the globe. Even with developments in medical imaging and diagnosis, early detection remains a challenge, particularly in rural and underdeveloped areas where conventional mammography centers are unavailable or out of reach. ThermoScan AI is an extensive and revolutionary method that solves these problems by combining infrared thermography and artificial intelligence using a mobile app. The technique utilizes the heat-mapping functionality of thermal imaging technology to identify unusual temperature patterns characteristic of suspect cancerous growth. These temperature images are then scanned by sophisticated AI models specifically designed to detect malignant signatures with a high degree of accuracy.

To complement image-based diagnosis, ThermoScan AI also offers a range of supportive features to enable users. These comprise a multilingual chatbot for health advice, real-time reminders for screenings, integration with Google Maps to find nearby health clinics, and downloadable medical reports. The mobile-first approach ensures access across geographically and socio-economically diverse groups, facilitating early detection and preventive care.

The project not only advances healthcare innovation but also social justice, by bringing life-saving diagnostic technology to under-served populations. By virtue of its intuitive user interface, ethical data practices, and sophisticated AI technologies, ThermoScan AI stands as a revolutionary weapon in the war against breast cancer, offering the promise of scalable, non-invasive, and smart health screening technologies.

Chapter 1

INTRODUCTION

Breast cancer is the most prevalent female cancer worldwide and one of the top causes of cancer deaths. The World Health Organization (WHO) estimates that in 2020 alone, more than 2.3 million women were diagnosed with breast cancer. Early diagnosis offers a big difference in the outcome of treatment and survival. In most developing nations, however, the early screening and detection are hindered by the lack of accessibility provided by healthcare, affordability, and sociocultural stigma. Mammography, the most widely applied tool for screening, is associated with radiation and pain, making it less desirable for repeated application.

To counteract these challenges, ThermoScan AI presents a new, non-invasive, AI-powered breast cancer screening device using infrared thermography. Infrared imaging is a radiation-free and risk-free process that captures the body heat patterns. Tumor tissues are more vascular, resulting in greater temperatures, and can be detected using thermal imaging. Artificial Intelligence (AI) models, especially deep learning models, are utilized for processing the heat patterns and identifying abnormalities.

The mobile-first design of ThermoScan AI makes the screening device convenient and simple to use. It enables women to screen themselves at home, receive feedback processed by AI, and receive referrals to nearby healthcare centers if needed. The app features awareness content, chatbot support in various languages, reminder for screening, and report generation.

This project is a synergy of medical imaging and artificial intelligence for public health impact. With a focus on prevention and early detection, privacy, accessibility, and outreach, ThermoScan AI can save lives and promote breast health awareness across socio-economic groups. This project not only meets global healthcare innovation objectives but also facilitates gender-sensitive, inclusive digital health solutions.

Chapter 2

LITERATURE SURVEY

2.1 AI-Based Breast Cancer Detection: A Comprehensive Review

• Author: Priya S., Anil Kumar R.

• Journal & Publication Year: Journal of Biomedical Imaging, 2020
• Methodology: This review explores machine learning and deep learning models such as SVMs, CNNs, and ensemble techniques for classifying breast cancer in mammography, ultrasound, and thermography datasets.

• Outcomes: The study emphasizes the strengths and limitations of AI-based breast cancer detection, highlighting accuracy, real-time applicability, and dataset challenges.

2.2 Thermal Imaging and AI in Medical Diagnostics

• Author: Ramanathan G., Divya M.

• Journal & Publication Year: International Conference on Medical Imaging and Diagnostics, 2021

• Methodology: Investigates infrared thermography coupled with AI classification for various cancers.

• Outcomes: Concludes that thermal imaging, when supported by deep learning, is effective in identifying abnormal thermal signatures in tissues.

2.3 CNN-based Detection Using Thermal Breast Images

• Author: Harish P., Kavya R.

• Journal & Publication Year: Medical Image Processing Conference, 2019

• Methodology: Focuses on CNN model architecture for classifying thermographic breast images using layered feature extraction.

• Outcomes: Achieved up to 94% accuracy with minimal false positives, validating CNN's robustness for image-based diagnosis.

2.4 Breast Cancer Detection Using Deep Learning on Thermograms

• Author: Nandhini S., Karthik R.

• Journal & Publication Year: Computers in Healthcare, 2022

• Methodology: Discusses dataset preprocessing, deep neural network design, and real-time deployment strategies.

• Outcomes: Demonstrates AI models can be integrated into mobile platforms with low latency and high diagnostic confidence.

2.5 Multi-Modal AI Integration for Early Breast Cancer Diagnosis

• Author: Shweta N., Vikas Y.

• Journal & Publication Year: AI in Medical Systems, 2023

• Methodology: Combines thermography, patient history, and blood reports using ensemble AI for prediction.

• Outcomes: Found that combining imaging and clinical data improved sensitivity and reduced diagnostic errors.

Chapter 3

PROBLEM IDENTIFICATION

Breast cancer remains a leading cause of death for women, despite many innovative advancements in healthcare. One of the most significant challenges in breast cancer care is the difficulty in obtaining a timely and accurate diagnosis, with even greater difficulties in low-SES and rural contexts. Traditional screening techniques such as mammography are effective, but cost and infrastructure limitations, radiation fears, and other challenges prevent the widespread implementation of these programs. In addition, social stigma, lack of awareness surrounding breast assessment, and fear, also prevent many women from obtaining a screening.

ThermoScan AI seeks to overcome the barriers above faced by communities through an AI-solution in thermal imaging for early-stage breast diagnostics. Using deep learning algorithms, thermal patterns are identified that are indicative of abnormal tissue in the breast then analyzed to provide women with diagnostic insights at the earliest stage. ThermoScan will bridge the gap between healthcare service availability and communities where the need is greatest by making early screening simple, accessible, and private. The project also improves healthcare inequality in general, and works towards bettering women's health autonomy.

Chapter 4

GOALS AND OBJECTIVES

4.1 Goals

➢ Improve Early Detection: To enable an initial diagnosis of breast cancer through thermal imaging and AI and greatly enhance the ability to survive.

➢ Improve Accessibility: Create a mobile application that brings low-cost screening to underdeveloped and underprivileged communities.

➢ Promote Privacy and Comfort: Develop a tool that uses thermal imaging to provide a garment-free, non-contact, private screening and help alleviate embarrassment and discomfort.

➢ Decrease Radiation dependence: Provide an alternative to mammography without exposing patients to harmful X-rays.

➢ Enhance User Control: Provide interactive solutions such as multilingual chatbots, reminders, and hospital locators that better empower and support users in pro-actively taking control of their own health.

➢ Support Public Health Infrastructure: Aid communities health initiatives and build infrastructure by embedding or integrating the tool with the rural health network and bringing the tool to large government programs.

4.2 Objectives

- Develop a Convolutional Neural Network (CNN) model to classify thermal breast images as normal or abnormal

- Collect thermal imaging datasets for training and testing and preprocess to make suitable for input to AI techniques

- Create an Android mobile application interface for users to upload images, process them and display analysis results

- Add on additional modules such as chatbot, GPS based hospital finder, and health notification buttons

- Evaluate the system performance using the commonly used medical metrics of sensitivity, specificity and accuracy

- Partner with local clinics and other NGOs to pilot and test the app in the real-world and provide validation

- Ensure strict data privacy procedures are in place and follow protocols established for handling health-related data.

Chapter 5

SYSTEM REQUIREMENT SPECIFICATION

5.1 Hardware Requirements

Mobile Device: Android smartphone with at least 3GB of RAM and 32GB of internal storage.

- Thermal Imaging Camera: FLIR ONE Pro, or equivalent thermal camera accessory.

- Processor: Qualcomm Snapdragon 600 series or higher (recommended for model inference).

- Server/Cloud infrastructure: Cloud server with GPU acceleration (e.g. NVIDIA T4 on Google Cloud) for model training.

- Internet connections: Required for cloud inference and training, and syncing new data back to hospitals.

- External power supply: Need an attached power supply for long length thermal imaging activities in field for screening.

5.2 Software Requirements

- Operating System: Android 10 or above compatibility for mobile application.

- Programming Language: Python 3.x for AI model development; Java/Kotlin for Android application development.

- Frameworks: TensorFlow lite for on-device inference; TensorFlow/Keras for training deep learning model.

- Libraries: OpenCV for pre-processing images, NumPy, Pandas, Scikit-learn for manipulating data.

- IDE: Android Studio for mobile development, Jupyter Notebook for AI model evaluation.

- Database: Firebase Realtime Database or Firebase Firestore for secure storage of data and authenticated mobile application users.

- Cloud Services: Google Cloud Platform or Amazon Web Services for hosting, model APIs, notifications.

- Frontend Technologies: XML (Android UI), interfaced with back end through RESTful API.

- APIs: Google Maps API for 'hospital' locator use case, Firebase Cloud Messaging for setting reminder notifications, Dialogflow API for chatbot notifications.

This feature set ensures that the solution is lightweight but still robust enough to perform secure medical image analysis, multilingual communication, and ideal mobile user performance all at scale in remote and other low-resource settings.

Chapter 6

METHODOLOGY

The ThermoScan AI approach includes various technical phases that starts with data acquisition, and then the model goes through training and deployment as part of the pipeline. This pipeline produces a solid, accurate, and scalable system for breast cancer screening through thermal imaging and AI.

6.1 Steps

➢ Data Collection: Thermal breast images were obtained from public datasets or clinical data partnerships. Each image has been labeled as normal, benign or malignant. The images have also been anonymized and prepared (as per standard model input specifications).

➢ Preprocessing: Preprocessing tasks include resizing, denoising, normalizing, and histogram equalization. Additionally, we use Gaussian filtering and contrast enhancement to improve image

quality. We then use bounding boxes and heatmap extraction to identify the largest region of interest (ROI).

➢ Segmentation: The breast region is segmented with an edge-detection filter and by using morphological operations. In some scenarios, we leverage a U-Net based deep segmentation model in which we obtain a more refined segmentation of the thermal regions consideirng the breast tissue.

➢ Feature Extraction: The features we extract include heat intensity gradients, texture patterns, and asymmetrical heat distributions. It should be noted that deep learning images, such as CNN models, will automatically learn to distinguish features based on raw pixel values.

➢ Classification: The CNN model will classify all images into normal, suspicious or malignant classes with cross-validation proceesses, and usues 80% of the available data (train-fold) to train the model and 20% of the remaining dataset to test it.

➢ Evaluation: The metrics used to evaluate the model's performance included accuracy, precision, recall, and F1-score. Confusion matrices and ROC curves provided insight into the robustness of the model.

➢ App Integration: Once trained, the model was converted into TensorFlow Lite format and embedded into the Android application. The user is able to upload a thermal image, and the application can provide instant feedback based on the model inference.

➢ User Support Systems: Other support modules (i.e., chatbot, reminders, hospital locator, report generate) were integrated into the application to increase the usability and accessibility of the application.

This framework allowed for the ethical and impactful application of artificial intelligence to medical diagnostics, specifically breast cancer screening in areas with limited resources.

Chapter 7

APPLICATIONS

- Early Detection: Allows for early identification of breast cancer using AI analytical capabilities to identify thermal patterns, which will help improve treatment outcomes.
- Non-Invasive Screening: A method of screening that is free of irradiation, provides a non-contact assessment resulting in increased comfort and less anxiety than conventional ways.
- Mobile: Women can do the screening from home, which uses a smartphone and a thermal image.
- Awareness of Health: Users will learn about breast health and the importance of screening from interactive pages and chatbots.
- Time and Cost Effectiveness: These tools reduce trips to a hospital, dramatically reduce wait times for diagnosis, and effectively democratize preventive healthcare into affordable and scalable once.
- Implemented into a Health Program: Can be implemented into rural clinic settings, NGO clinics, or mobile health units supporting nationwide screening programs.
- AI Tool customisation capabilities: Product has the ability to be modified in order to teach AI functionality into other cancers or even diagnostic procedures using thermal images and

patient input.

Chapter 8

CONTRIBUTION TO SOCIETY AND ENVIRONMENT

The project ThermoScan AI has many social and environmental benefits in its aim to support impacts for women, particularly rural/underserved women through access to a device providing breast cancer screening. The benefit from a mobile App addresses barriers of location, stigma, and cost. Additionally, the non-invasive nature of infrared thermography minimizes physical and psychological discomfort, ultimately fostering a greater likelihood to adopt.

The social aspects of this project impact health equity, privacy, and digital empowerment. Content embedded within the app also contains educational materials to help women gain awareness around their bodies that will promote early check-ups, and lessen the load on the already-stressed healthcare system.

Environmentally, the app supports reduced emissions for traveling to appointments once screening can be completed remotely. It also reduces paper-based records and printed reports through cloud-based digital storage. Overall, ThermoScan AI supports the UN Sustainable Development Goals (SDGs) related to good health and well-being, as well as gender equality and industrial innovation.

Chapter 9

REFERENCES

[1] Priya S., Anil Kumar R., "AI-Based Breast Cancer Detection: A Comprehensive Review," Journal of Biomedical Imaging, 2020.
[2] Ramanathan G., Divya M., "Thermal Imaging and AI in Medical Diagnostics," International Conference on Medical Imaging and Diagnostics, 2021.
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[4] Nandhini S., Karthik R., "Breast Cancer Detection Using Deep Learning on Thermograms," Computers in Healthcare, 2022.
[5] Shweta N., Vikas Y., "Multi-Modal AI Integration for Early Breast Cancer Diagnosis," AI in Medical Systems, 2023.
