# Thermal Camera Face Detection and Alignment using MTCNN

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***Abstract*—With the current situation of the increasing pandemic all over the world, thermal cameras detecting temperature gives a huge advantage of measuring an individuals temperature. Cascade has been widely used in face detection, where classifier with low computation cost can be firstly used to shrink most of the background while keeping the recall. CNN-based cascade face detectors have been further improved by using multi-task learning, i.e., jointly learning face/non-face classification,bounding box regression as well as facial key point detection. Recent studies show that deep learning approaches can achieve impressive performance on these two tasks. We aim to bring the highest possible result when it comes to speed, accuracy, effciency using MTCNN-based face detection applied in thermal camera with low-cost. This paper proposes a MTCNN-based face detection and alignment applied to a thermal camera that has temperature and distance estimation included as an additional feature in the future work.**

***Index Terms*—MTCNN, Thermal Camera, Tensorflow, Face Detection, Distance Estimation, Deep Learning**

## I. Introduction

Face detection is an indispensable scenario in real-world applications. Many large companies and technologies uses face detection as part of their growing innovation like: Apple Face Recognition, Facebook, Kakao, etc. The performances of various face based applications, from face identification and verification to face clustering, tagging and retrieval rely on accurate and efficient face detection. Face detection plays an important role and becomes one of the hottest field in the area of computer vision. Now that an increasing frequency of pandemic has been occurring worldwide, it is an advantage to have a computer vision machine that uses facial detection and alignment algorithm that detects faces and at the same time measures the temperature of the person being detected. Convolutional neural networks (CNNs) have been effectively applied to image classification [1] due to their great capacity for representation learning [2]. Inspired by this, CNNs have been introduced to cascade face detection [3] and improved by jointly training all stages [4]. Recently, CNN-based cascade face detectors have been further improved by using multi-task learning, i.e., jointly learning face/non-face classification, bounding box regression as well as facial key point detection [5]. The implementation of face detection continuously grow up until now and various algorithms and methods had been proposed and continuously improved to provide efficient and accurate result. One of the most popular method in the field of face detection is Multi-task Cascade Convolutional Network (MTCNN). A famous implementation in face detection is from David Sandberg (FaceNet's MTCNN) based on the the paper of Zhang, K et al. (2016) [ZHANG2016] wherein a multi-task cascade convolutional neural network (MTCNN) is used for face detection [5]. The MTCNN network can be used for face detection and key point detection, which includes five key points: the left and right mouth corners, the center of the nose, and the centers of the left and right eyes [5]. MTCNN is a face detection method based on deep learning method, which is more robust to light, angle and facial expression changes in natural environment, and has better face detection effect. Face recognition based on deep learning has shown more advantages and has been applied to various fields such as computer vision and pattern recognition. Deep learning has been proven in its powerful learning ability [10]. Other advantages of MTCNN includes: the memory consumption is small, and real-time face detection can be realized [7].

The rest of this paper is organized as follows. Section 2 discuss about some basic principles. Section 3 provides some of the previous works in face detection and utilization of MTCNN. Section 4 shows the proposed work of this paper. Finally, in Section 5, we give our conclusions and future work.

## II. Basic Principles

### A. Face Detection

Face detection is an important aspect in computer vision especially in face recognition and face expression identifica-


(a) RGB (b) Thermal

Fig. 1. Simulation of MTCNN using RGB and Thermal Camera.

tion technically human-computer interaction. Just like humans, neural networks will be trained to detect faces using facial features.

*1) Face Recognition:* Traditional Face recognition mainly consists of four methods: (1) Face Detection, (2) Face Alignment, (3) Face Extraction, (4) Face Verification

In this paper we will mainly focus on face detection using MTCNN applied on thermal camera.

### *B. MTCNN*

MTCNN model must be numpy-based mainly consisting of three parts: Proposal Network (P-Net), Refine Network (R-Net), and Output Network (O-Net). P-Net is for generating a candidate window. Candidate windows are used to classify face and non-face windows, to estimate bounding box regression vectors to face location and non-maximum suppression (NMS) candidate merge. R-Net rejects false candidates from the P-Net. Lastly, O-Net, outputs five facial landmarks: the left and right mouth corners, the center of the nose, and the centers of the left and right eyes.

## III. Related Work

Various works, methods and applications in face detection have been proposed and implemented in real-world applications . Most of the works uses MTCNN-based face detection.

Li et al. [3] use cascaded CNNs for face detection, but it requires bounding box calibration from face detection with extra computational expense and ignores the inherent correlation between facial landmarks localization and bounding box regression. In [5], they have proposed a multitask cascaded CNNs-based framework for joint face detection and alignment. In [7], they proposed a combination of MTCNN algorithm and the improved VGGNet deep convolutional neural network. Their experiment automatically learns the effective features from a large number of face image data and the experimental results show that the method has a good recognition result. [8] also uses MTCNN that leverages face classification and bounding box regression. Instead of NMS, they use facial emotions classification since their goal is to use facial detection to identify facial expressions. A CNN method for thermal face recognition is presented in [10] where three conditions, i.e., head rotation, expression variation, illumination variation, which affect recognition rate where consider in their paper. They claim that their proposed method in thermal face recognition is a promising method under extreme conditions, such as side face view and rapid changing illumination environment. Viola and Jones constructed a frontal face detection system based on cascade face detector using HaaR-Like features and AdaBoost to train cascaded classifiers that achieves detection and false positive rates which are equivalent to the best published results when it comes to good performance in real-time efficiency [11].

## IV. Proposed Method

As per the related works, there are no much work related to MTCNN-based face detection using thermal camera. In this paper, we propose a MTCNN-based face detection applied to a thermal camera. Previously, we have implemented MTCNN using RGB Camera shown in Fig. 1(a). Then we apply the same MTCNN face detection method in thermal camera by importing a foreign python function library that provides C compatible data types namely 'ctypes'. The library ctypes is a foreign function library for Python that allows calling functions in Dynamic-link Libraries (DLLs) or shared libraries. See Fig. 2.

We are going to apply the same method used in RGB for the proposed MTCNN-based thermal face detection implementation with i3system. Python programming language is used in this project. We will use Keras which is designed to enable fast experimentation for deep neural networks. TensorFlow, which will be used as the underlying backend, is a foundation library that can be used to create Deep Learning models directly or by using wrapper libraries that simplify the process built on top of it will be utilized as well. See Fig. 3. This implementation will be executed using Nvidia Titan Xp GPU which is a CUDA-compatible GPU. Face detection will be executed using

```
from ctypes import *

lib = cdll.LoadLibrary("./TermalLCY.dll")
```

Fig. 2. Syntax use for accessing thermal camera using python.

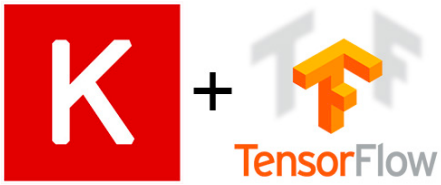


Fig. 3. In order to train custom neural networks, Keras requries a backend. tensorflow became the default backend of Keras starting from the release of Keras v1.1.0.

mtcnn with the help of python classical feature-based cascade classifier OpenCV library. Other libraries will be leveraged as well including: numpy, time, and most especially mtcnn. The code was written in PyCharm and was being executed using Anaconda prompt command line interface.

Our goal is to achieve a state-of-the-art overall performance of thermal camera using MTCNN, that will provide temperature and distance estimation as an additional feature, when it comes to speed, accuracy, efficiency at the same time low computational cost.

## V. Conclusion

In this paper, we showed that there are no existing MTCNN-based face detection work applied in thermal camera so, we proposed a MTCNN-based face detection and alignment applied in thermal camera. We showed two simulation output of MTCNN face detection using RGB and Thermal camera. Future works include improving speed, accuracy and efficiency given the use of GPU and adding temperature and distance estimation as an additional feature. We are looking forward in achieving the highest accuracy and efficiency of our future work.

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