ISSN: 0976-822X

Available online on www.ijcpr.com

International Journal of Current Pharmaceutical Review and Research 2022; 14(1); 23-31

Original Research Article

STUDY ON FABRICATION OF A DEVICE FOR FINDING VEINS AND EARLY DETECTION OF BREAST CANCER USINGOPTICAL SPECTROSCOPY

HuuThuan Mai*, Ngoc Anh Vu Thi, HuuTiep Nguyen, Minh Chau Nguyen Thi

School of Engineering Physics, Hanoi University of Science and Technology, Ha Noi 100000, Vietnam

Received: 01-03-2022 / Revised: 15-03-2022 / Accepted: 31-03-2022
Corresponding author: Huu Thuan Mai
Conflict of interest: Nil

Abstract

Detection of veins is very important technique in the medical clinic applications. Moreover, early detection of cancer, especially breast cancer is the important with patient. This paper presents a preliminary study on the design and fabrication of blood vessel and breast tumor detection devices (BVTDD). The BVTDD device uses a red to a near-infrared light-emitting diode that allows practitioners or doctors to visualize blood vessels and superficial organizations like breast tumors with the naked eye. It has three operating modes including start, shallow test and deep test with a scanning time of 3-5 minutes. The results showed that the BVTDD could provide clear images of blood vessels and breast tumors with the skin penetration depth up to 15 cm. The breast tumor scan tests with the BVTDD for the patients were also found in good agreement with the respective MRI scans. The BBDD device has the advantages of simplicity, ease to use, providing potential practical applications in the medical field, e.g., for assisting superficial tumor diagnoses with MRI and/or CT scans.

Keyword: Blood vessels detection device, red LED lights, breast tumor.

INTRODUCTION

In medicine, the skill of identifying veins in infusions, taking blood is a skill that not all doctors can perform well. Finding a vein is difficult (especially for children, women, and obesity) [1-7]. It is not uncommon for cases of vein deviation or rupture of vessels when injected or drawn blood that has adversely affected the patient. The vein retriever process requires the precise operation of people with experience and is not allowed to make mistakes because if taken many times will cause pain and discomfort to the patient [5,6]. Moreover, as we known, breast cancer is one of the most commonly diagnosedcancer and has become the leading cause of cancer death for women [8,9]. On the other hand, in the current breast cancer screening, there are still methods such as ultrasound [10,11] tomography [8,12] MRI [13]. It is quite expensive, and it takes about 10-30 minutes to get results and may take many steps.

In the world, there are a few researchers who have come up with vascular screening devices of different styles to improve the quality of medicine [9,14-16]. In Vietnam, there is no research facility to manufacture handheld devices to locate blood vessels and tumors. Due to the modern equipment and high cost of imports, the downline medical facilities are not equipped. Therefore, the study of making this device using red LED chips in Vietnam has practical and necessary significance. In this paper, we presented some of the initial results when using blood vessel and breast tumor detection devices to identify veins and shallow tumors on the breast.

EXPERIMENTS

Research Methods

The BVDD is based on biomedical physics principles. Analyze and select electronic elements and suitable materials for fabrication equipment.

Physical basis and operating principle of BVTDD

In the composition of hem pigment, red blood cells of the porphyrin type are substances capable of combining with metal atoms. Hem in humans is protoporphyrin IX in combination with Fe. Hem has 4 pyrol nuclei linked together by the menten bridge (-CH=). Porphyrin rings are attached to methyl (-CH3) root in positions 1, 3, 5, 8; vinyl originals (-CH=CH2) at 2 and 4; propionyl radicals (-CH2 - CH2 - COOH) at 6 and 7. Fe is attached to the inner top of the pyrol nucleus by two homonymous and two coordinated links and with globin through the base of histidine. Each Hb has 4 hems, in which one hem has 1Fe2+. Based on these connections, when analyzing blood on spectrometers, we obtain the maximum absorption spectrum in the region of 540 nm ÷ 580 nm (□1 = 542 nm, □2 = 556nm, □3 = 578nm). At 633 nm, the optical properties of human blood with hematocrit are 10% and oxygen saturation of 98% is 0.210 ± 0.002 mm-1 for μa, 77.3 ± 0.5 mm-1 for μs and 0.994 ± 0.001 for G factor [2], [6]. An increase in hematocrit up to 50% led to a linear increase in absorption and a decrease in scattering. Fluctuations in osmosis and wall cutting speed have led to a change in all three parameters, while the change in oxygen saturation only affected a significant change in absorption coefficient. A spectrum of all three parameters is measured at a wavelength of 400 ÷ 2500 nm for oxidized and de-oxidized blood, indicating that blood absorption follows the absorption of hemoglobin and water. The reduced scattering factor for wavelengths λ = 500 nm with approximately 1.7; The g coefficient is 0.9 higher than the entire wavelength range [9], [14], [17]. By determining the properties and intensity of the reflexes on the surface of layers of skin tissue, muscles, and blood vessels. Based on the above reasons, we designed and manufactured BVTDD equipment.

Techniques

Analysis of circuit components, electronic devices.

Determine the physical parameters of the device by modern measuring devices and reliable devices (Kyoritsu 1052 - Japan, Lux Meter Testo 0500 - the USA, Testo 608-H2-US electronic thermometer).

Fabrication design

Component selection: RED LIGHT LED Chip, IC Stable Pressure and Line Stabilization, Line stabilization circuit design for LED and device shell scheme show in Fig.1

Device case: Aluminum Projector

material: Hard plastic Projector

diameter: Φ=32.90 mm Projector

length: 34.50 mm Device size: 200.00 x38.20 x50.06 mm.

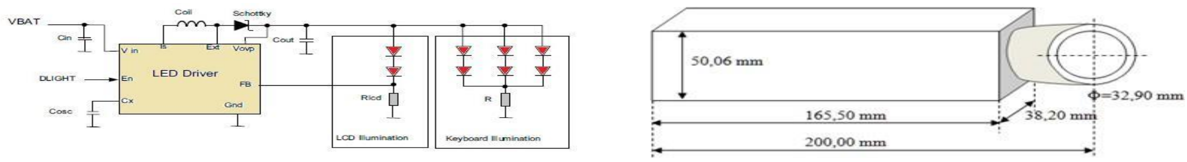

Figure 1: Current stabilizer circuit for LED and Device shell scheme

Measurement process

Experiment 1: After designing and testing the elements of the device, the equipment is assembled according to the design scheme, then the basic electrical parameters of the BVDD (voltage, current intensity when operating) are measured using a universal meter (Kyoritsu 1052 - Japan) and some other indicators.

Experiment 2: Survey the parameters of BVTDD: measure the brightness intensity on three modes of the device (start, shallow test, deep test) and check the heat increase of the device in the screening area for a period of 1 to 25 minutes.

Experiment 3: Screening of BVTDD on the surface of the hands of adults and children.

Experiment 4: Use BVTDD to identify a position on volunteers and breast cancer patients, then test with MRI.

RESULTS AND DISCUSSION

Studies of basic parameters of BVTDD

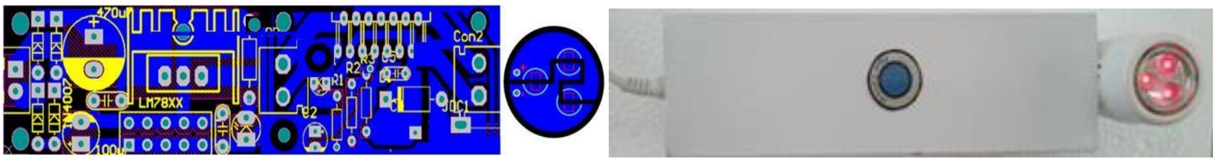

Figure 2: Printed circuit scheme and the BVDD

Device specifications

The BVDD presented in Fig.2 with device specifications: Power supply: 220V ~ 50Hz; Power Consumption: 7W; Dimensions: 200.00 x 38.20 x 50.06 mm; Φ 32.90 ± 0.02 mm (use caliper, micrometer); Weight: 720 g and ability to project deep through tissue layer 3 ÷ 5 cm;Measure brightness and local heat measurement of the illuminated area

Using the Lux Meter (Testo 0500 USA), place the sensor head of the lux meter close to the header of the BVTDD, measure the brightness intensity in different changing modes. Using an electronic thermometer (Testo 608-H2), place the head of the skin contact sensor in the area of the area, measure the heat increase in different changing modes as startup mode temperature (Tst), shallow test mode temperature (Tsh), average test mode temperature (Tav), and deep test mode temperature (Tde), respectively. The results of the brightness of the device (BVTDD) exhibited in table1. The brightness of the device (BVTDD) in starting mode is about of 4008.4 lux which is bright enough to scan the capillaries close to the skin. This model is suitable for the mode of shallow tumor surface scanning or vascular examination. Shallow test mode is about of 63032 lux suitable for tumor screening, subcutaneous lymph nodes (cervical, nasopharyngeal, breast tumors), and this mode has a depth of about 3÷ 4cm (Fig. 3b). Deep test mode is about of 98238 lux is suitable for the tumor, deep under the skin of the breast area 7 ÷ 15 cm this mode is suitable for the diagnosis of breast cancer (Fig. 3c). Moreover, the temperature of test mode is changed not much following to duration of screening (Fig. 3a). The temperature changed of deep test mode is the largest in the modes and it is about 0.59 oC in 25 mins. It means that the device operates stably with temperature.

Table 1: Results of measuring the brightness of BVTDD

No.	Startupmode(lux)	Shallowtest mode (lux)	Deeptest mode(lux)
1	4007	63030	98240
2	4009	63040	98230
3	4012	63040	98240
4	4006	63030	98230
5	4008	63020	98250
Average	**4008.4**	**63032**	**98238**

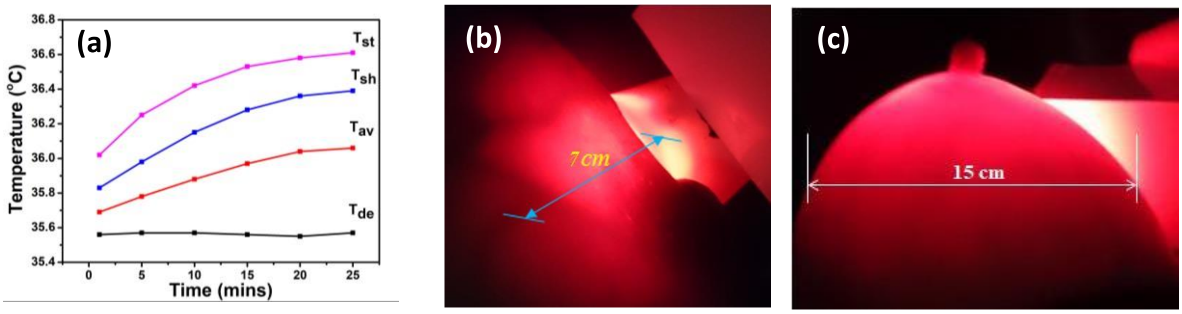

Figure 3:(a) The relationship between temperature and duration of screening, (b) and (c) ECDD device image that scans through layers of adult breast tissue.

Vascular results in adults and children

Angiogram of blood vessels image on the arm and hands of adults and children (1 to 6 age) using the BVTDD device presents in Fig.4. The difference in vein images was compared by adult's hand and children's hand imaging. The results of the study showed the effectiveness of the device in identifying the vein in real-time for both locations and both case.

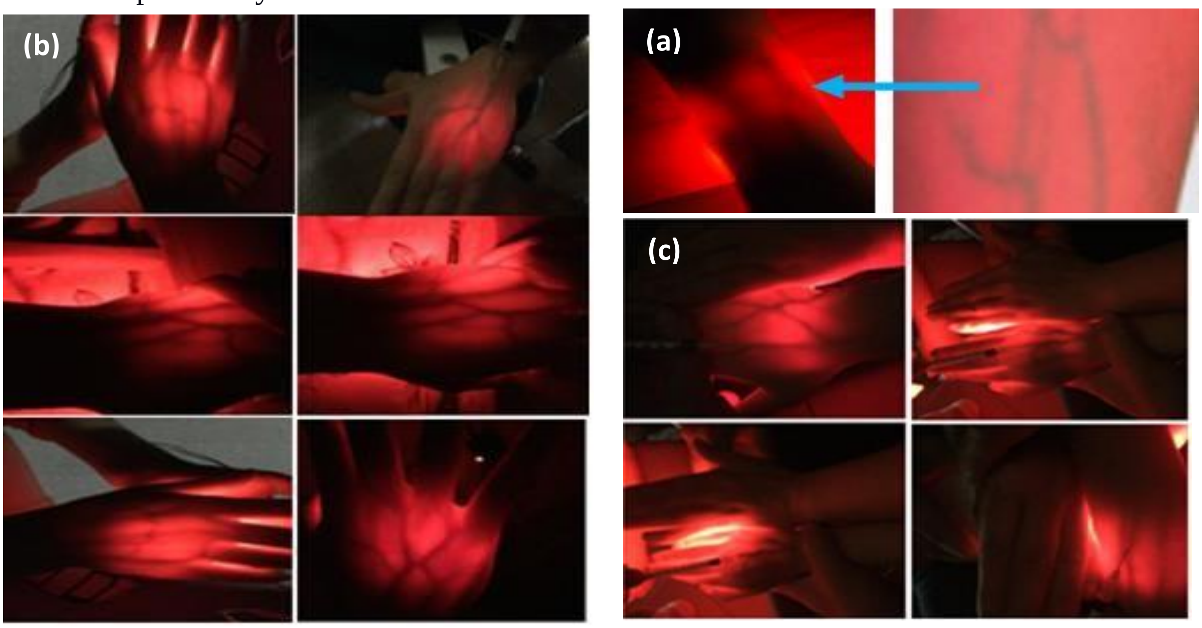

Figure 4: Vascular screening using BVTDD device: (a) an adult's arm, (b) an adult's hand and(c) the children's hands.

Breast test results on volunteers & patients.

The first, a screening image of BDTDD was conducted on volunteers. The volunteer was randomly selected between the ages of 18 and 60 (never had breast cancer tested with any medical devices, no suspicious or conclusive signs of breast cancer). Information of volunteers is shown in the table S1. The scan results illustrated in Fig.

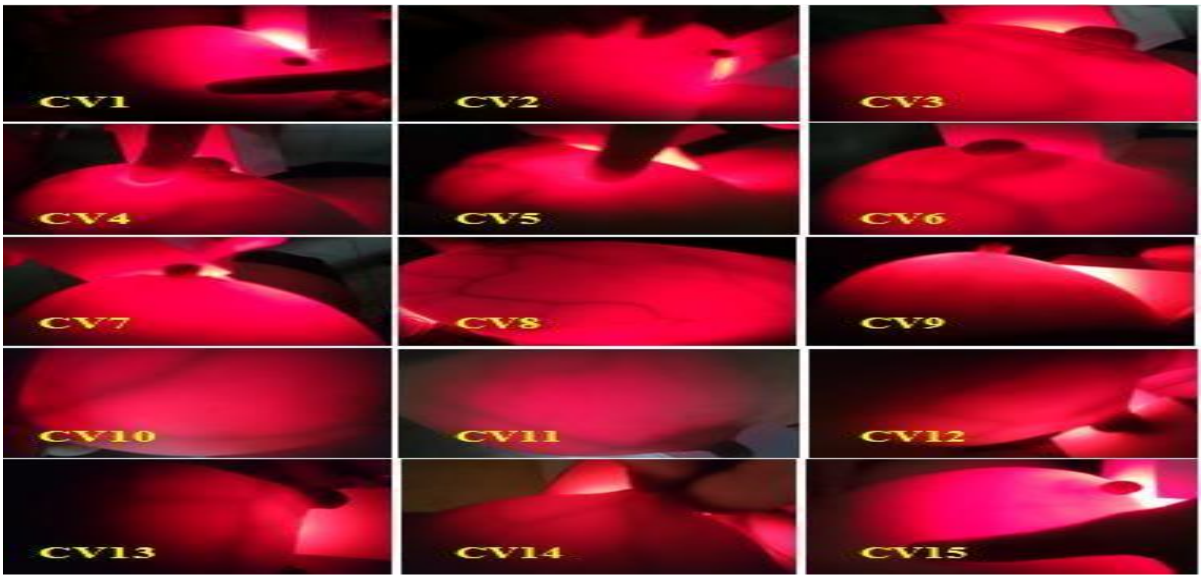

Figure 5: BVTDD image on breast of the volunteer

The non-screening area and the scanning area. At the illuminated area, we observe with the eye sees the mammary gland blood vessels with a dark red color, with the appropriate brightness intensity we can observe the layers of breast tissue. Therefore, no need for an infrared camera auxiliary device to connect a computer to simulate the image, we can also see the inside image of the breast when using used equipment. The results of breast cancer screening with the BVTDD on 15 volunteers showed quality images, observed with the naked eye, the mammary glands, blood vessels are very clear, no abnormal organization, no lymphoma.Twelve (12) patients who took part in the scan had abnormal breast abnormalities (table S2). Two MRI patients found to have tumors then had breast cancer scans using BVTDD devices, the rest were clinically examined suspected that the tumor had an MRI scan (appendix I), conducted a BVTDD scan and an MRI scan.

Patient profile: Nguyen Thi H, 58. Profile number: 7673/20. Address - Giap Bat - Hai Ba Trung-Hanoi. Diagnose: Mammary tumor (T), size 60 x 63mm, middle tumor in the breast (T), non- mobile soft tumor (□(t): Left mammary K (T) T4N0M0. GTB UT GDII). The MRI and BVTDD exhibited in Fig.6. The MRI image showed the tumor, location, and size of 60 x 63 mm of these images taken after the photoreceptor injection and through a computer simulation system. Observing two perpendicular images from the BVTDD device, we also see that the tumor area is darker than the area around the tumor, especially the border area is very clear, so it is easy to recognize the shape of the tumor's position and size. Because the device has not integrated the computer, the tumor size on the image of BVTDD is not quantized, but through the naked eye, we also estimate the size of the tumor.

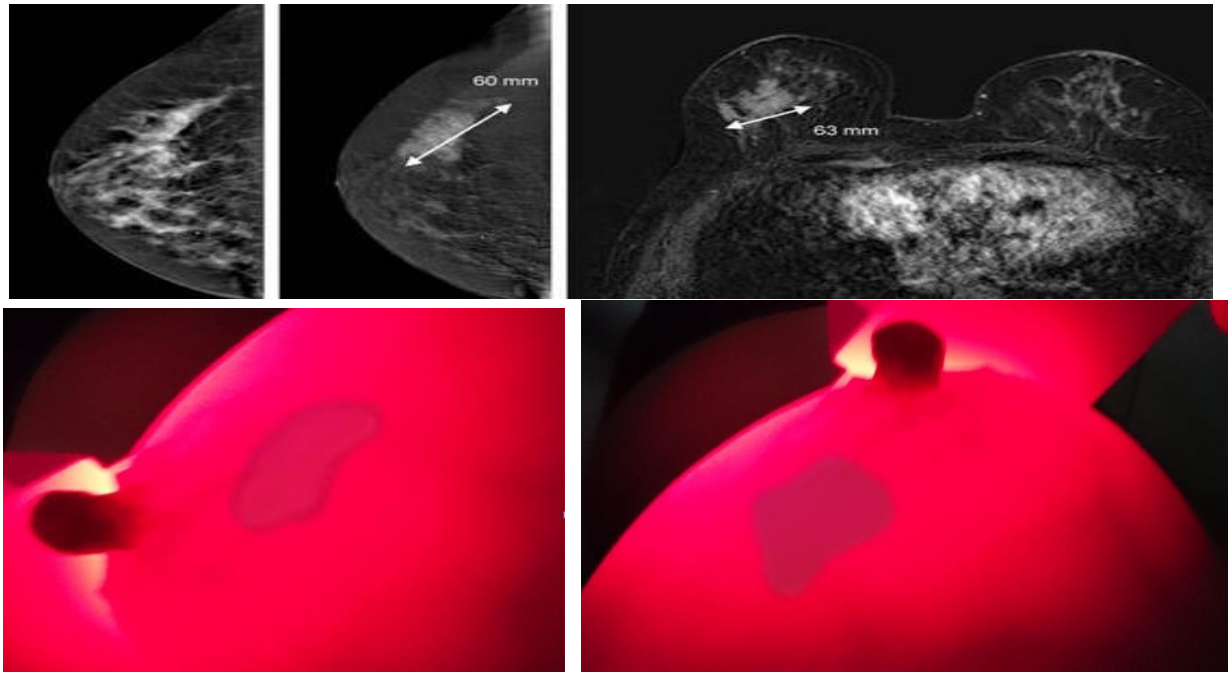

Figure 6: MRI images and BVTDD scans of patient Nguyen Thi H

Patient profile: Vu Thi L, 64. Profile number: 7692/20. Address - Nghèn Town, Cam Loc, Ha Tinh. Diagnose: Mammary tumor (T), size 16 x 29mm, Inner protrusive bottom (T), I am probably not mobile (□ (t): Left mammary gland (T) T4N0M0. GTB UT GDII). Results of MRI and BVTDD scan showed in Fig.7. Similar to Nguyen Thu H patient, the images were taken on the disease give clearer and darker images (it may be because one patient has a different type, solid lymph nodes according to the results of clinical examination) we observe the depth of the tumor, the area around the tumor (yellow vinculum) develops many capillary organizations so it is darker than the middle area tumorcente (blue vinculum fig.8).

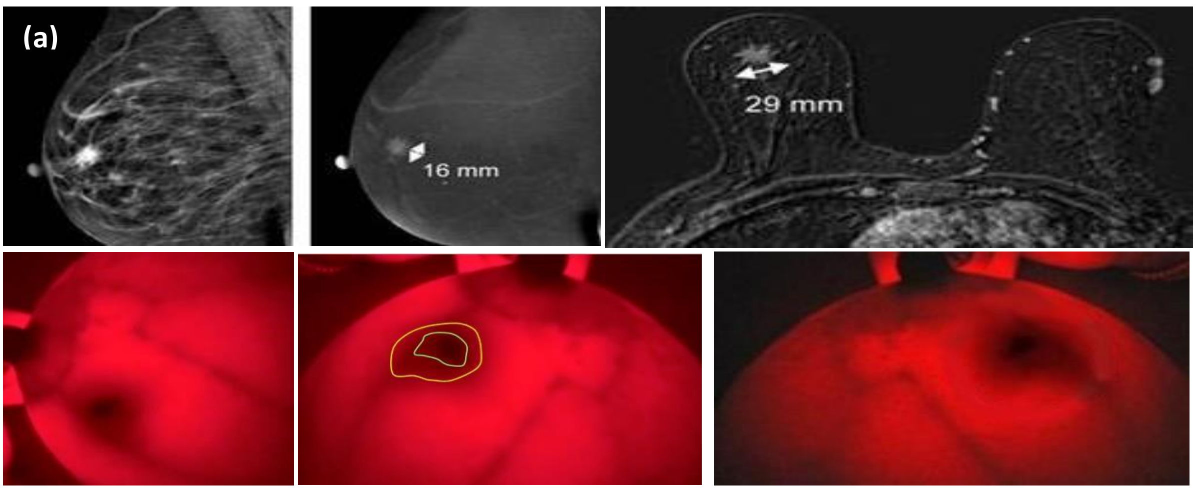

Figure 7: MRI images (a) and BVTDD scans (b) of patient Vu Thi L

The results of BVTDD and MRI scans showed in Fig.8. Observations on the images taken on the BVTDD show that the location and size of the tumor are very clear the depth or density of cells and the internal environment in and out of the typical tumor in patients UHV1, UHV7, UHV8, and UHV9. On the other hand, breast MRI images on the upper patients also show the location and size of the tumor for the same result as BVTDD. The advantage is that the penetrating image compared to the black and white image on the MRI is recommended to observe the tumor boundary area. The BVTDD device takes 2D, 3D images of the screening area on the body. Visually observing with the naked eye into the image, we can have seen some of the structures inside the skin that are layer-by-layer vascular systems in depth. For breast tumors, it is also close to the location, size, and invasive areas around the tumor. The device has the advantage of simple structure, easy to use, clear images can be observed with the naked eyes. The area of light emitted in the red area of the spectrum is not harmful to the eyes or skin, because infrared lights are used in the treatment of skin diseases in the cosmetic industry and other areas in health. BVTDD is specialized for a blood angiogram of shallow tumors. There are outstanding advantages when it comes to breast scans compared to CT scan or MRI methods: Without photovoltaic injections, the 3÷5minutes scan time (CT scan, MRI 25÷30 minutes) costs an estimated 7 ÷ 9 million so if the cost of a test is negligible compared to the MRI (2.3 ÷ 2.8 million / 1 degree), The patient can take a selfie and easy to see their result, easy-to-use.

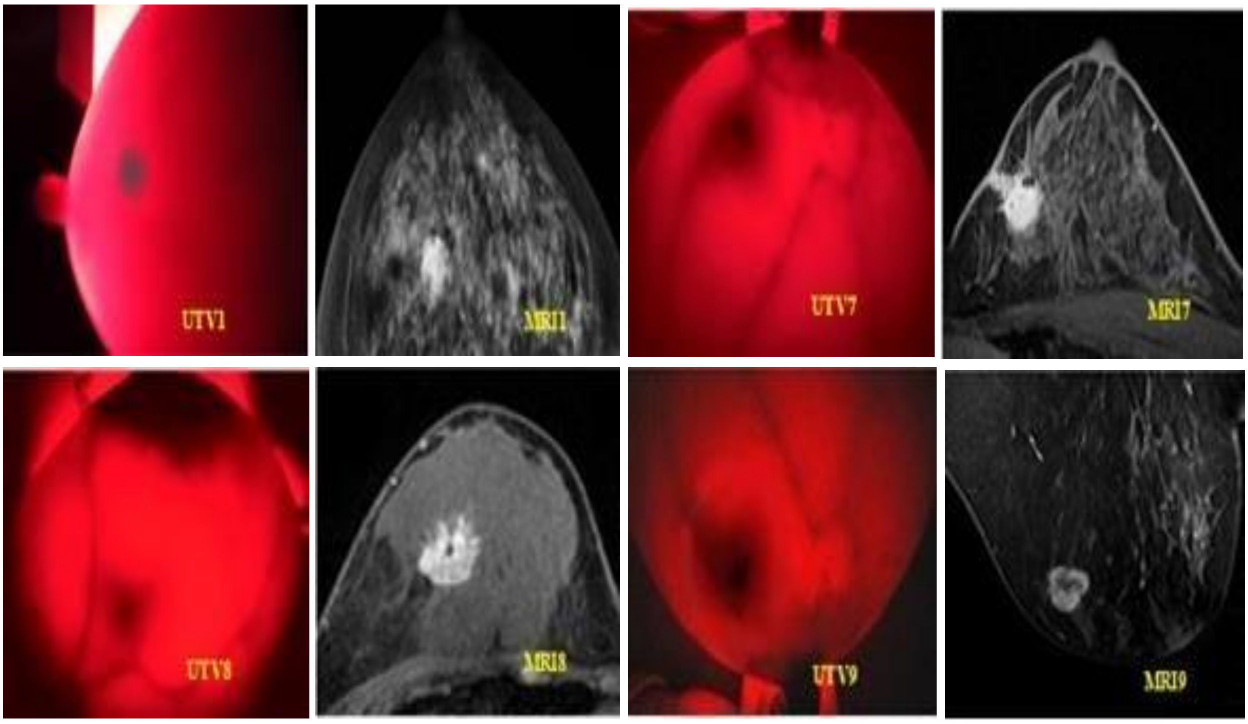

Figure 8: BVTDD and MRI scans of breast cancer patients

CONCLUSIONS

The designed and fabricated equipment (BVTDD) with basic specifications: Power supply: 220V ~ 50Hz; Power Consumption: 7W; Size: 200.00 x 38.20 x 50.06 mm; Φ 32.90 ± 0.02 mm; Weight: 720 g; Ability to project deep through the largest layer of breast tissue 7 -15 cm. BVTDD does not burn on the screening part, emits red light (the main wavelength of 633nm is healthy radiation, does not cause side effects), there are three screening modes, maximum brightness intensity 98238 lux, inspection time 3 ÷ 5 minutes, the image is close to the naked eye. Surveyed safety specifications when using the BVTDD on volunteers and patients gives very good initial results: XCS observations identify blood vessels, tumors in the breast, and surrounding organizations very clearly to determine the location, size of the tumor, the area around the tumor directly without surgery or other diagnostic methods. A parallel examination on the MRI with reliable result. Imaging method based on the principle of energy absorption of the mass is a new method in diagnostic imaging, both in the world and in Vietnam, so this study could help to access and update research and application in other industries. The subject's BVTDD also expected superior applications with other diagnostic methods. The BVTDD device is also expected to have applications that are superior to reality.

Acknowledgments: This study is funded by the ministry-level theme, grant number: B2021-BKA-06. The authors would like to sincerely thank the funding support of the Vietnam Ministry of

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