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Early-Stage Detection of Cancer in Breast Using Artificial Intelligence

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Abstract

One of the deadly diseases among humans is Cancer, which occurs almost anywhere in the human body. Cancer is caused by the cells that spread into the surrounding tissues by dividing itself uncontrollably. Breast Cancer is the most common cancer among women. Early detection and diagnosis of breast cancer are treatable and curable. Many women have no symptoms for this cancer at an early stage. The abnormal cells in the breast will risk for the development of breast cancer. So, it is important for women to regularly examine their breast. Technologies can be utilized in a smarter way with Artificial Intelligence techniques to assist the women during their examination of the breast at their living place to avoid the risk of breast cancer. The main aim is to develop a lowcost self-examining device for the detection of breast cancer and abnormality in the breast using an efficient optical method, Deep-learning algorithm and Internet of Things.

Key-words: Abnormality in Cells, Artificial Intelligence, Breast Cancer Detection, Internet of Things.

1. Introduction

Billions of cells together form the human body. These cells have a normal life and divide as needed. When a cell malfunctions or ages, it dies. When this process is disrupted, abnormal or old cells stay in the body for a long time, eventually leading to cancer cells. These cancer cells will grow in size, crowding out healthy cells. Cancer can grow in any part of the body such as Bladder, Breast, Colon or Rectum, Kidney, Lungs, Pancreas, Thyroid, Uterus, Prostate, and Oropharyngeal. It is named after its first place such as Bladder Cancer, Kidney Cancer, Lung Cancer, and Breast Cancer.

The most common cancer is Breast Cancer for women, which affects 2.1 million women each year and causes the most cancer associated deaths. Breast cancer has claimed the lives of 6,27,000 women by 2018, which means that about 15% of all cancer deaths are due to this cancer. Figure 1.1 shows normal breast tissue. The mammary glands are where most breast cancer originated, some develop in breast milk production areas, and other types of breast cancer, such as phyllode tumor and angiosarcoma, are rare. Breast cancer is divided into five stages, as shown in Figure 1.2. Non-invasive ductal carcinoma in situ (DCIS) is classified as Category 0 (zero), and non-invasive breast cancer is classified as category I to IV (1-4). New lumps on the chest or under the armpits, swelling of the breasts, discharge of the breast without breast milk, redness or delicate skin in the nipple or breast area, thinning of the breast skin, any changes in breast structure, and discomfort in any part of the breast are all warning signs of breast cancer.

Figure 1.1 - Normal Breast Tissue

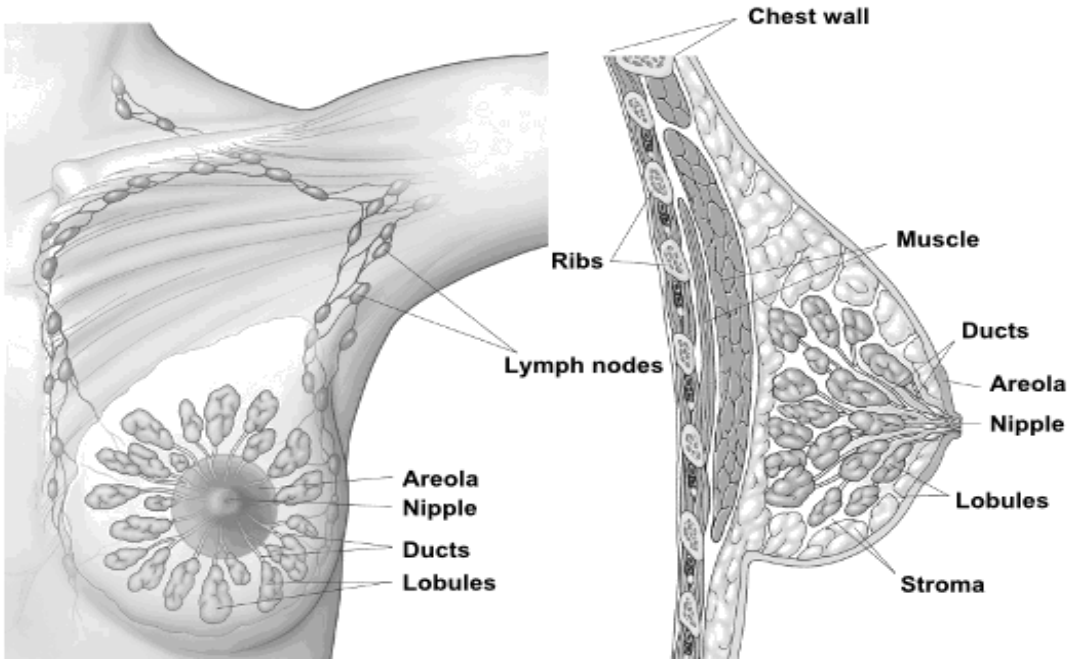

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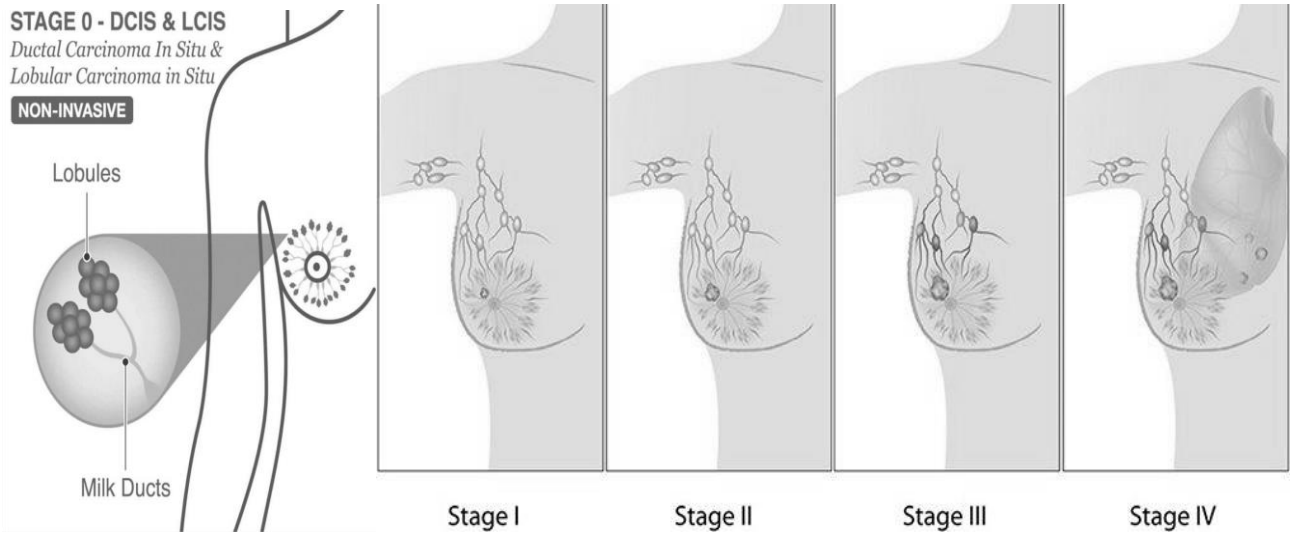
Figure 1.2 - Stages of Breast Cancer



Two methods of breast cancer screening such as Breast Self-Examination (BSE) and Clinical Breast Examination (CBE). CBE is a method by which medical professionals examine the chest physically. Clinical breast examinations are used in combination with mammograms to detect breast cancer in women. Due to a lack of response and incorrect procedures, many women are unaware of BSE, according to the analyzed data. The lives of many women can be saved if breast cancer is found using the BSE method with a handheld device.

Smart technology can be used to help women during breast screening at their place of residence to avoid the risk of breast cancer. The main goal is to develop a low-cost diagnostic tool to detect breast cancer and breast abnormalities using the most effective optical methods, the Internet of Things and Deep-learning algorithms. This helps women to detect abnormalities in the breast at an early age. The proposed device is a red light-based, radiation-free hand-held self-use device with adjustable light intensity based on skin tone. This handheld device is securely interfaced with mobile phones and privacy-sensitivity is also achieved. Thus, the proposed device assists humans in examining their breasts at home, and the results of the examination can be identified from their home.

2. Literature Review

Breast Cancer is the most common cancer in women, which affects more than 10% of women worldwide. Its mortality rate is very high compared to other cancers [H. Yang, JY Kim, H. Kim, and SP Adhikari, 2019] and its popularity has increased since the 1990s, especially in developing countries [Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, and Jemal A, 2012]. In 2012, it

was found that about 1.67 million new breast cancer cases account for about 12% of all new cancer cases and 25% of all cancer cases in women [J. Ferlay and et. al., 2015]. There have been 2,088,849 new breast cancer diagnoses worldwide along with the combined data on 11.6% of all cancers. In India, cervical cancer as the leading cause of death for women [Kaarthigeyan K, 2012] with 144, 937 new cases [Ferlay J and et. al., 2012]. This is expected to continue due to changes in child acquisition and dietary practices [Babu GR, Lakshmi SB, and Tiyagarajan JA, 2013]. The International Agency for Research on Cancer revealed that the growing trend continued in 2018 [Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA and Jemal A, 2018]. In addition, the IARC has clarified that screening for 626,679 breast cancer-related deaths in 2018 itself. Breast cancer was the second largest identification of any cancer diagnosis reported in 2018 [Ferlay J and et. al., 2019]. In India, the majority of women seek treatment in progressive stages leading to lower survival rates [Chopra R, 2001] [Agarwal G and Ramakant P, 2008]. Breast cancer forecast for 2020 rises to 1,797,900 bringing a new challenge to the Indian health system [Malvia S, Bagadi SA, Dubey US, and Saxena S, 2017]. Information about breast cancer, its symptoms and signs or diagnostic procedures is very poor for Indian women. Appropriate prevention methods focused on both the first and second prevention methods are needed to diminish the occurrence of breast cancer. Early adoption is an important strategy for low-income and middle-income countries to improve survival and affordable treatment that is less expensive [Pasick RJ, Hiatt RA and Paskett ED, 2004]. The breast lump is often overlooked due to a lack of awareness in India [Shulman LN, Willett W, Sievers A, and Knaul FM, 2010]. Some women follow the treatment of traditional healers [Abuidris DO and et. al., 2013], some have limitations such as improper access, social barriers expensive health care and stigma surrounding symptoms. A significant approach is to assess breast cancer awareness, as well as breast self-examination, among vulnerable women, especially those in low-income and resource-intensive sectors. Prompt detection of breast cancer is significant in handling breast cancer and reducing the mortality and morbidity associated with this cancer. Early recognition of breast cancer with the help of mammography and CBE. In addition, these methods, like standard mammograms, are extremely expensive for millions of women worldwide, especially in developing countries. As a result, for many women in low-income services, the BSE system is a key strategy for early detection and treatment of breast cancer, especially in resource-intensive settings. [Azemfac K no et. al., 2019] [Gupta R, Gupta S, Mehrotra R and Sodhani P, 2019]. BSE increases prediction by reducing abnormal cell function and disability, as well as improving health and survival quality. It is a public initiative to remain for recommendation of BSE because it is safe, easy, fast, requires minimal expertise, and can be educated. It is a popular way to get lumps and other abnormalities on the breast every month.

[Ahuja S and Chakrabarti N, 2010]. Women need a BSE self-assessment tool. The physical characteristics of human breast tissue have been studied in many ways. The acquisition and dispersion of light coefficients intersect with the chest tissue, allowing for the reconstruction of the image using continuous or irregular variations. Medical applications for fluorescence molecular tomography, diffuse optical spectroscopy and imaging, photoacoustic imaging, and multiparametric infrared imaging include lesion characterization, cancer risk estimation, and neoadjuvant therapy monitoring. [Giovanni Di Leo, Rubina Manuela Trimboli and Tamar Sella Francesco Sardanelli, 2017]. Various handheld devices are well designed and used in phantom, in vivo, and in early breast cancer screening studies or as a diagnostic tool. The wide-angle infrared optical scanner is designed for transillumination-based breast imaging, in addition to various optical devices produced by different research teams. [Godavarty Suset Rodriguez Young-Jin Jung Stephanie Gonzalez, 2015]. By implementing machine learning techniques such as supervised, unsupervised and reinforcement learning, the data can be processed using fog computing and cloud computing along with IoT [Mansi Jindal, Jatin Gupta and Bharat Bhushan, 2019].

3. Methodology for Breast Cancer Detection

Breast cancer is a major risk factor for women in their 30s to 50s. It can be treated and cured easily if detected and detected early. Most women with first-line breast cancer have no symptoms. Surviving breast cancer becomes more difficult as it progresses, so it is recommended that women check their breasts for cancer regularly.

Existing Methods

Breast cancer screening methods such as Breast Self-Examination (BSE) and Clinical Breast Examination (CBE). Common breast screening methods are Mammography, Digital mammography, Breast ultrasound, Breast magnetic resonance imaging (MRI) and removal of a sample of breast cells for biopsy. Chest cancer screening and diagnosis is done using a Mammogram. Low-power X-rays are used in Mammogram to examine a person's chest. Breast cancer can be diagnosed early with a mammogram, usually through different masses or micro calcifications. It has a great challenge to prove that there is something wrong and false in the test results in the early stages. In addition, these low-power X-rays can be used in a clinical lab and will not be used by the average person. The Computer Tomography Laser Mammography (CTLM) technique detects angiogenesis in the breast

tissue in the near-infrared region of the spectrum using laser energy. Oxygen and deoxygenated hemoglobin is used for molecular optical imaging using CTML. Lasers used in the same way as X-Rays are used in computer tomography, these poles move through the tissue and shrink. It is a time-consuming and difficult process that can only be used in clinical labs. Handheld devices in the international market are expensive for people to own and women's awareness is lacking. Further they are not personally used devices and they require a technician. Analysis of test and test results can only be obtained by consulting a physician.

Proposed Method

The Proposed system employs the functionality of the portable device, a mobile application named ABCD (Application for Breast Cancer Detection) and a deep-learning based image classification system using Amazon Web Services (AWS) as shown in Figure 1.3. The first stage is a microcontroller based battery operated portable device. This portable device consists of high and low intensity light selection and Bluetooth pair option. High and low intensity light selection can be made based on the skin tone of women. Light Emitting Diode (LED) emits the light intensity as selected by the user. A portable hand-held device and mobile are paired using Bluetooth. The various perspective of the breast is captured through the mobile application ABCD and the images are stored for the analysis. Normal and abnormal breast images are trained in the AWS platform using a deep-learning algorithm. Through IoT, the stored images are sent to AWS for image classification. The Portable hardware device consists of Light Emitting Diode, Control buttons, Battery indicator, Light intensity indicator, Power indicator and Bluetooth. This device is designed in such a way that its structure achieves light weight and compact.

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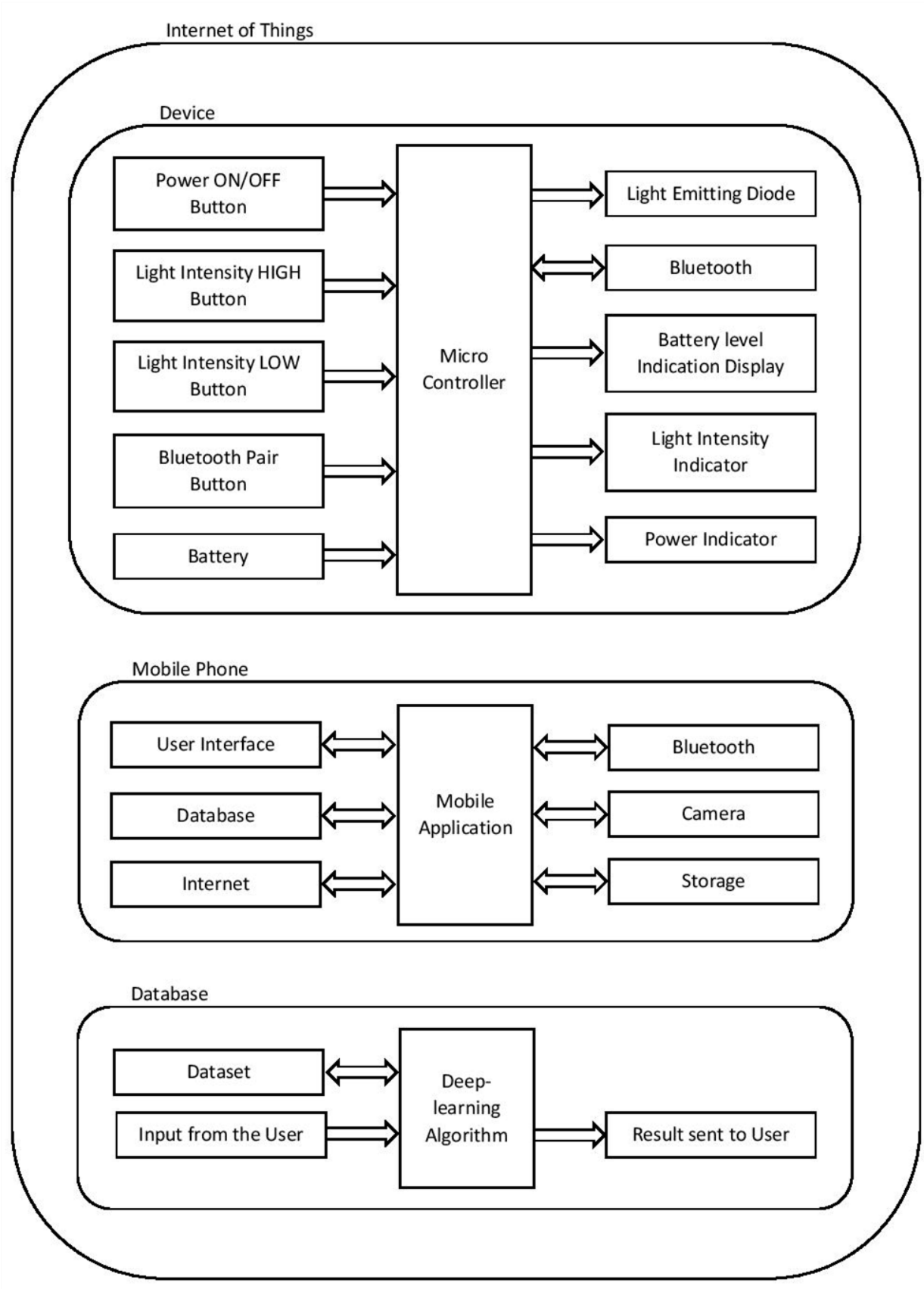
Figure 1.3 - Block Diagram of Early Stage of Cancer in Breast Using Artificial Intelligence



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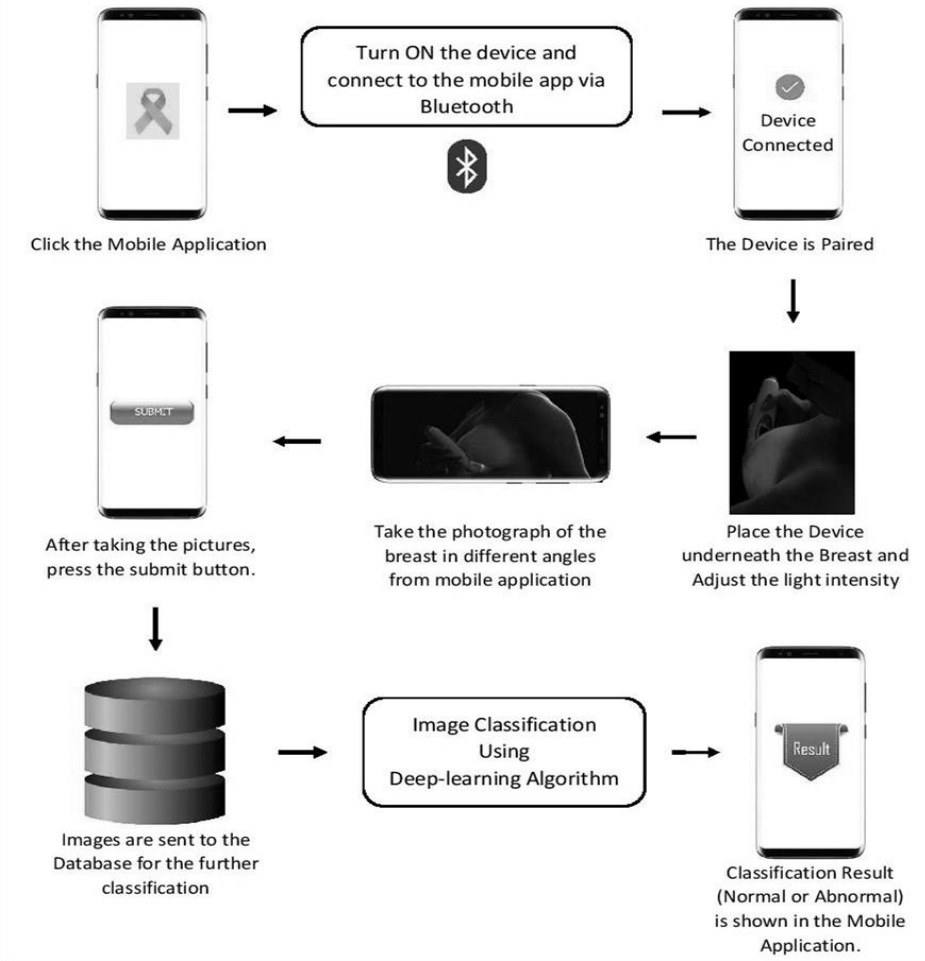
In a darkened room, the woman by self has to place the device underneath the breast such that light should pass through the breast. The intensity of the light has to be tuned as required. Moreover, it is to keep the device on top of the breast and observe underneath the breast. Light is scattered through the breast tissues providing it a uniform pink or red colour with blood vessels. Each breast has to observe and the photograph of each breast from different angles has to be taken in the mobile application ABCD. The camera of the mobile phone can be accessed through the device. As shown in Figure 1.4, Photograph of each breast will be analyzed in AWS using a deep-learning algorithm and the result will be shown in the mobile application.

Figure 1.4 - Working Flow of Early-Stage Detection of Cancer in Breast Using Artificial Intelligence



4. Experimental Results

The proposed system for diagnosis of Breast Cancer through internet via mobile application has been implemented. The outcome of Early Stage Finding of Cancer in Breast using Artificial

Intelligence is shown in this section. The working result of the Early-Stage Detection of Cancer in Breast using Artificial Intelligence is shown in Table 1.1.

Mobile Application

Mobile Application named as Application for Breast Cancer Detection (ABCD) has been established for the user to comfortably examine their breast at their living place as shown in Figure 1.5.

Figure 1.5 - Mobile Application (ABCD); Figure 1.6 - Login in ABCD

Figure 1.7 - UI of ABCD; Figure 1.8 - AWS Confirmation; Figure 1.9 - Results

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It comprises login, Bluetooth pairing, new test and results button as shown in Figure 1.6 and Figure 1.7. By pressing the New Test button, images of the breast with the required light intensity are taken and sent to AWS for image classification as shown in Figure 1.8. Breast examination results are available in mobile application and can be viewed at any time as shown in Figure 1.9.

Database

Amazon Web Services has been set up to classify images. When the examination images are sent to the database, it classifies and recognizes them before sending the image result to the user.

Portable Device

The device permits the user to adjust the intensity of the LED based on their skin tone. It associates to the mobile application via Bluetooth.

Table 1.1 - Expected and Actual Outcome

S.NO	FEATURES	EXPECTED OUTCOME	ACTUAL OUTCOME
Portable Device			
1.	Bluetooth Connectivity	Bluetooth pairs the device with mobile application	Same as the expected outcome
2.	Light Intensity Control	The light intensity of the LED is controlled with the help of Light Intensity HIGH button and Light Intensity LOW button.	Same as the projected outcome
Mobile Application (Application for Breast Cancer Detection)			
3.	Privacy-sensitivity	Login is formed for each and every user to attain privacy. Results of breast examination can be observed after the login.	Same as the estimated outcome
4.	Camera and Storage	After employing the LED of the portable device under the breast, images are taken using the camera. These images are stored in the mobile application.	Same as the predictable outcome
5.	Communicating AWS and Retrieving results	Images are sent to Amazon Web Server for Image classification after taking the images for examination. The classified result is directed and stored in user's profile in the mobile application.	Same as the estimated outcome
Database (Amazon Web Service)			
6.	Image Classification	The algorithm in the database classifies and identifies the incoming image and sends the result to the same user.	Same as the expected outcome

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5. Conclusion

Diagnosis of Breast Cancer with the efficient optical method, women can examine their breast at their living place and with IoT, AWS and Deep-learning algorithms the examined results can be known from their living place through the mobile application ABCD. The purpose of this device is to identify the cancer cells in the breast of women in the early-stage by self-examination. Thus, the Breast Cancer detection device is designed, developed and tested for the identification of breast cancer cells in real-time. The outcome of the device had promising results. Thus, this device is used for the early-stage detection of cancer cells in the breast.

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