PEMANFAATAN DEEP LEARNING UNTUK DETEKSI DINI PENYAKIT BERBASIS CITRA TERMAL

DR. KHAIRUN SADDAMI, S.T

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING &
TELEMATICS RESEARCH CENTER
UNIVERSITAS SYIAH KUALA
khairun.saddami@unsyiah.ac.id

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TELEMATIKA

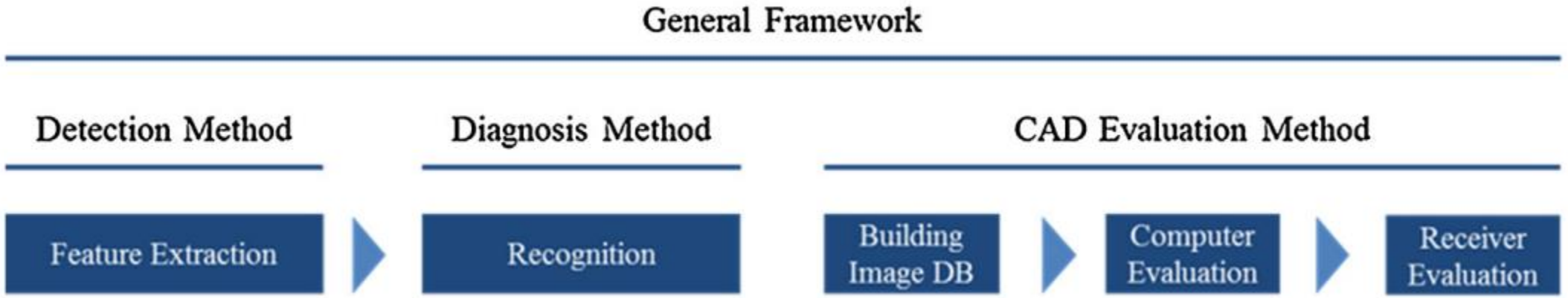
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT
SYIAH KUALA UNIVERISTY

OUTLINE

- DETEKSI DINI
- CITRA TERMAL
- DEEP LEARNING
- DETEKSI DINI KANKER PAYUDARA
- DETEKSI DINI KAKI ULKUS
- DETEKSI OBESITAS

CAD UNTUK DETEKSI DINI

- Computer aided diagnosis (CAD) adalah pemanfaatan sistem komputer untuk menghasilkan output sebagai **alat** yang dapat **membantu** untuk diagnosis klinis.



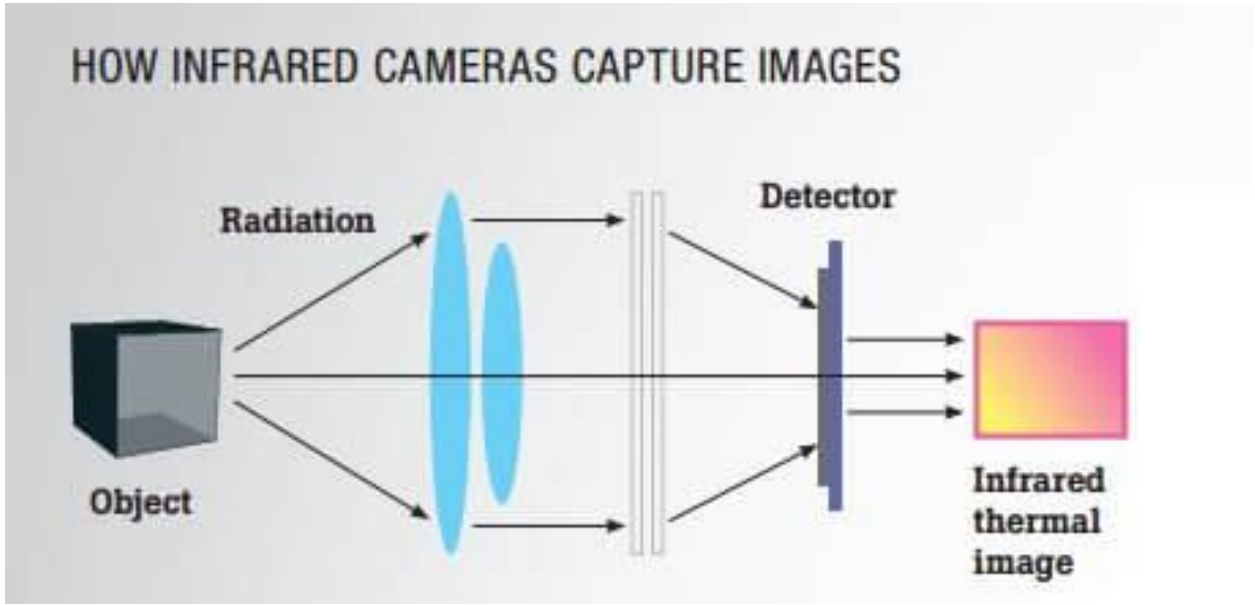
(Takahashi, 2017)

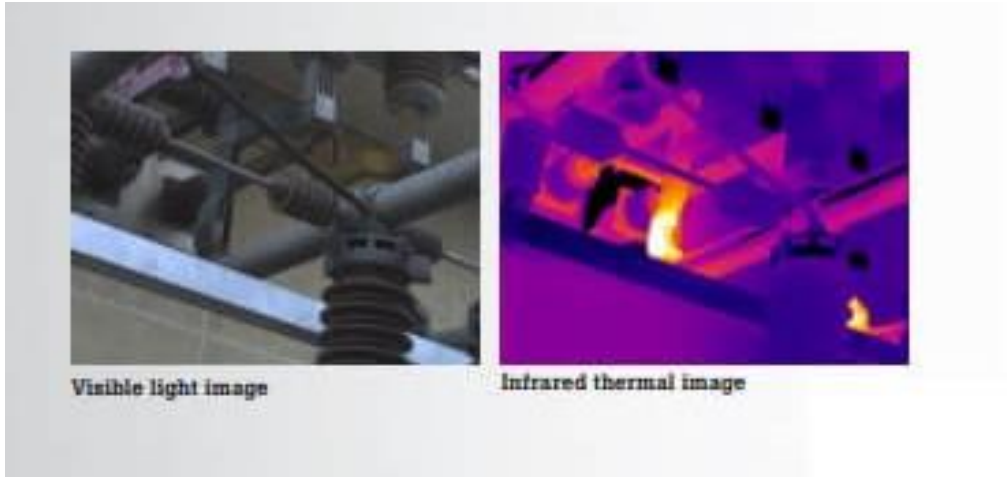
URGENSI CAD DETEKSI DINI

- **Penyakit tidak terlihat atau terdeteksi sejak awal sehingga sering diabaikan oleh penderita.**
- **Tidak ada gejala ringan atau berat sehingga mencapai level yang tinggi.**
- **Pengobatan ketika sudah mencapai level tinggi sudah sangat sulit dilakukan.**
- **Diperlukan teknik deteksi dini, yang mudah, praktis, memungkinkan dilakukan secara mandiri (self screening)**

CITRA TERMAL

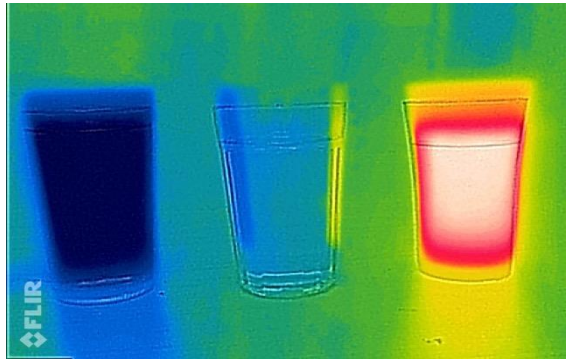
- Pendekatan untuk memperoleh fitur termal (*thermal signature*) suatu objek (tanpa kontak langsung) sering dikenal sebagai pencitraan termal (*thermal imaging*) atau *thermography*



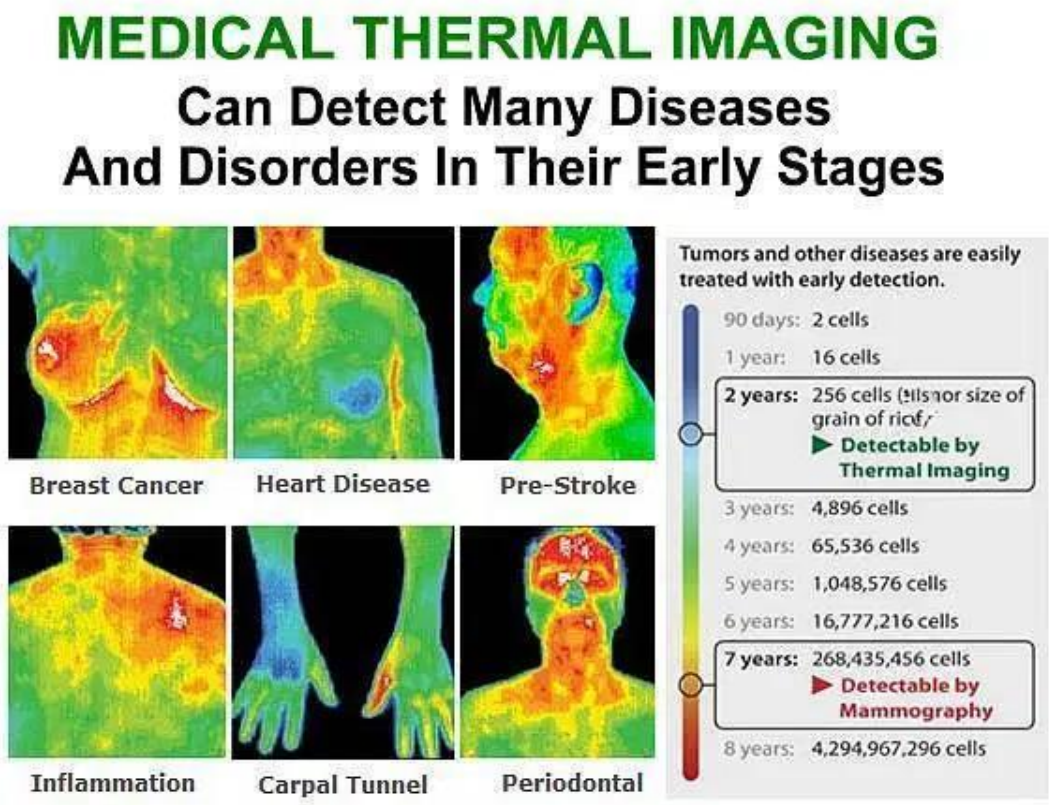


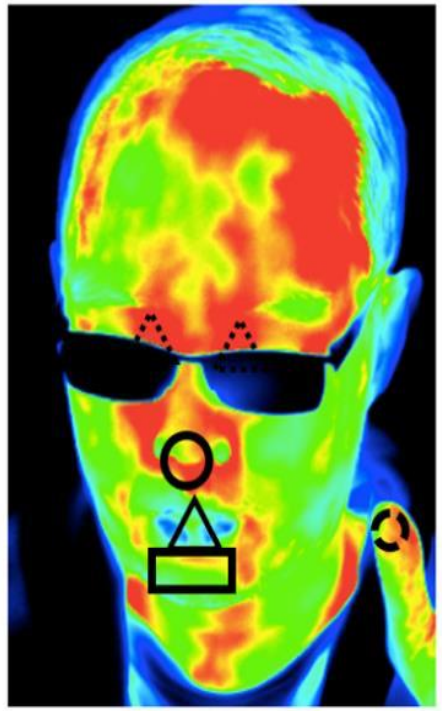
(source: windpowerengeneering.com)

CITRA TERMAL



PEMANFAATAN CITRA TERMAL





- **Mental Stress / Workload**
  - Nose tip ↓ — Genno et al. (1997), Or and Duffy (2007), Veltman et al. (2005), Engert et al. (2014), Abdelrahman et al. (2017)
- **Fear**
  - Finger tip ↓ — Kistler et al. (1998)
  - Nose tip ↓ — Di Giacinto et al. (2014)
- **Startled**
  - Upper lip ↓ — Shastri et al. (2012)
  - Periorbital ↑ — Pavlidis et al. (2001)
- **Sexual Arousal**
  - Mouth, Nose tip, Periorbital ↑ — Hahn et al. (2012)
- **Love**
  - Whole face ↑ — Salazar-López et al. (2015)

KELEBIHAN DAN KEKURANGAN CITRA TERMAL

- MAMPU MEMETAKAN KONDISI JARINGAN BAGIAN DALAM TUBUH MANUSIA.
- FAKTOR EKSTERNAL BERUPA SUHU ATAU TEMPERATUR SANGAT MENENTUKAN HASIL.
- CITRA AKUISISI SANGAT BERGANTUNG KEPADA SENSOR TERMAL DAN KONDISI TERMAL TUBUH.
- DIBUTUHKAN NORMALISASI SAAT PEMETAAN SUHU MENJADI CITRA TERVISUALIASI.
- SENSOR YANG AKURAT MASIH SANGAT MAHAL

KAMERA TERMAL FLIR E95

FLIR E95 Datasheet
(https://www.flir.com/support/products/e95/#Documents)

FLIR

BUILDING APPLICATIONS

FLIR EXX-SERIES™

The FLIR E75, E85, E95, and the entry-level E53 Advanced Thermal Imaging Cameras bring superior sensitivity and a true 42° field of view* together in a user-friendly, handheld platform. These cameras feature a vibrant 4" LCD that makes it easy to spot the subtle indications of building deficiencies and moisture intrusion. With built-in tools such as laser-assisted autofocus*, on-screen area measurement*, and Wi-Fi capability, the FLIR Exx-Series will help you quantify and document air leaks, moisture, and other building problems.

www.flir.com/Exx-Series

Features By Camera	E95
IR Resolution	464 × 348 (161,472 pixels)
UltraMax®	645,888 pixels
Object Temperature Range	-20°C to 120°C (-4°F to 248°F) 0°C to 650°C (32°F to 1200°F) 300°C to 1500°C (572°F to 2732°F)
Focus	Continuous, one-shot laser distance meter (LDM), one-shot contrast, manual
Field of View (FOV)	42° × 32° (10 mm lens), 24° × 18° (18 mm lens), 14° × 10° (29 mm lens)
Time-lapse (Infrared)	10 sec to 24 hours
Laser Area Measurement	Yes
Laser Distance Measurement	Yes, on-screen
Measurement Presets	No measurement, center spot, hot spot, cold spot, User Preset 1, User Preset 2
Spotmeter	3 in live mode
Area	3 in live mode
Picture-in-Picture	Resizable and movable

FLIR E95 Datasheet

(https://www.flir.com/support/products/e95/#Documents)

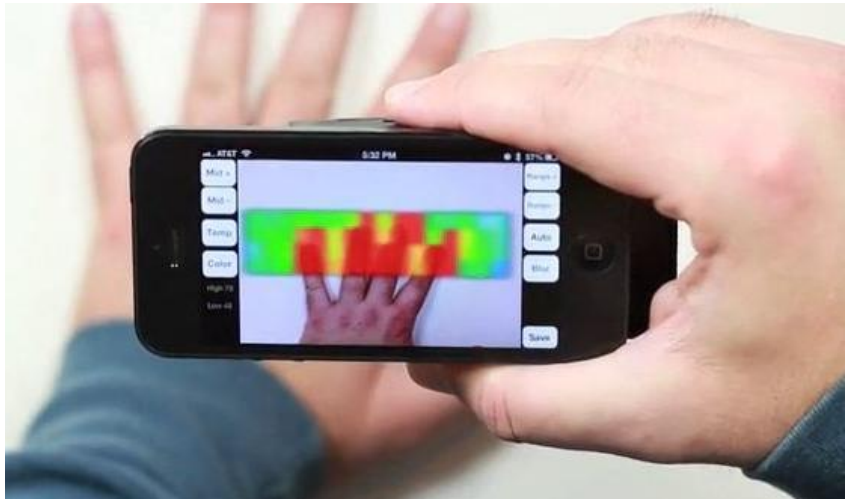
Common Features	
Detector Type and Pitch	Uncooled microbolometer, 17 µm
Thermal Sensitivity (NETD)	<0.04°C @ 30°C (86°F), 24° lens
Spectral Range	7.5 - 14.0 µm
Image Frequency	30 Hz
F-Number	f/1.3
Lens Identification	Automatic
Digital Zoom	1-4x continuous
Image Presentation and Modes	
Display	4", 640 × 480 pixel touch screen LCD with auto-rotation
Digital Camera	5 MP, 53° × 41° FOV
Color Palettes	Iron, Gray, Rainbow, Arctic, Lava, Rainbow HC
Image Modes	Infrared, visual, MSX®, Picture-in-Picture
MSX®	Embosses visual details on full resolution thermal image
Measurement and Analysis	
Accuracy	±2°C (±3.6°F) or ±2% of reading for ambient temperature 15°C to 35°C (59°F to 95°F) and object temperature above 0°C (32°F)
Alarms	Moisture alarm, insulation alarm, measurement alarms
Color Alarm (Isotherm)	Above/below/interval/condensation/insulation
Compass, GPS	Yes; automatic GPS image tagging
METERLiNK®	Yes; several readings
Laser Pointer	Yes; dedicated button

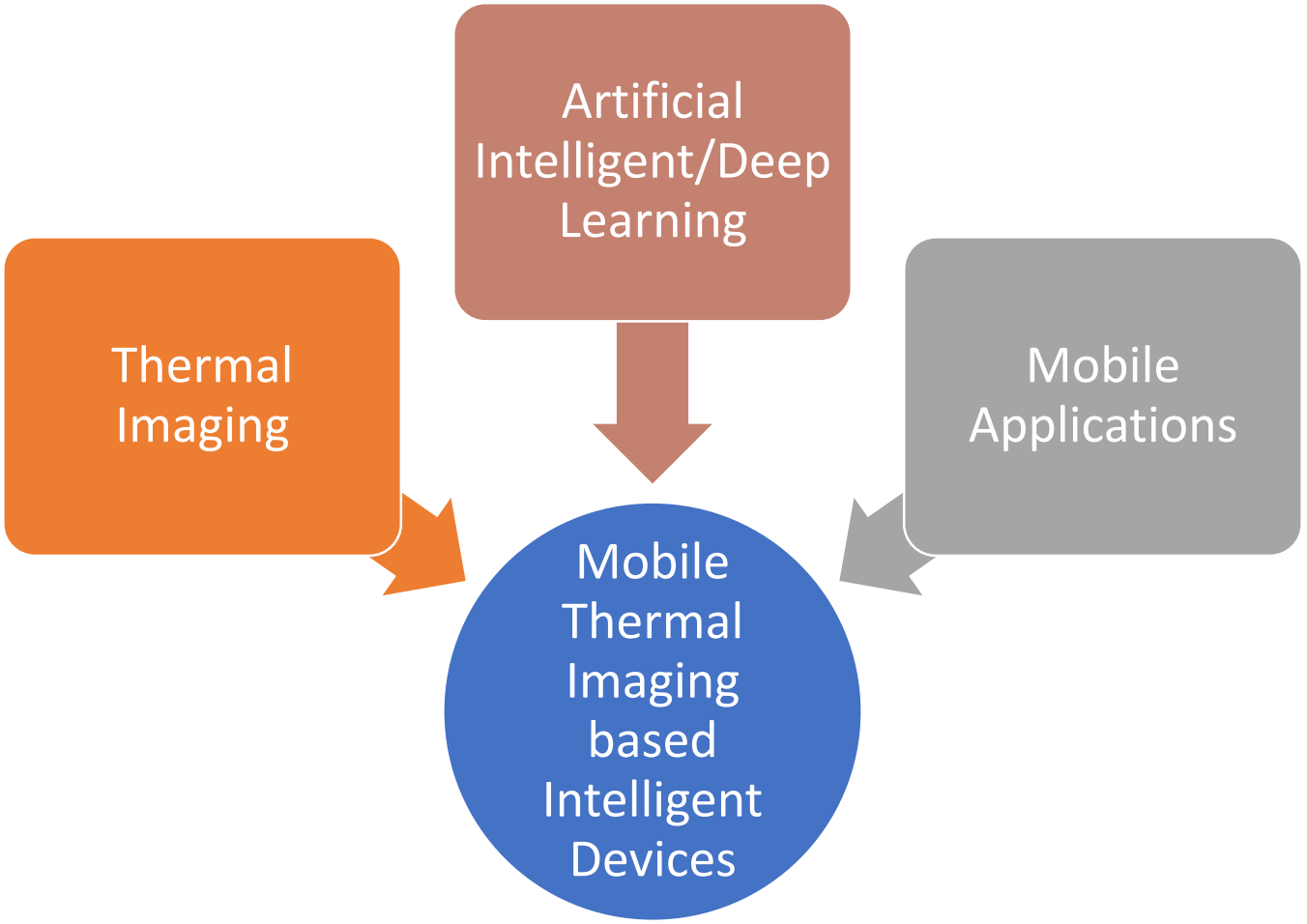
Image Storage	
Storage Media	Removable SD card (8 GB)
Image File Format	Standard JPEG with measurement data included
Video Recording and Streaming	
Radiometric IR Video Recording	Real-time radiometric recording (.csq)
Non-Radiometric IR or Visual Video	H.264 to memory card
Radiometric IR Video Streaming	Yes, over UVC or Wi-Fi
Non-Radiometric IR Video Streaming	H.264 or MPEG-4 over Wi-Fi; MJPEG over UVC or Wi-Fi
Communication Interfaces	USB 2.0, Bluetooth, Wi-Fi, DisplayPort
Video Out	DisplayPort over USB Type-C
Additional Data	
Battery Type	Li-ion battery, charged in camera or on separate charger
Battery Operating Time	Approx. 2.5 hours at 25°C (77°F) ambient temperature and typical use
Operating Temperature Range	-15°C to 50°C (5°F to 122°F)
Storage Temperature Range	-40°C to 70°C (-40°F to 158°F)
Shock/Vibration/ Encapsulation; Safety	25 g / IEC 60068-2-27, 2 g / IEC 60068-2-6, IP 54 /IEC 60529; EN/UL/CSA/PSE 60950-1
Weight/Dimensions	1 kg (2.2 lbs), 27.8 × 11.6 × 11.3 cm (11.0 × 4.6 × 4.4 in)

DEEP LEARNING

- SALAH SATU SISTEM KECERDASAN ARTIFISIAL YANG MEMPUNYAI KINERJA YANG SANGAT BAIK.
- BEKERJA DENGAN MENGHASILKAN FITUR SECARA ARTIFISIAL DAN MENGKOMBINASIKAN SETIAP FITUR DENGAN METODE KLASIFIKASINYA.
- DEEP LEARNING MEMBUTUHKAN DATA DAN SUMBER DAYA YANG BESAR.

APLIKASI SISTEM DETEKSI DINI





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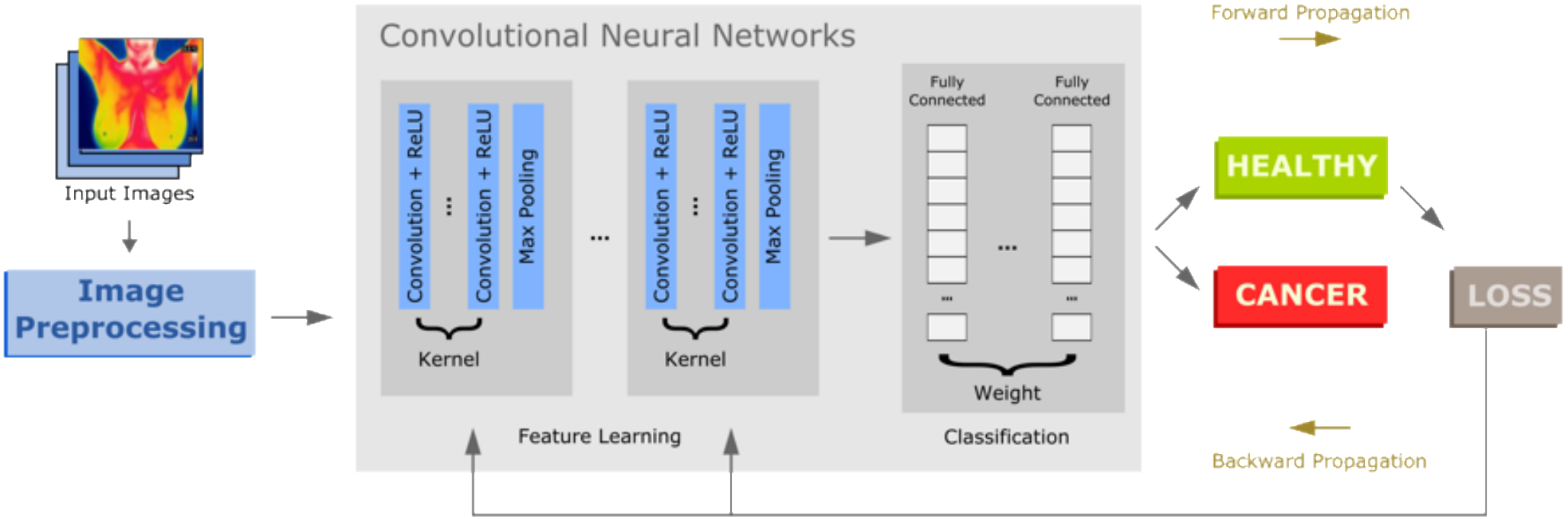
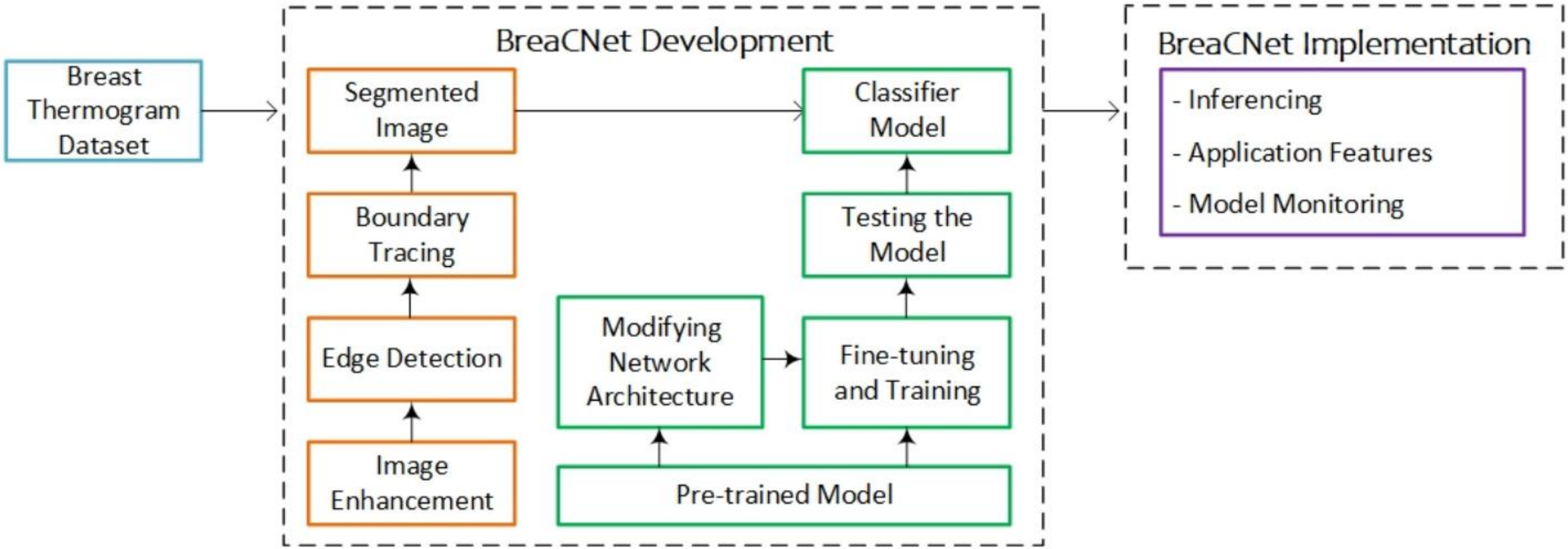
APLIKASI DEEP LEARNING UNTUK KANKER PAYUDARA



(Roslidar, 2019)

BREACNET DEVELOPMENT



PENGARUH SEGMENTASI

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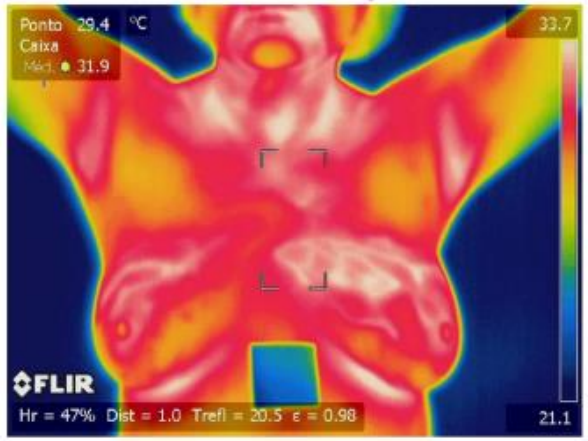

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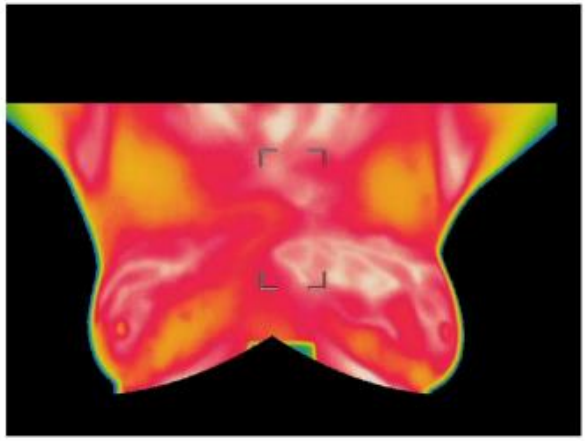

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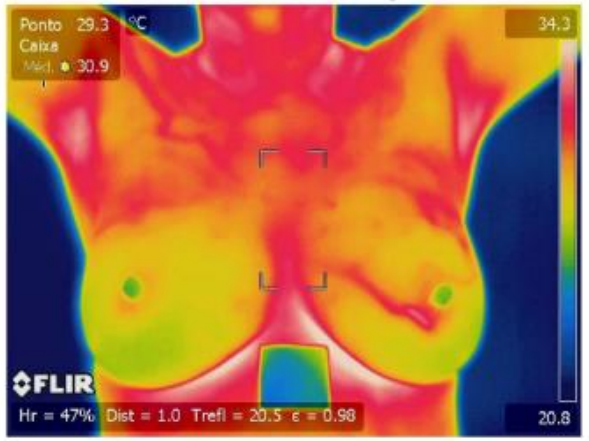

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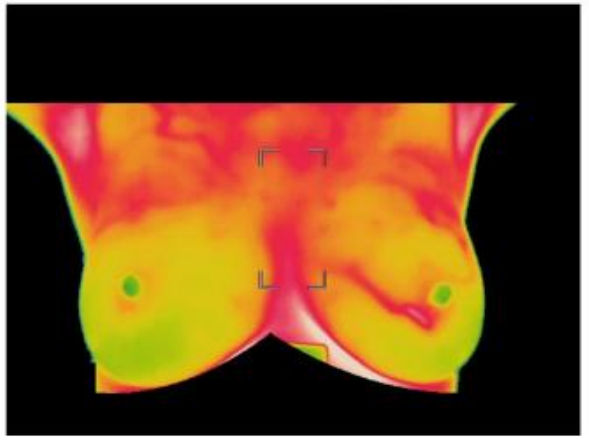
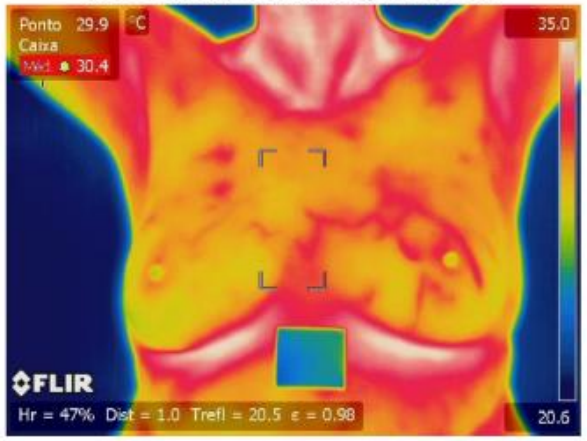


Abnormal with Probability of:0.98798



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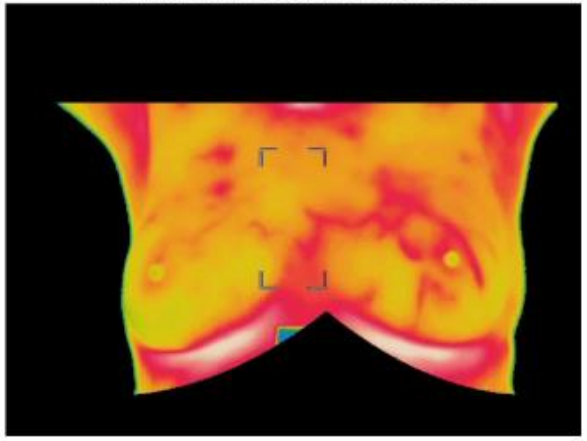

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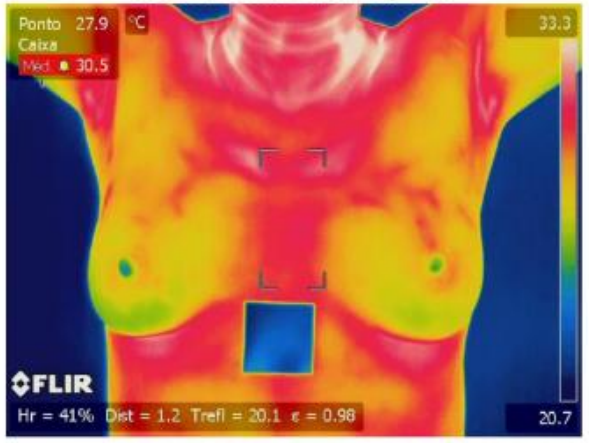
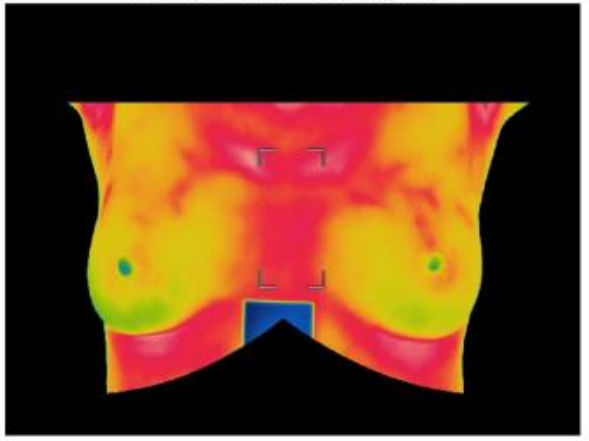
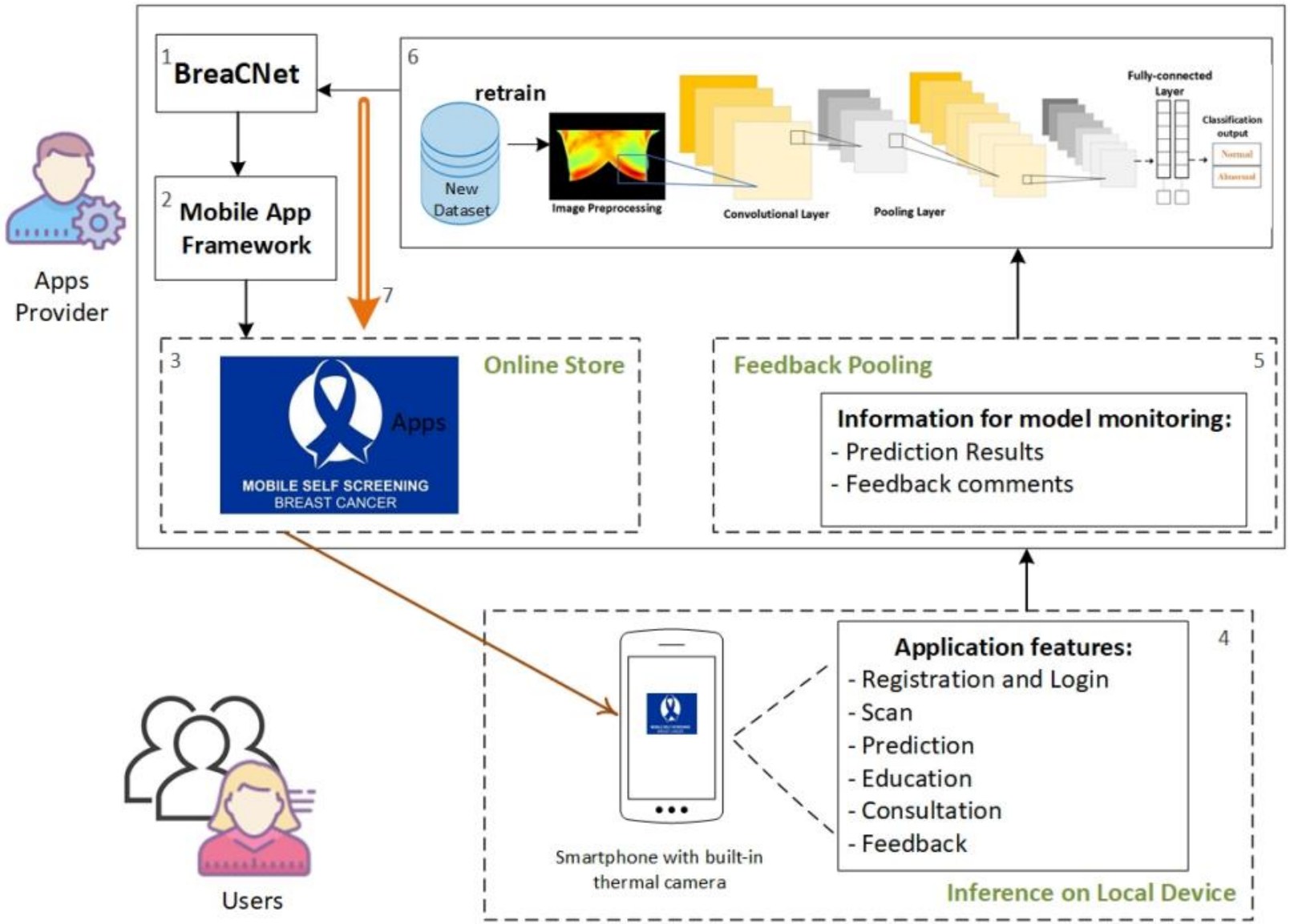


Normal with Probability of:1




1 BreaCNet
2 Mobile App Framework
Apps Provider
6
retrain
New Dataset
Image Preprocessing
Convolutional Layer
Pooling Layer
Fully-connected Layer
Classification output
Normal
Abnormal
7
3
Online Store
Apps
MOBILE SELF SCREENING
BREAST CANCER
Feedback Pooling
5
Information for model monitoring:
- Prediction Results
- Feedback comments
Users
Smartphone with built-in thermal camera
4
Application features:
- Registration and Login
- Scan
- Prediction
- Education
- Consultation
- Feedback
Inference on Local Device

MOBILE APPS

- https://play.google.com/store/apps/details?id=com.breacnet.breacnet

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APLIKASI DEEP LEARNING UNTUK DETEKSI DINI KAKI ULKUS

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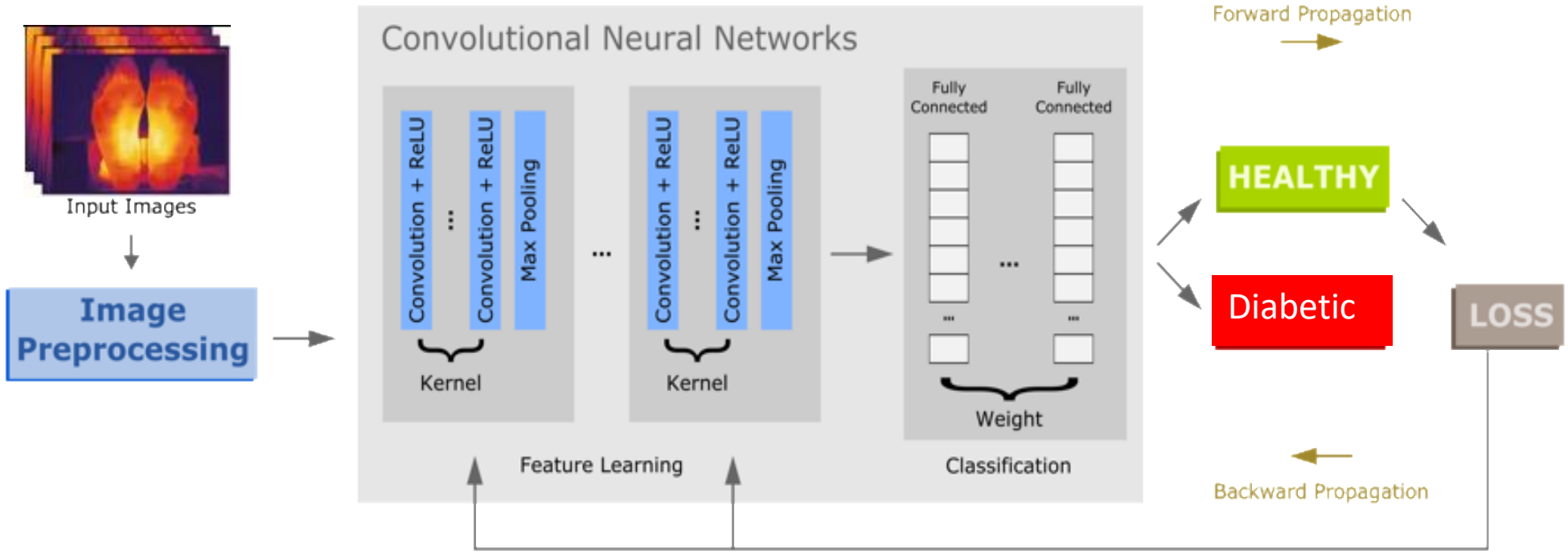
APLIKASI DEEP LEARNING UNTUK KAKI ULKUS

- Diabetes Mellitus (DM) adalah salah satu penyebab kematian paling sering di dunia.
- DM disebabkan oleh aktivitas insulin yang tidak normal.
- Salah satu akibat dari DM yang paling berbahaya adalah kaki ulkus.
- Kaki ulkus disebabkan oleh rusaknya jaringan kulit yang ada tapak kaki.
- Pencegahan kaki ulkus dapat dilakukan dengan melakukan deteksi dini terhadap kaki ulkus dan dilakukan perawatan.

APLIKASI DEEP LEARNING UNTUK KAKI ULKUS



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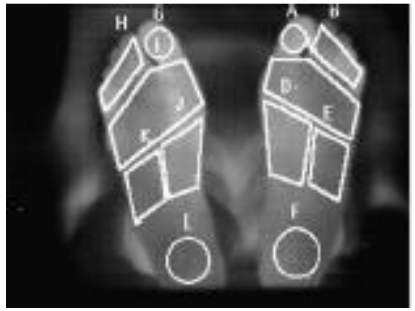
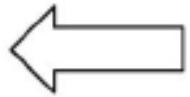
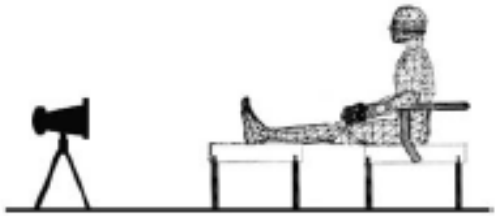
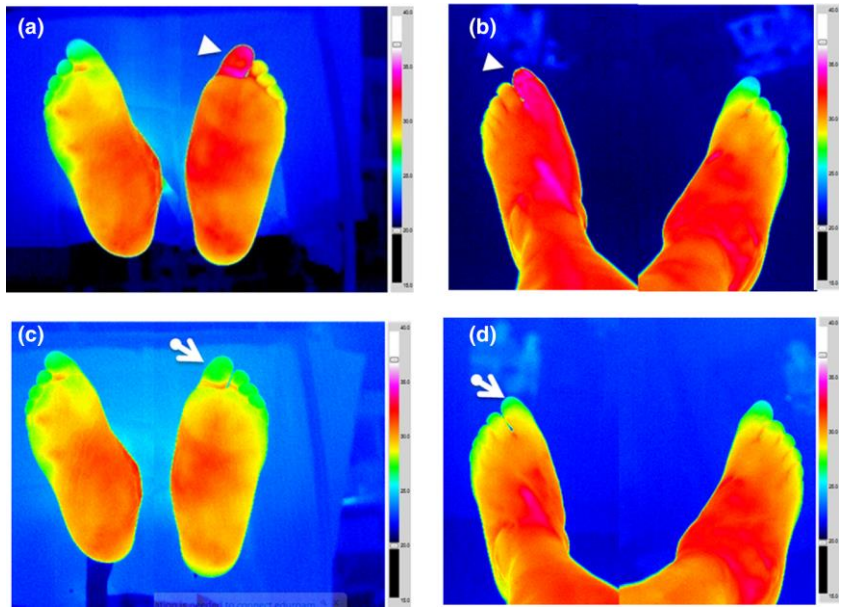


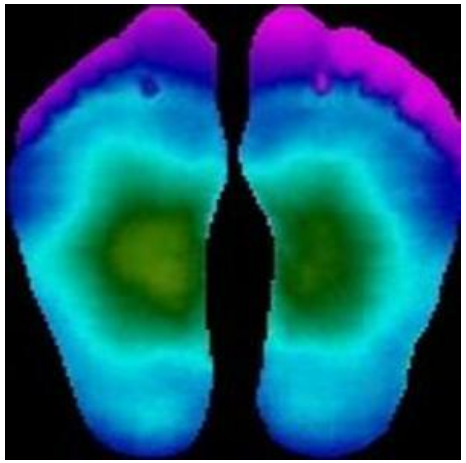


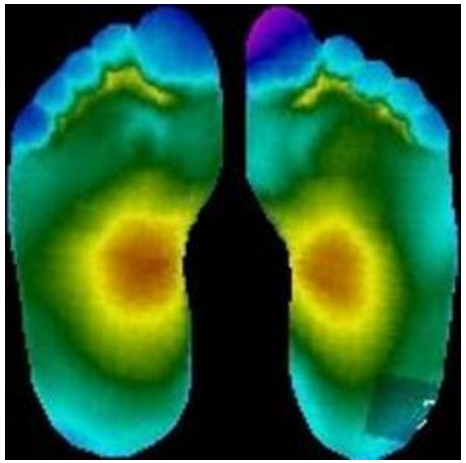




(Vilchauman, 2014)

DATASET THERMOGRAM DFU

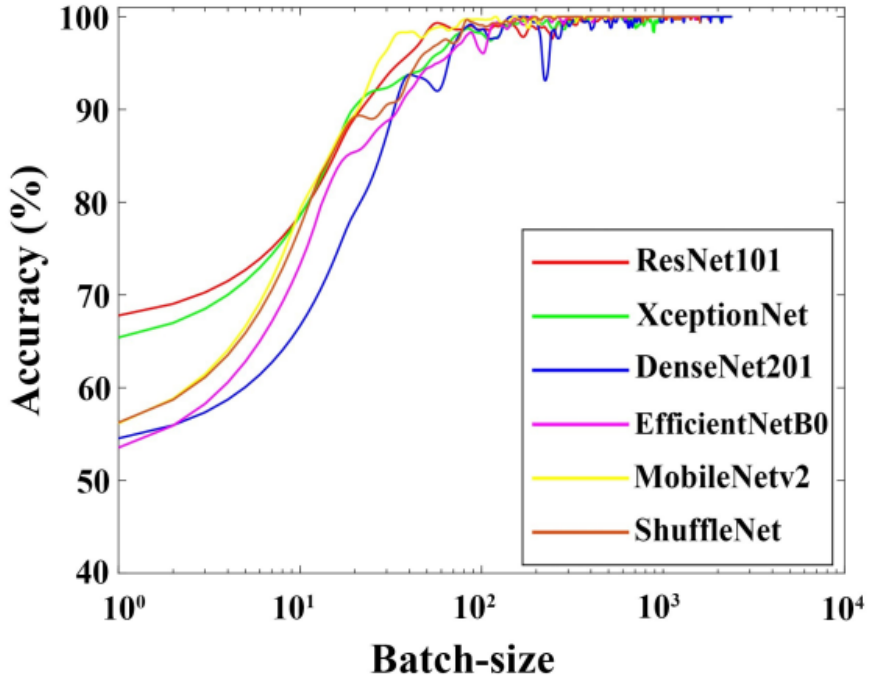


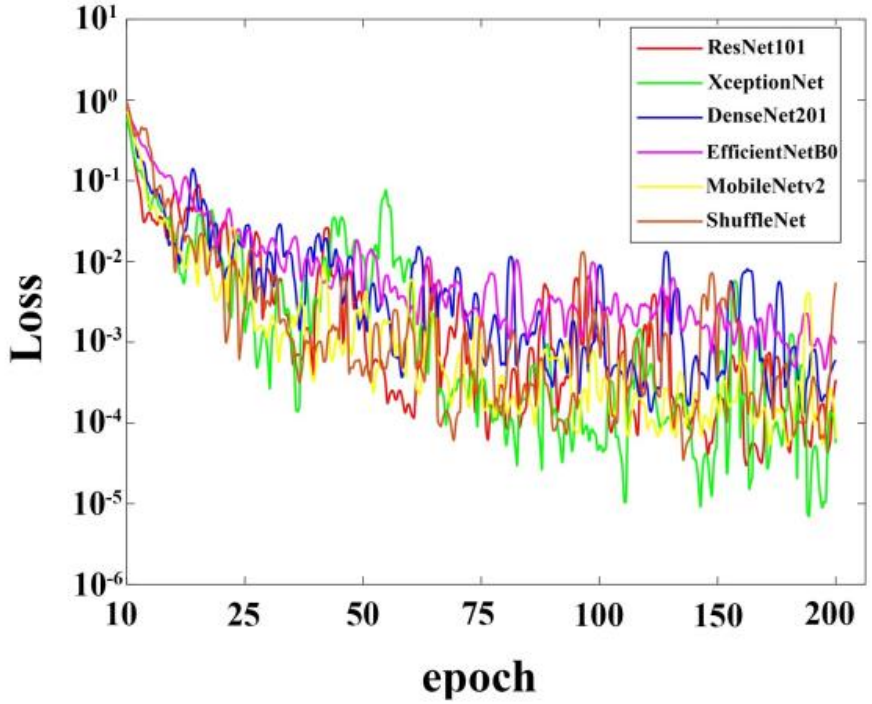



(Hernandez-Contreras, 2019)

APLIKASI DEEP LEARNING UNTUK KAKI ULKUS

- Data Augmentasi
- Variasi dataset yang rendah





MOBILE APPS

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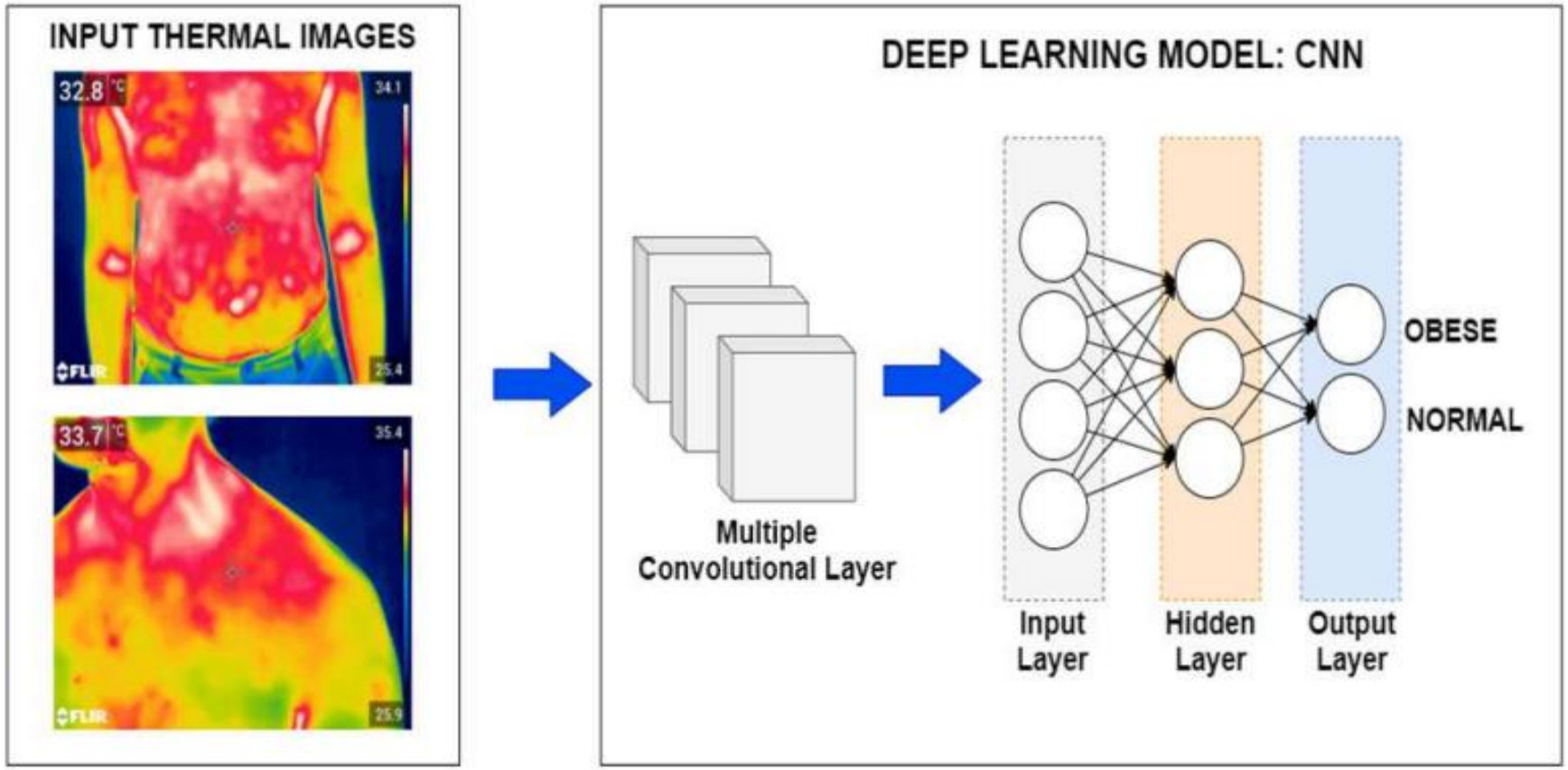
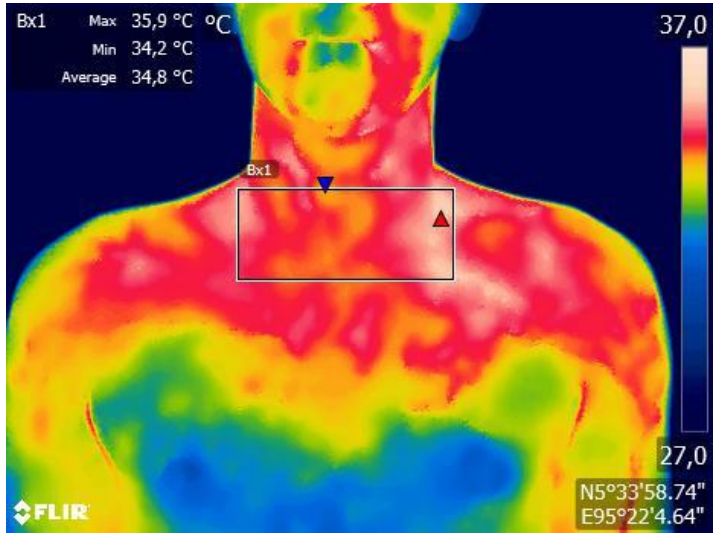
APLIKASI DEEP LEARNING UNTUK OBESITAS

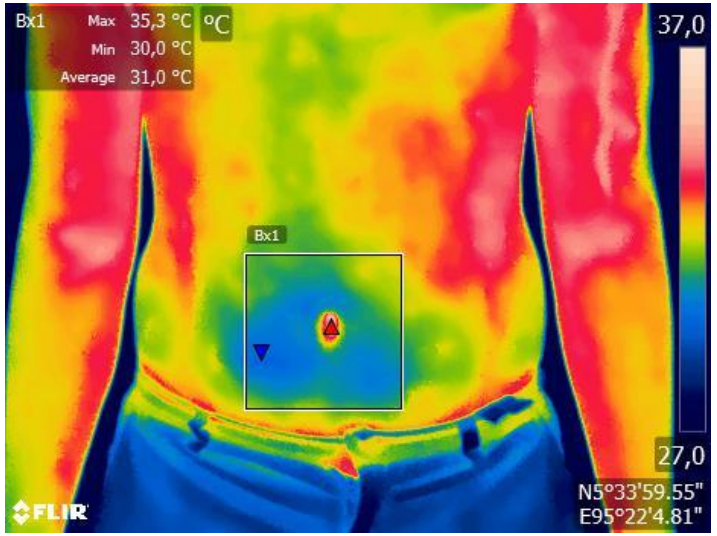
- Obesitas adalah kondisi dimana terdapat lemak berlebihan dalam tubuh.
- Kondisi ini dapat menjadi pemicu penyakit membahayakan lainnya seperti diabetes, heart disease, stroke, dan cancer (Berglund, 2018).
- Citra termal dapat digunakan untuk mendeteksi obesitas, karena mampu mengukur jaringan brown adipose tissue (BAT) yang mengubah energi pada makanan menjadi termal.

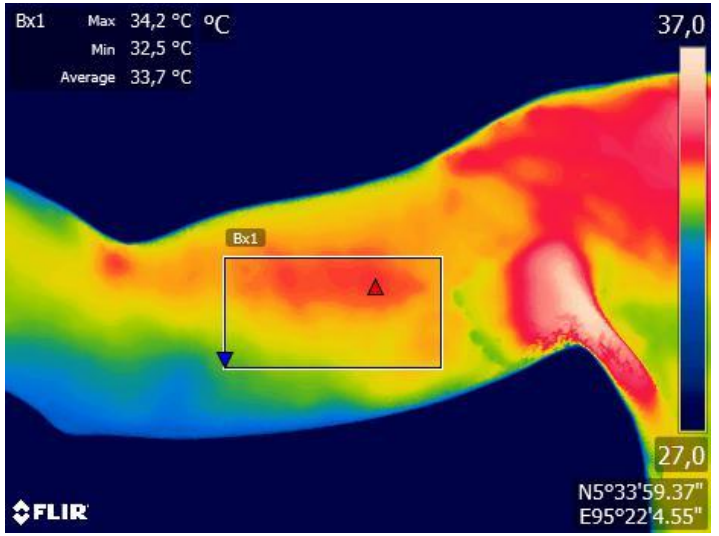
APLIKASI DEEP LEARNING UNTUK OBESITAS

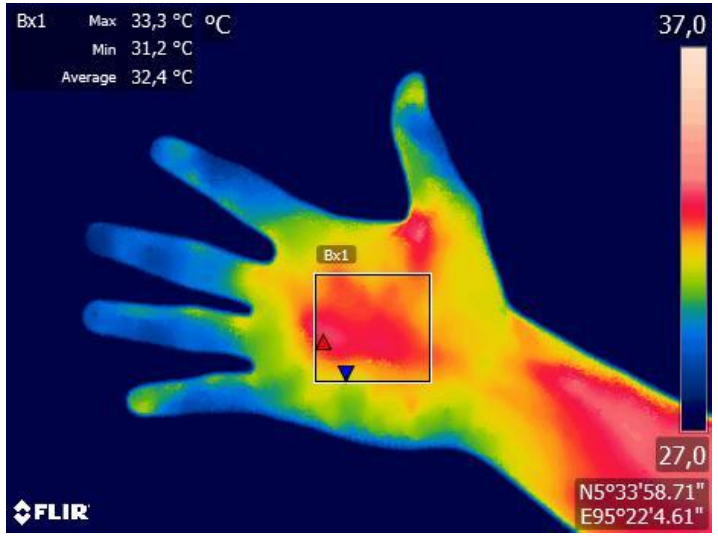


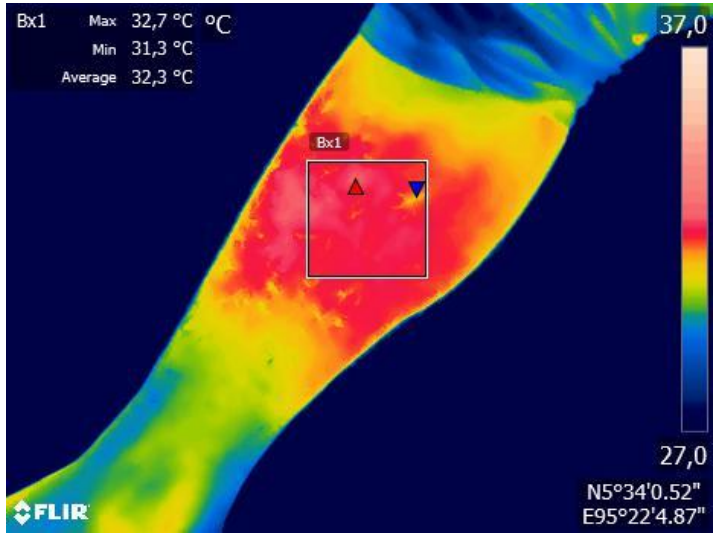
Region of Interest (ROI) Measurement





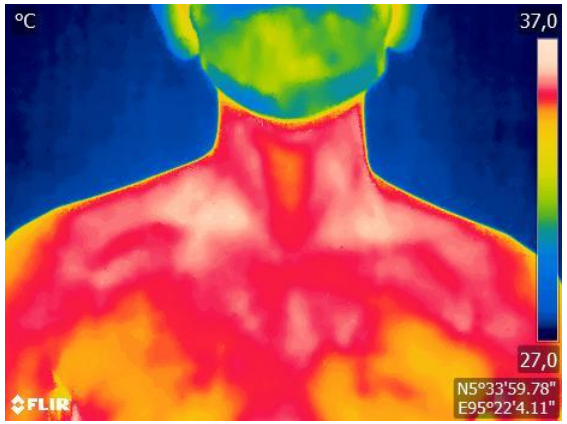


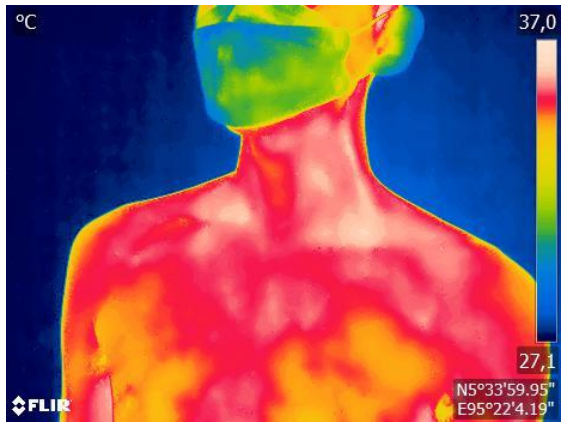




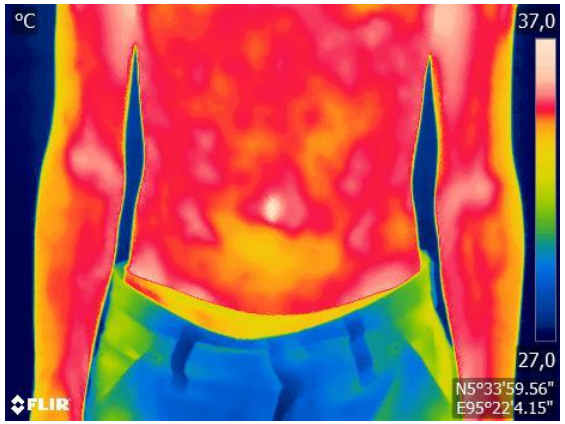
Normal

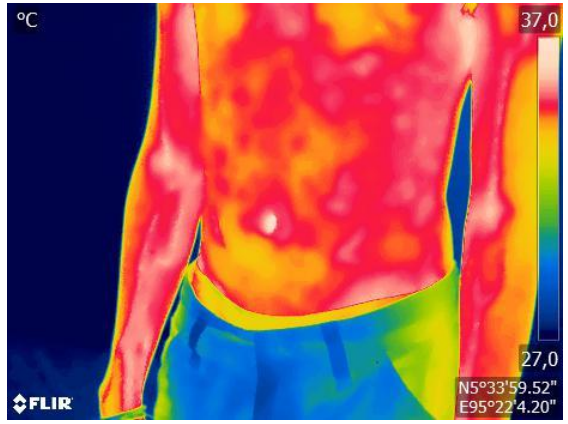
1. Supraclavicular (Bagian Leher)





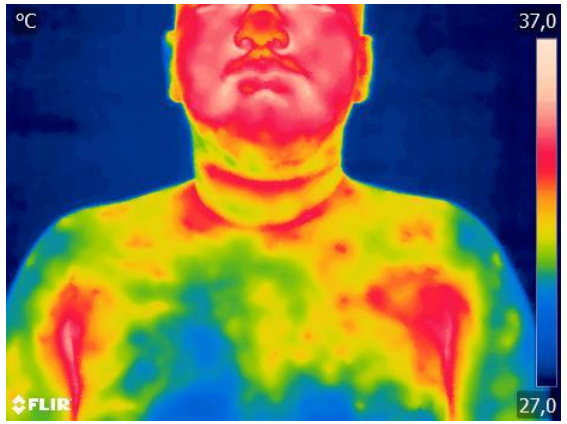
2. Abdomen (Bagian Perut)

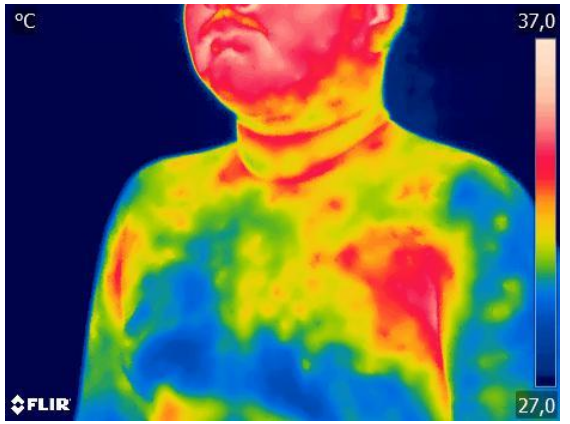




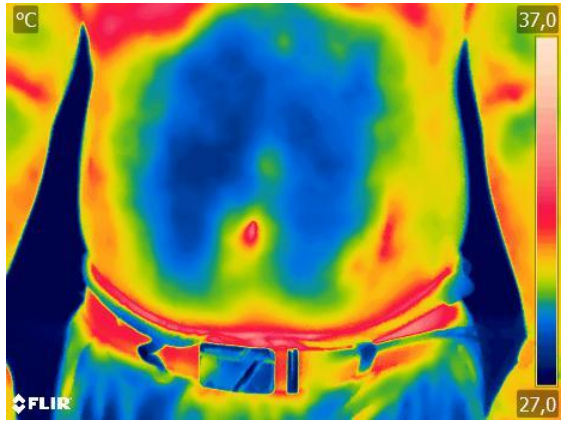
Obesitas

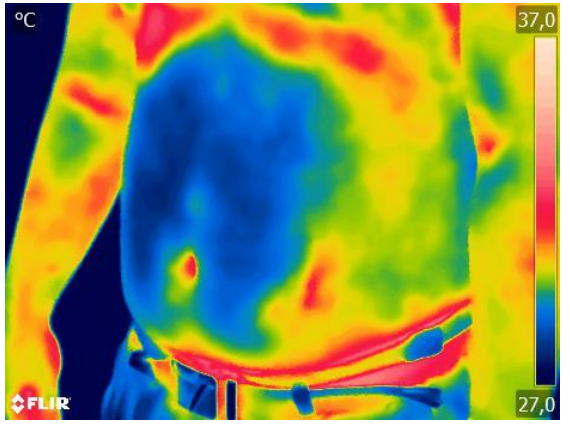
1. Supraclavicular (Bagian Leher)





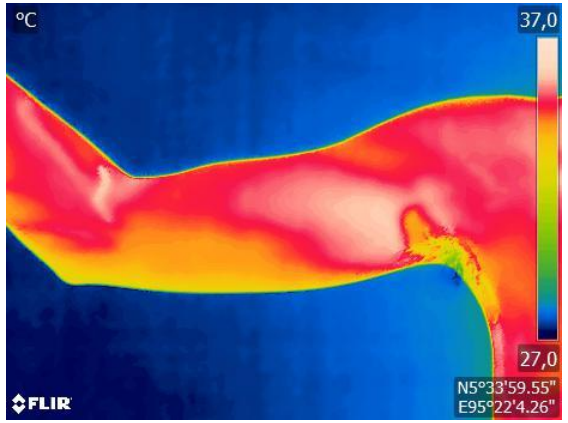
2. Abdomen (Bagian Perut)

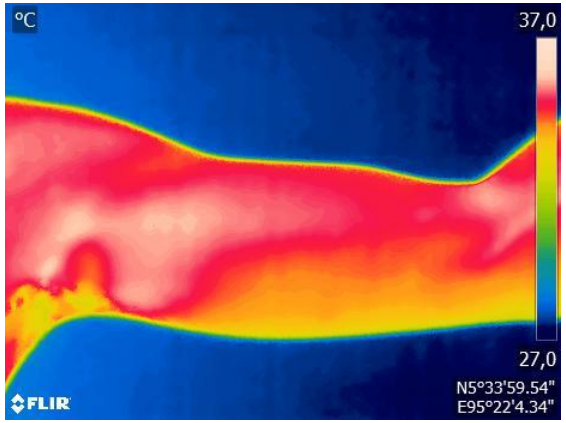




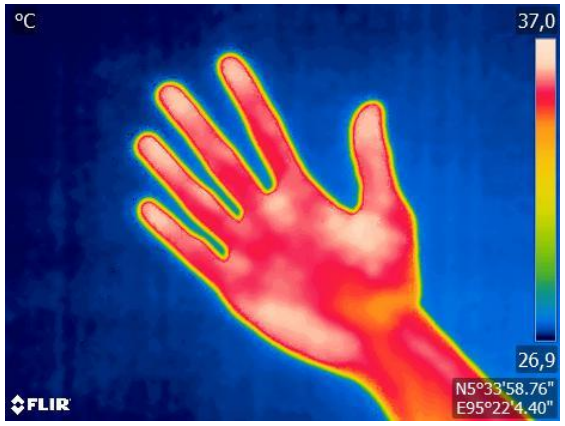
Normal

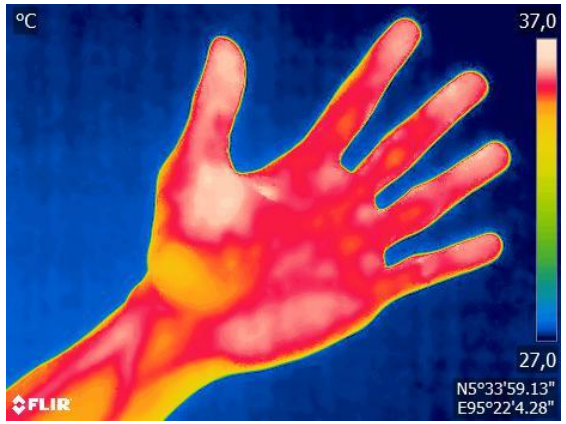
3. Forearm (Bagian Lengan)





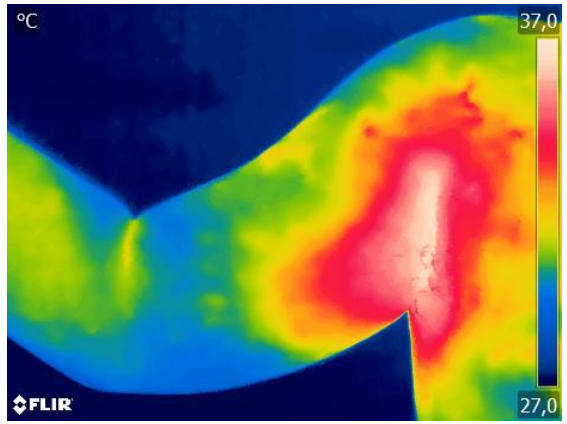
4. Bagian Palm (Telapak Tangan)

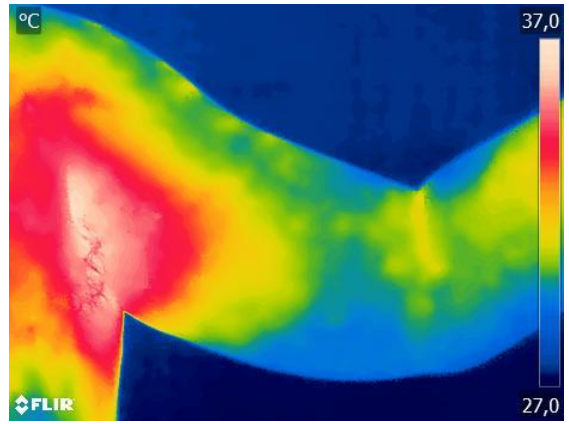




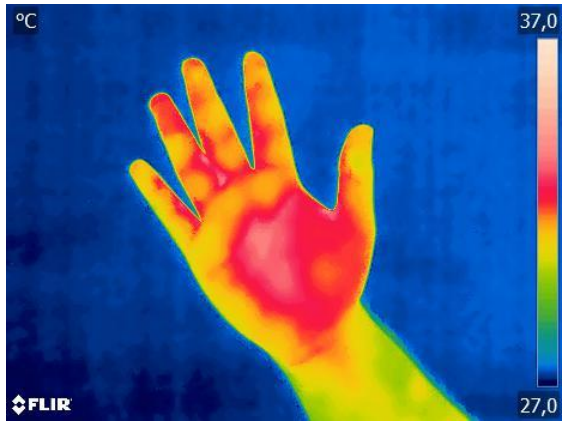
Obesitas

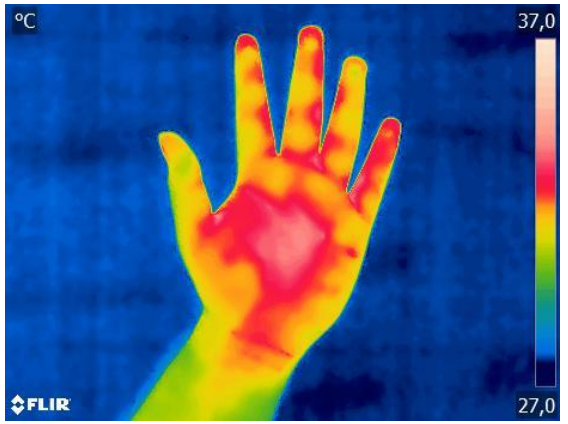
3. Forearm (Bagian Lengan)



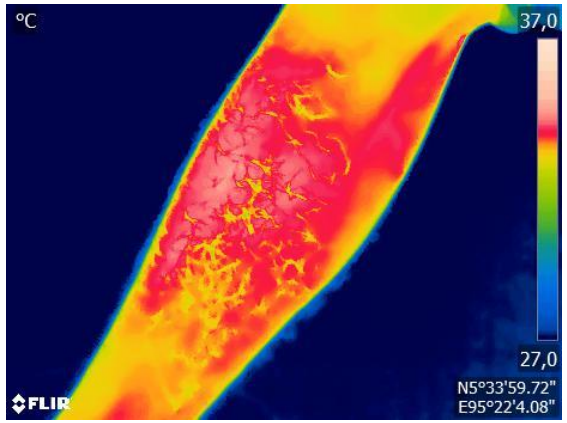


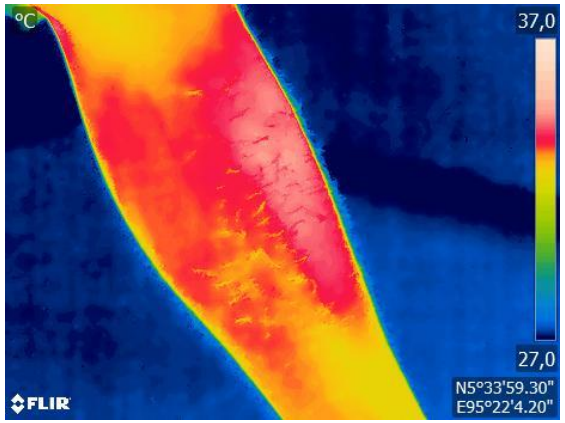
4. Bagian Palm (Telapak Tangan)





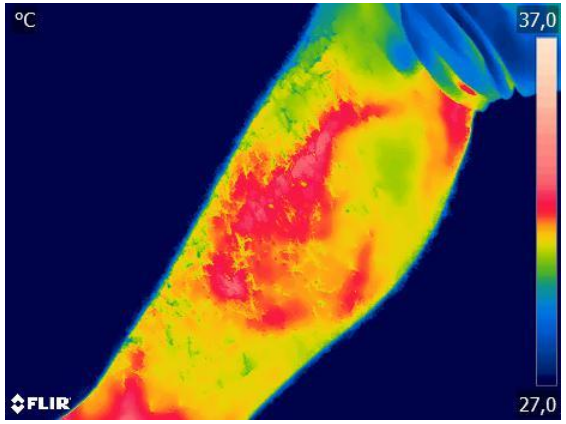
5. Shank (Bagian Paha)

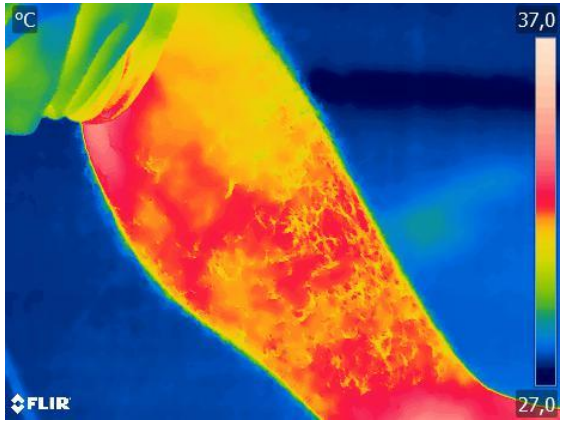




Normal

5. Shank (Bagian Paha)





Obesitas

TANTANGAN DAN HAMBATAN

- JUMLAH DATASET SANGAT SEDIKIT UNTUK IMPLEMENTASI DEEP LEARNING
- AUGMENTASI MENGHASILKAN DATA YANG DENGAN VARIANS YANG RENDAH.
- DATASET YANG TIDAK SEIMBANG (IMBALANCE)

PUBLIKASI

1. Al Rasyid, M.B., Arnia, F. and Munadi, K., 2018, February. Histogram statistics and GLCM features of breast thermograms for early cancer detection. In *2018 International ECTI northern section conference on electrical, electronics, computer and telecommunications engineering (ECTI-NCON)* (pp. 120-124). IEEE.
2. Roslidar, R., Saddami, K., Arnia, F., Syukri, M. and Munadi, K., 2019, August. A study of fine-tuning CNN models based on thermal imaging for breast cancer classification. In *2019 IEEE International Conference on Cybernetics and Computational Intelligence (CyberneticsCom)* (pp. 77-81). IEEE.
3. Roslidar, R., Rahman, A., Muharar, R., Syahputra, M.R., Arnia, F., Syukri, M., Pradhan, B. and Munadi, K., 2020. A review on recent progress in thermal imaging and deep learning approaches for breast cancer detection. *IEEE Access*, *8*, pp.116176-116194.
4. Muchamad, M.K., Arnia, F., Syukri, M. and Munadi, K., 2021, May. A Conceptual Framework of Deploying a Trained CNN Model for Mobile Breast Self-Screening. In *2021 18th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)* (pp. 533-537). IEEE.

PUBLIKASI

5. Leo, H., Saddami, K., Roslidar, R., Oktiana, M., Arnia, F. and Munadi, K., 2021, October. A Study of Parameters Required for a Thermogram Dataset in Obesity Detection: A Systematic Review. In *2021 International Conference on Computer System, Information Technology, and Electrical Engineering (COSITE)* (pp. 112-117). IEEE.
6. Roslidar, R., Saddami, K., Irhamsyah, M., Arnia, F., Syukri, M. and Munadi, K., 2021, October. Effective Loss Function for Unbalanced Breast Thermal Image Segmentation. In *2021 International Conference on Computer System, Information Technology, and Electrical Engineering (COSITE)* (pp. 107-111). IEEE.
7. Roslidar, R., Syaryadhi, M., Saddami, K., Pradhan, B., Arnia, F., Syukri, M. and Munadi, K., 2022. BreaCNet: A high-accuracy breast thermogram classifier based on mobile convolutional neural network. *Mathematical Biosciences and Engineering*, *19*(2), pp.1304-1331.

KESIMPULAN

- CITRA TERMAL SANGAT COCOK UNTUK DETEKSI DINI DAN BERPOTENSI DIKEMBANGKAN DI INONESIA.
- MAMPU MEMETAKAN KONDISI JARINGAN TUBUH BAGIAN DALAM DAN TIDAK DAPAT DIVISUALISASI
- PERANGKAT CERDAS BERBASIS *THERMAL IMAGING* DAPAT DIBANGUN DENGAN INTEGRASI TERMOGRAFI + KECERDASAN ARTIFISIAL + PERANGKAT *MOBILE*
- KAJIAN DAN RISET LINTASDISIPLIN DIBUTUHKAN UNTUK MENGHASILKAN PERANGKAT CERDAS BERBASIS TERMOGRAFI YANG APLIKATIF DI BERBAGAI BIDANG.
- INTERAKSI DAN RISET LINTASDISIPLIN PERLU LEBIH DIGERAKKAN UNTUK MEMPERKUAT KONTRIBUSI PT DALAM PENYELESAIAN PERSOALAN DI BERBAGAI BIDANG.

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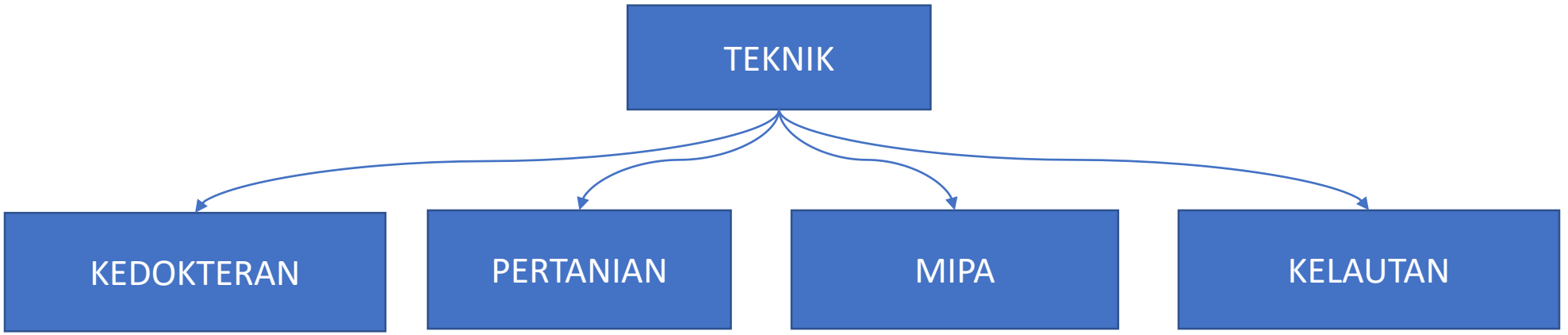
TRC **Members**

4
Professor

12
Ph.D.

11
Master



ACKNOWLEDGEMENT

- PROF. KHAIRUL MUNADI
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- TELEMATICS RESEARCH CENTER

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- Hernandez-Contreras, D.A.; Peregrina-Barreto, H.; de Jesus Rangel-Magdaleno, J.; Renero-Carrillo, F.J. Plantar thermogram database for the study of diabetic foot complications. *IEEE Access* **2019**, *7.*

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