IMPROVING INFRARED HAND LANDMARK DETECTION FOR LEPROSY DIAGNOSIS

Investigating The Role and Effectiveness of Colorization and Image Transformations

Author:
Zofia Rogacka-Trojak
zrogackatrojak@tudelft.nl

Supervisors:
Jan van Gemert
Zhi-Yi Lin
Thomas Markhorst

Affiliations:
EEMCS, Delft University of Technology, The Netherlands

1 BACKGROUND

- Early diagnosis is crucial for effective leprosy treatment.
- **Subtle symptoms** and slow progression delay diagnosis.
- A new approach [1] uses an **infrared (IR) camera** for blood flow observation.
- The current process is **manual** and **slow**, thus automation is needed.
- Main detection models do not work with greyscale infrared.

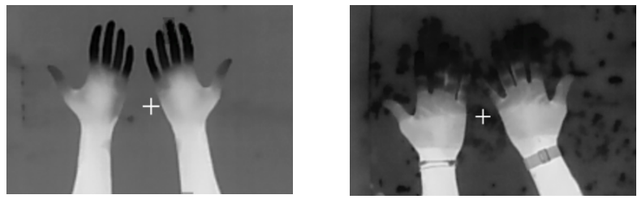

Figure 1: IR images present two challenges: hands with sharp color transitions (left) and obscured edges(right).

2 QUESTION

How much will colorization and/or image transformations help the input-mismatch for the visual hand prediction AI?

Why?

- Computational resource limitations
- Lack of annotated data

3 METHODOLOGY

- **Data:** 80 annotated infrared images.
  - Hands with sharp colour transitions
  - Edge-obscured hands
- **Tools:** Python, MediaPipe (MP), OpenCV.
- **Evaluation:** Percentage of Correct Keypoints metric compared with lower bound (MP performance on unaltered IR images) and upper bound (MP performance on RGB images)
- **Proposed Solutions:**
  - Removing occlusion by masking green and red temperature indicators. Occlusion is one of the major causes in poorer performance of object detection models [2].
  - **Pipeline 1 - Solution for hands with sharp color transition**
    - Transition into negative, so that the images resemble train dataset of colorization model.
    - Colorization using SIGGRAPH17 model [3].
  - **Pipeline 2 - Solution for edge-obscured hands**
    - Contrast enhancement using Contrast Limited Adaptive Histogram Equalization (CLAHE). Used previously to improve feature detection using MediaPipe on greyscale images [4].
  - **Landmark Merging**
    - Landmarks are merged based on recognized gesture.
    - *Open Palm* gesture is favoured.

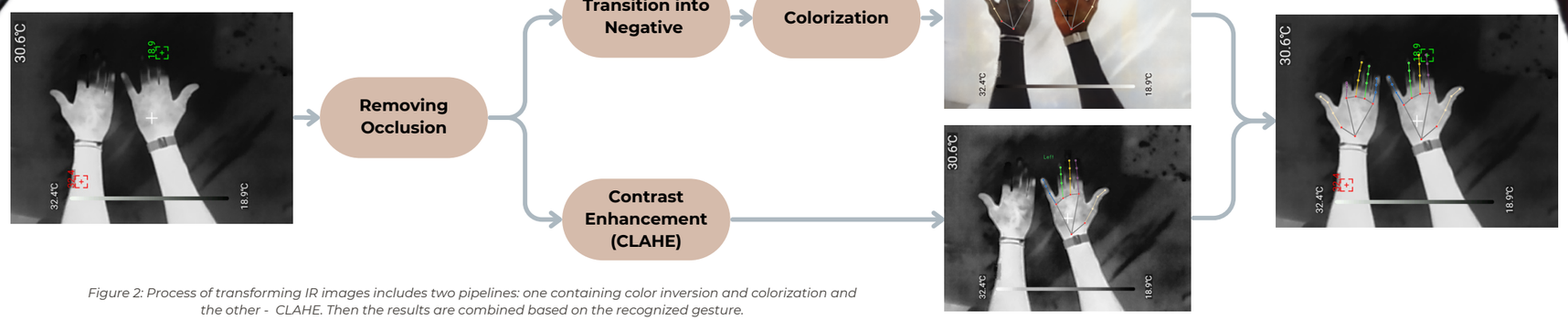

Figure 2: Process of transforming IR images includes two pipelines: one containing color inversion and colorization and the other - CLAHE. Then the results are combined based on the recognized gesture.

4 RESULTS

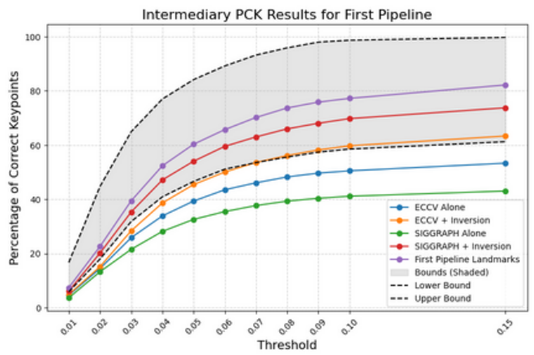

Figure 3: Transitioning images into their negatives significantly improves the accuracy.

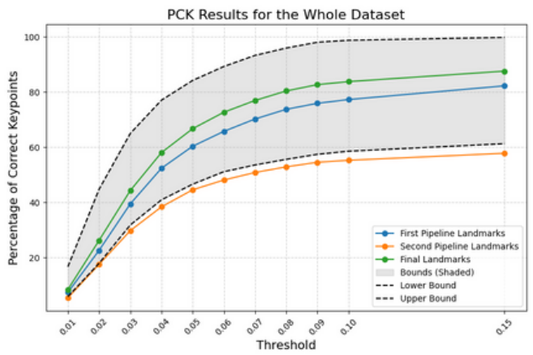

Figure 4: Combination of both pipelines yields the best results.

5 CONCLUSIONS

- Colorization improves detection for hands with sharp color transition.
- Contrast enhancement improves detection for hands with obsured edges.
- Combination is necessary for the highest accuracy increase (up to 25%) and most meaningful results.

6 LIMITATIONS

- Relies on image quality.
- Addresses only two challenges due to small dataset.
- Logic for landmark merging is simplistic.

REFERENCES

[1] Cavalheiro, A. L., et al. (2016). Thermographic analysis and autonomic response in the hands of patients with leprosy.
[2] Saleh, K., et al. (2021). Occlusion handling in generic object detection: A review.
[3] Zhang, R., et al. (2017). Real-time user-guided image colorization with learned deep priors.
[4] Musa, P., et al. (2018). A review: Contrast-limited adaptive histogram equalization (CLAHE) methods to help the application of face recognition.
Image of the hand was generated by ChatGPT.