

AI Based Remotely monitoring Web User Interface to capture patient temperature and medicine consumption

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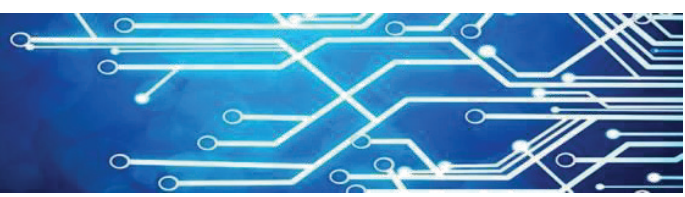
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Abstract - The Coronavirus disease 2019 (COVID-19) pandemic has impacted the world like no other pandemic in history. COVID-19 has progressed rapidly affecting health care in the global community. Although professional medical advice and hospitalization are necessary for high-risk COVID-19 patients, home isolation is an effective strategy for low and medium risk patients. Recent advances in Machine Learning (ML) and Deep Learning (DL) have strengthened the power of imaging techniques and can be used to remotely perform several tasks that previously required the physical presence of a medical professional. In this work, we look at the web user interface for elderly patients to easily keep track of their daily temperature and their pill consumption record and see if there is a need to visit a doctor. We are going to use Efficient Net, a Deep Learning Convolution Neural Network (CNN) architecture for systematical use of model scaling and balancing network depth, width, and resolution for better performance of our model. We are using angular components to develop user interface and expressJS to write backend services and MongoDB to store user records for the application which we learn in depth throughout the paper. we have trained and developed a model that could successfully detect people from the video and confirm the pill consumption by patient with high accuracy rate connected to a THT thermal camera. This study will help medical professionals, especially during the COVID-19 pandemic, in remotely monitoring the patient's dosage and determining appropriate action in case of non-compliance.

Keywords – COVID-19, Image Classification, AngularJS, THT Thermal camera, Deep learning

INTRODUCTION

Image classification is a supervised learning problem where we define a set of target classes and train a model to recognize the classes using labeled training image data. THT45 thermal camera is an absolute innovation in the sector of thermal cameras, both for the advanced prescriptions typical of a high-level thermal camera and for its reduced size. THT45 is provided with an IR sensor with resolution 80x80pxl which makes it the ideal device for maintenance operations and everyday analyses. Using a THT thermal camera temperatures have been recorded and services are written to extract necessary information and display it to the user on the web UI. Along with that, artificial intelligence trained models are used to detect if the patient has consumed the pill in a timely manner and let the patients view the results on the web UI. The challenge is choosing the best technology that fits the desired solution and can be easily integrated with other systems to provide the best user experience. Currently, there are several cross-platform client-side frameworks. Most of which include an array of libraries and responsive user interactions, often referred to as 'single-page applications' and angular would serve the purpose for our need and it is used along with expressJS as a backend for handling services. Overall, we are developing a simple UI



with every functionality that is needed for elderly patients to monitor their health at home and allow medical professionals to monitor their patients with minimal contact. As part of the literature review, we identified techniques involved in deep learning to find efficient and relatable solutions for our research and also read about solving multiclassification problems for image processing through supervised learning to train and test the models in paper [1] and input and output generation for convolutional neural network models which is a powerful nonlinear method that can automatically extract hierarchical features of the data to evaluate quantitative results in paper [2] and [3]. We identified and investigated Facial Recognition Technology (FRT), Automated Data Capture (ADC), and Artificial Intelligence (AI) that are needed to automate and monitor health conditions of elderly patients in nonclinical settings. The expected significance of this research is to demonstrate the potential for the Artificial Intelligence and facial recognition system to improve the patient chances for better healthcare and treatment outcomes for COVID-19. Our long-term research goal is to detect sickness of the person using facial features and health of high risk patients, specifically, African American elderly patients. The motivation of this research is to reduce contact with the people, without having them in physical observation and help minimize the spread of COVID-19. The aim of this application is to improve the efficiency and reduce the cost of COVID-19 pandemic disease control with automated engineering techniques.

BACKGROUND

Efficient Net, a Deep Convolutional Neural Network architecture, has been used for multiclass image classification problems to classify skin lesions. In our paper, we adopted the Efficient Net to classify human action recognition for the multiclass classification problem to record temperature using THT thermal camera and AI based methodology for tracking pill intake confirmation. We discussed that deep learning models are very helpful to gain insights about the key decision-making activities for COVID-19 related work. In our paper, we used the Efficient

Net to provide a contactless solution to minimize the spread of COVID-19. We compared different Convolutional Neural Networks such as Convolutional Neural Networks and Recurrent neural network with Efficient Net and identified that Efficient Net is a good scaling method that uniformly scales all dimensions of depth/width/resolution using a simple yet highly effective compound coefficient which achieve much better accuracy and efficiency than previous ConvNets. Conventional neural networks have been demonstrated to be a powerful framework for background subtraction in video acquired by static cameras. Indeed, the well-known Self-Organizing Background Subtraction (SOBS) method and its variants based on neural networks have long been the leading methods on the large-scale CDnet 2012 dataset. Convolutional neural networks, as a popular deep learning architecture, have been excessively employed recently for background initialization, foreground detection, and deep learned feature. Along with that, there are several cross-platform client-side frameworks currently and most of which include an array of libraries and responsive user interactions, often referred to as 'single-page applications'. In particular, angular would serve the purpose for our need and it is used with expressJS for handling backend services which is a web based technology to handle functionalities like login, registration and database operations[1]. Angular JS is framework manage by Google, it help build responsive sites. Angular JS use to make a smooth web performance. Angular JS is a toolset for building the framework most suited to your application development. It is fully extensible and works well with other libraries. Every feature can be modified or replaced to suit your unique development workflow and feature needs.

METHODOLOGY

3. Data Processing

In this section, we will discuss the data collection and data cleaning steps performed.

3.1 Data Collection

We have collected data of human temperatures using a THT thermal camera that is THT 45W which is equipped with high resolution 384x288 pxl . The temperatures were recorded using this camera by taking screenshots from the application and then we used opencv library to read the temperature values from the image.The temperature data is being stored in the MongoDB database, which fetches the temperature records and display to user in an efficient way. For this purpose we used packages like easyocr, matplotlib, OpenCV, to read the data from the image and store the data in the csv file and then form a visualization using the stored data. The output was used for analyzing statistics and the code will give the alert messages to the patients according to the body temperature recorded.

Once we have recorded the temperatures we created login credentials for users to securely log in to our application and keep track of their health records. The login page has been made simple which serves the purpose and is shown in Figure1.

Login

Username

Password

Login
Register

Register

First Name

Last Name

Username

Password

Register
Cancel

Figure1. User Login and Registration Page

When a user securely logs in into our application, we can see a user-friendly and easy-to-use interface for the overall output, where users can easily look at their body temperature, can easily read notifications of whether they are feeling sick or not, and is there a need to go to a hospital. They would also quickly check their pill consumption record by just clicking on a tab displayed on the main display as shown in Figure 2.



Figure2. Application Home Screen

Along with viewing his temperature and pill consumption records, user can also look at the how their temperature is varying over past weeks and months as shown in Figure 3.

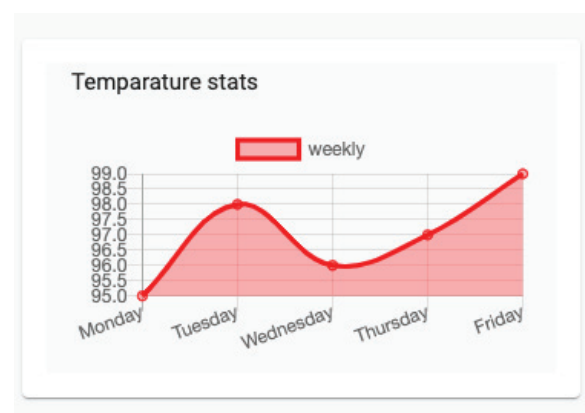


Figure3. Temperature Statistics

We have collected some data samples with high degree of similarity and added them to our dataset because in the future we might get almost similar data from users and our algorithm should not be biased by giving deep neural network additional opportunities to learn patterns specific to the duplicates while it is predicting. As it negatively

affects the ability of our model to generalize to new images outside of training data.

The figure 4 and 5 shows the live capture of images from the THT camera that is connected to the web application. We are then reading the temperatures from the captured images and storing data in a csv file and then displaying to the user on the application.

The following piece of code is to capture the images from the live stream of camera and read the temperature details from the captured images.

```
dur=20
start=time.time()
while (True) and time.time()<start+dur:

    success, frame = capture.read()
    #start = time.time()
    if success:
        time.sleep(5)
        cv2.imwrite(f'./raidimages/frame_{frameNr}.jpg',
frame)

    else:
        break

    frameNr = frameNr+1
    cv2.waitKey(1)

capture.release()
```

Figure 4. Code snippet for reading images

Below lines of code are for reading the temperature from captured images and storing in csv file and then application fetches the data to display to user.

```
for filename in os.listdir('./raidimages'):

img=cv2.imread(os.path.join('./raidimages',filename))
    reader=easyocr.Reader(['en'])
```

```
results=reader.readtext(img)
text=""
for result in results:
    try:
        if 'S:' in result[1]:
            S=float((re.findall("\d+\.\d+",
str(result[1])))[0])

        elif 'H:' in result[1]:
            H=float((re.findall("\d+\.\d+",
str(result[1])))[0])

        except Exception as e:
            S=0
            H=0

    now=datetime.now()
    current_time=now.strftime("%d/%m/%Y
%H:%M:%S")
    import string
    import random
    string.ascii_letters
    def random_char(y):
        return ".join(random.choice(string.ascii_letters)
for x in range(y))
    name=random_char(3)
```

```
ttq,22.3,24.4,21/07/2021 12:23:17
BnX,22.8,25.1,21/07/2021 12:25:18
aFq,23.1,25.1,21/07/2021 12:26:09
zhu,23.1,25.1,21/07/2021 12:26:58
X0o,23.1,25.2,21/07/2021 12:27:48
```

Figure 5. Code snippet for extracting data from images

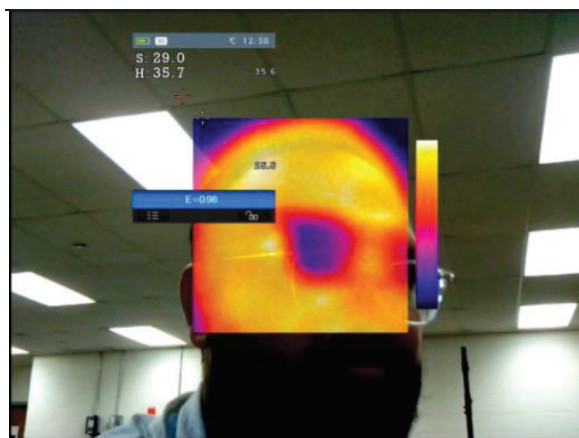


Figure 5. Face recognition

We have created service endpoint for refreshing the recent temperature data on the UI by reloading the csv data into cloud database. All the processes of capturing images from live thermal camera when a user is detected and reading temperatures from the images and storing in the Mongo database and then fetching from DB and displaying on UI is all automated with a single click of a button and a time delay of 1 minute to display real time temperature which is shown in Figure 6.

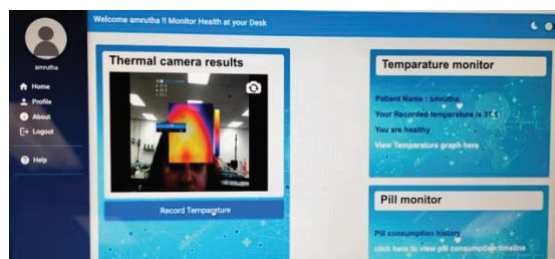


Figure 6 Need Figure Caption]

3.2 Model Training and Testing.

The deep learning architecture Efficient Net was used as it outperformed other Convolution Neural Networks based on our study. Convolutional Neural Networks are commonly developed at a fixed resource budget and then scaled up for better accuracy if more resources are available. In the paper [4] they systematically study model scaling and identify that carefully balancing network depth, width, and resolution can lead to better performance. Based on this observation, they propose a new scaling method that

uniformly scales all dimensions of depth/width/resolution using a simple yet highly effective compound coefficient. For recognizing pill consumption using AI models, we have used the 'mediapipe' library for pose estimation. Also, the developed program can detect how many times hand is raised up and how many times hand is brought down by the user.

5. Results and Discussion

The main objective of our model is to classify the images and identify if the person is taking medicine or not. This will help medical professionals remotely monitor the patient's dosage and determine appropriate action in case of non-compliance. Out of the 10 Epochs, the results were consistent right from the second Epoch, which tells the model trained is very successful in classifying. We can use this in the real world to observe the COVID-19 affected patient's recovery status and the effect of medicines on them without physical observation. To achieve this goal, we need to have the patients to be in a closed environment with cameras surrounding them, which can be very helpful not only for COVID-19 but also for future pandemics and other dangerous contagious diseases.

As part of model evaluation, for login component, we created 50 user credentials for elderly patients and health care professionals who can use our application. For temperature component, we asked all the lab members to use the login details and record their temperatures. Everyone who recorded the temperatures saw their thermal results on the application and viewed how their temperature is varying when they are monitored the next time. For pill detection, 80% of the time pill was detected. When a user opens and closes the mouth with a pill in hand our algorithm detected that patient had taken the pill and the recorded date time was noted. Overall we achieved an efficiency of 80% when we tested our application and trained the model for a dataset of 50 members.

5. Conclusions

In this paper, we proposed a contactless solution for monitoring a patient's pill consumption process. This study is highly significant in the current scenario of COVID-19 Pandemic that there is a need of social distancing [9]. To achieve our objective, we created a dataset with 4 major actions related to COVID-19. An Efficient Net based deep learning model is trained on this dataset to classify human action (medicine consumption) and solve a multi-classification problem. To maximize the performance, we used similar image removal and data augmentation [11] techniques. Our model was able to confirm the pill confirmation with a high accuracy successfully. This study can be used by medical professionals in virtually monitoring the patients and confirming whether the patients are taking medicines as prescribed and can take actions in case of non-compliance.

6. Future Work

In the future, we can work on behavioral recognition of the patients using Artificial intelligence, we can predict the behaviors of patients that could be really helpful in allocating proper resources to these patients and also we will be working on sickness detection of patients using facial features.

7. Acknowledgments

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