Zulfaqar J. Def. Sci. Eng. Tech. Vol.2 Issue 2 (2019) 40-48

ZULFAQAR Journal of
Defence Science, Engineering & Technology

Journal homepage: zulfaqar.upnm.edu.my

Aggressive Movement Feature Detection using Color-based Approach on Thermal Images

Suzaimah Ramli[a,*], Tuan Khalisah Tan Zizi @ Tuan Zizi[a], Norulzahrah Mohd Zainudin[a], Nor Asiakin Hasbullah[a], Norshariah Abdul Wahab[a], Noor Afiza Mat Razali[a], Norazlin Ibrahim[b]

[a] *Universiti Pertahanan Nasional Malaysia, Malaysia*
[b] *Universiti Kuala Lumpur, Malaysia*

*Corresponding author: *suzaimah@upnm.edu.my*

ARTICLE INFO

Article history:
Received
08-03-2017
Received in revised
27-08-2019
Accepted
08-11-2019
Available online
31-12-2019

Keywords:
thermal images,
aggressive behavior,
face view,
prefrontal,
periorbital

e-ISSN:
Type: Article

ABSTRACT

Thermal imaging technology can be used to detect aggressive levels in humans based on the radiated heat from their face and body. Previous researches have proposed an approach to figure out human aggressive movements using Horn-Schunck optical flow algorithm in order to find the flow vector for all video frames but still not strong enough to confirm and verify the existence of an aggressive movement. In this work, we propose an approach by using thermal videos for frontal views of the human body which is face view. Then, video frames are collected using thermal camera and further extracted into thermal images. We use thermal imaging to monitor the face including prefrontal and periorbital region's thermal variations and test whether it can offer a discriminative signature for detecting aggressiveness. We start by presenting an overview of 3400 thermal images extracted from 50 participants. The results obtained is promising where aggressive and non-aggressive features can be detected by using color-based approach.

© 2019 UPNM Press. All rights reserved.

Introduction

In recent years, various approaches have been proposed for human activity recognition. Human aggressive movement detection is insufficient and inconclusive by using data from digital images. Therefore, to overcome this problem, there was renovations and enhancement in this research by converting from digital images method to thermal image method. The movement detection using a thermal camera projected an image based on surrounding images temperature which is more accurate to be analysed compared to an ordinary normal images.

In addition, nowadays an application of movement detection is using the latest technology especially the thermal video camera which is part of military technology, is very crucial with the current rapid changes. In fact, from the military aspect point of view, this technology has been long used by the major powers such as United States, Russia, and China. Therefore, there are an image processing switching between digital or ordinary camera to thermal videos.

This application is using several techniques of image processing in MATLAB software toolbox. For a national defence organisation, the aspect of technology advance is strongly emphasized. One of the most important key for national defence is the movement detection of an enemy or a motion object. However, an enemy will not only attack during daylight, but also at night. At this stage, the problem of detecting the motion will arise, as ordinary camera unable to perform very well at night. Other identified issues also are the technique that will be used to detect the movement object or enemy in that video. They often experiencing in determining a movement of certain object using a video that is taken at long distance at a certain of period. Ordinary camera normally will not be able to show a hidden object in a certain situation in a usual picture

In this research and study, we decide to use RGB channel which is most suitable for extract the aggressive features of human using thermal images. Previous research made by (Chen et al., 2010) also uses the analysis and extraction of flame color in the RGB color space. Therefore, we use frontal view of human body which if face view of thermal image data. From there we can classify the features that can be extracting from the conditions.

Research Background

Thermal Imaging is a process of transforming imperceptible infrared radiation to visible image. Every object in the universe emits infra-red radiation as long as the object is above absolute zero (-273°C). The temperature of an object governs the amount of infra-red radiation emitted. Using thermal imager, a pictorial representation is produced to represent the detected heat without visible light content (Ramli, Nurhana, Wahab, Baharon, & Zainudin, 2014; Ramli, Talib, Tuan Zizi, & Zainudin, 2015; Tuan Zizi, Ramli, Ibrahim, Zainudin, & Abdullah, 2015; Zainudin, Ramli, Ghazali, Talib, & Hasbullah, 2014).

All objects on earth have given a unique heat reversal whereby it can be discerned by the detector to produce an image. This heat detector is named after the *thermography,* a measurement and recording of heat changes of an object on earth that is under studied. The thermal image can be captured by tracking the ray signalled from an object under a different surrounding whether it's in daylight or night-time. The recording using thermal camera will capture a motion object that is producing various heat compared to a still object. Therefore, a thermal image may provide a useful information compared to an ordinary camera which is unable to track, especially in term of surveillance and monitoring (Ibrahim, Riyadi, Zakaria, & Mustafa, 2009; Ramli et al., 2015; Tuan Zizi et al., 2015; Zainudin et al., 2014).

According to the previous research referring to figure 1 below, both instantaneous and sustained stress conditions can be detected using thermal imaging since instantaneous stress brings about an increase in the periorbital blood flow while sustained stress is associated with elevated blood flow in the forehead (Yuen et al., 2009). The preliminary results of thermal in face area shown that the differences between emotional stress and physical stress as we already know that stress copying style also is part of aggressive behaviour (Lynn & Baron-cohen, 2014). For emotional stress, 50% increase of hot pixels in prefrontal region which are forehead, eardrum, lip & neck regions while for physical stress, little increase of hot pixels in periorbital region which is the region that around the eye.

Referring to the previous research made by (Xue & Blum, 2003), image fusion is studied for detecting weapons or other objects hidden underneath a person's clothing. The focus of their paper is to develop a new algorithm to fuse a color visual image and a corresponding thermal image for such a concealed weapon detection application. The fused image obtained by the proposed algorithm will maintain the high resolution of the visual image, incorporate any concealed weapons detected by the thermal sensor, and keep the natural color of the visual image.

While in this study, thermal images dataset was used to extract the temperature value changes among the normal and abnormal of human by using sum pixel calculation. Therefore, it's really suits with the research made by (Thou-Ho Chen et al., 2004) that using RGB component. They improve a real fire validation by verifying the extracted fire-pixels and smoke-pixels through RGB chromatic segmentation and disorder measurement. The decision function of fire-pixels is obtained by deducing with the intensity and saturation of R component, and the R, G B as compared with each other and intensity is utilized to deduce that of the smoke. If a fire is considered to be burning up a fire alarm will he immediately given became the fire may lead to a disaster. To simulate the color sensing properties of the human visual system, RGB color information is usually transformed into a mathematical space that decouples the brightness (or luminance) information from the color information.

Comparing to the research made by Thou-Ho (Chao-Ho) Chen et al. (2004) again, to reduce computational complexity, the previous fire-detection algorithm is based on RGB color model for extracting the fire region from an image. The corresponding RGB value will be mapped to the conditions: R>G and G>B, i.e., the color range of red to yellow. Thus, the condition of fire's colors to be detected is defined as R>G > B for the fire region in the captured image. Furthermore, there should be a stronger R in the captured fire image due to the fact that R becomes the major component in an RGB image of fire flames. This is because that fire is also a light source and the video camera needs sufficient brightness during the night to capture the useful image sequences. Hence, the value of R component should be over a threshold, R. However, the background illumination may affect the saturation of fire flames or generate a fire-similar alias, and then result in a false fire-detection. To avoid being affected by the background illumination, the saturation value of fire-flame extracted needs to be over someone threshold in order to exclude other fire-similar aliases. This will deduce three decision rules for extracting fire pixels from an image.

Methodology

The method of image processing system using thermal images is a key factor in solving the problem of detecting features of human aggressiveness. The thermal image recorded will be analysed to solve certain type of problems in certain applications such as agriculture, medical, defence system and others. The research flowchart is divided into four phases as shown in Fig. 1.

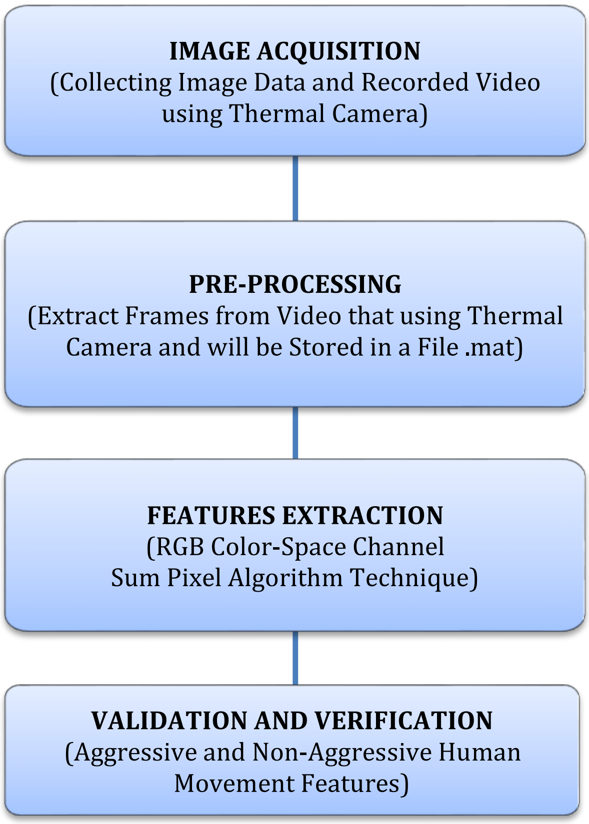


Fig.1: Human Aggressive Movement Feature Detection Flowchart

i. Acquisition Phase

This preliminary phase is the phase of collecting thermal image data and recorded video using thermal camera. A video showing few students is taken to ensure that the colour changes of human face can be traced, to give an accurate result based on temperature change of human body (face) in thermal images. The details will be described further in section Result and Discussion.

ii. Image Pre-Processing Phase

In this phase the thermal image will be used to extract temperature changes between both conditions of image frames which are normal and aggressive. If the differences are spotted between both conditions of image frames, it will show the colour changes and aggressive movement feature of human in those thermal images is exist. The pre-processing phase involved some procedures to prepare the images to be ready for image processing. Firstly, the recorded video had divided into RGB image frames. Then, the RGB images were converted to grayscale level. Next, the images were normalized to produce uniformity in term of image size and to reduce the processing time. During the pre-processing phase, all frames were standardised to the size of 180×320 double pixels. All of the image frames of digital and thermal cameras will be stored in a .mat file to facilitate the user to retrieve for the purpose of tracking the motion through those image frames.

iii. Feature Extraction Phase

The feature selected in this research is the Horn-Schunck optical flow. From the previous pre-processing phase, the image frames that have been isolated will recall for the purpose of tracking the motion between the image frames. Next, these features will be used to count the sum pixel value between both image frames. However, the classification for thermal images will retrieve the sum pixel value and differences between RGB channels.

iv. Validation and Verification Phase

This phase involved on validation and verification features obtained from feature extraction phase. The validation phase is the process to test whether the chosen features of aggressive and non-aggressive in human is can be accepted and is suitable or not. Moreover, verification phase is a testing stage that is used to carry out the activity of classification. In this phase the result will be able to discriminate between normal and aggressive movement features of human detection by using thermal camera images.

Result and Discussion

To achieve better result in detecting human aggression, thermal data will be used. For thermal data, we have to collect frontal views of human face. From face views, we retrieved all the thermal image frames from thermal video. From this view we can see and obtain the changes of the whole face of the human during normal or aggressive condition. The changes will be viewed by using histogram of RGB channel and get the RGB value at the same index of thermal images. After that, with the same thermal image data, we run the sum pixel algorithm to extract the pixel change between both conditions which is normal and aggressive thermal image frame. Then, we can differentiate between normal and aggressive condition through that thermal image. That's the reason why this thermal data of frontal view is really help in finding aggressiveness.

i. Result of Color-based: Color Space

Table 1: Result of Normal and Aggressive for Frontal View

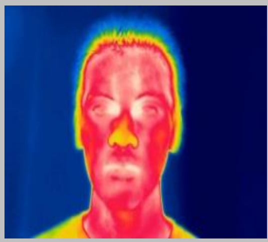
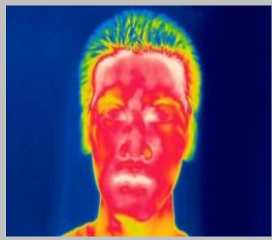
Motion Info	Non-Aggressive	Aggressive
Chosen Frame		
RGB	R: 1.000 G: 0.976 B: 0.839	R: 0.984 G: 0.176 B: 0.361

Table 2: Histogram for RGB of Thermal Frames for Normal and Aggressive for Frontal View

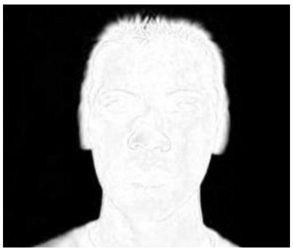
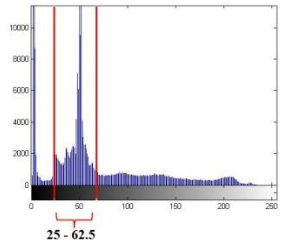
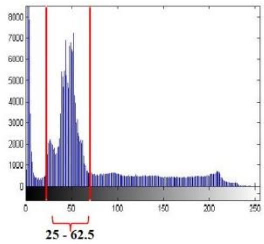
	Image Frame	
RGB Channel	**Non-Aggressive**	**Aggressive**
(a) Red Channel		
		

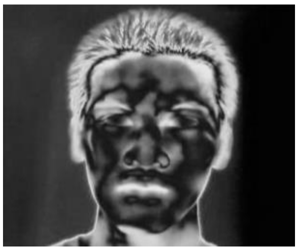
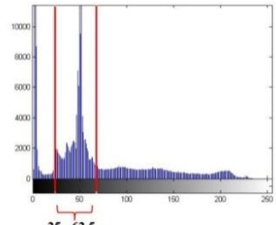
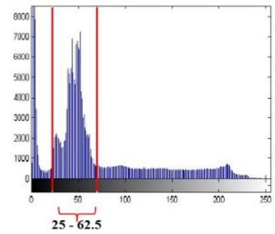
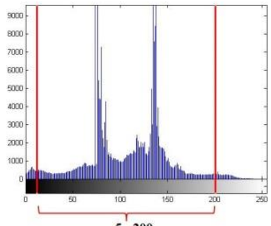
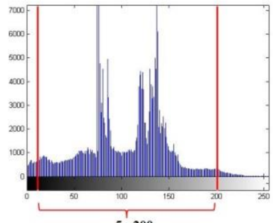
	Image Frame	
RGB Channel	**Non-Aggressive**	**Aggressive**
(b) Green Channel	 	 
(c) Blue Channel	 	 

Table 1 and Table 2 above showing that the comparison of results for thermal image of normal and aggressive using RGB channels. Each channel of the RGB-images (scaled between 0 and 255) is perturbed by additive, zero mean. Celik et al. (2006) used normalized RGB (red, green, blue) values for a generic colour model for the flame. The normalized RGB is proposed in order to alleviate the effects of changing illumination. Means that it is use for changing temperature in images same goes to this thermal image either normal behaviour image or aggressive image. The results shown in Table 1 indicate that for normal behaviour, little increase of hot pixels in periorbital region which is the region that around the eye while for aggressive behaviour temperature highly increased of hot pixels in prefrontal region which are forehead, eardrum, lip & neck regions, the changes of the temperature can be seen from colour based of the face which is from red turns to white.

As seen in the above images in Table 2, these three channel histograms are to distinguish the differences of non-aggressive and aggressive behavior in human for frontal view effectively. Table 2 (a) Red Channel shows the histogram of red channel of the thermal image. The changes of the thermal pixels value occurred at range 25 – 62.5. The most significant changes of the thermal pixels values is at range 45 which is 8000. Table 2 (b) Green Channel shows the histogram of green channel of thermal image. The changes thermal pixels value occurred at range 237.5 – 255. The most significant changes of the thermal pixels value is at range 200 which is increasing from 0.4 to 0.6. Table 2 (c) shows the histogram of blue channel of the thermal image. The changes thermal pixels value occurred at range 5 – 200. The most significant changes of the thermal pixels value is at range 125 which are increasing from 2100 to 4200. The optimum threshold technique is applied to the grey level image, to make the pixels belonging to the body thermal image region and the pixels belonging to the background region separable. Based on the result provided, there are differences between both non-aggressive and aggressive histogram for each channel. The histogram for the aggressive human is higher value compared to the non-aggressive behaviour of human.

ii. Result of Sum Pixel Algorithm

Fig. 2 until Fig. 4 shows that the sum pixel values of the changes of two different frames was get after run the sum of pixels algorithm.

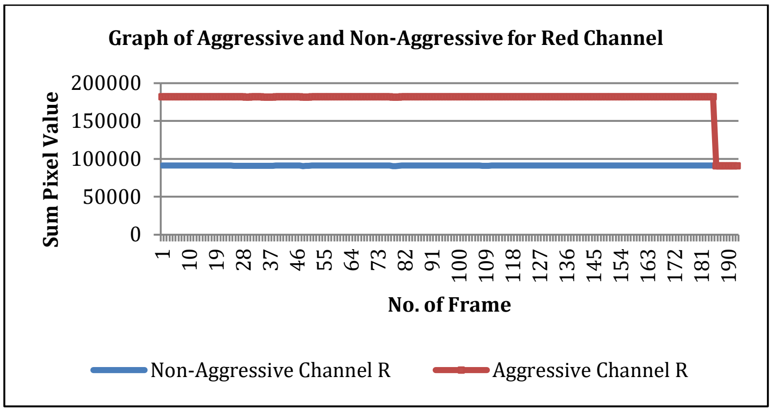


Fig. 2 Red Channel of Normal and Abnormal (Students Fighting 3 by 1) Behaviour

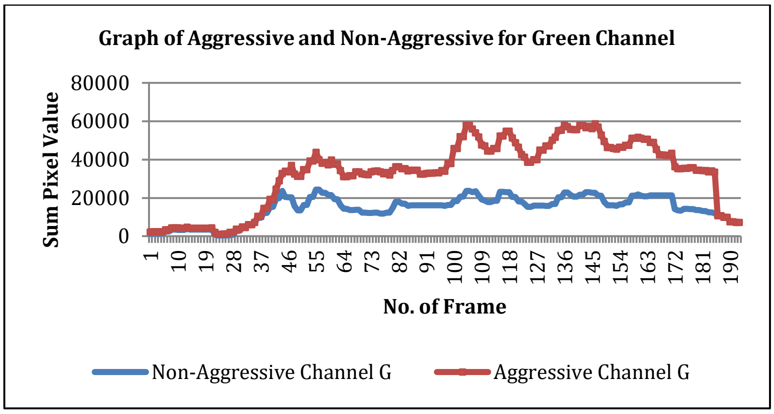


Fig. 3 Green Channel of Normal and Abnormal (Students Fighting 3 by 1) Behavior

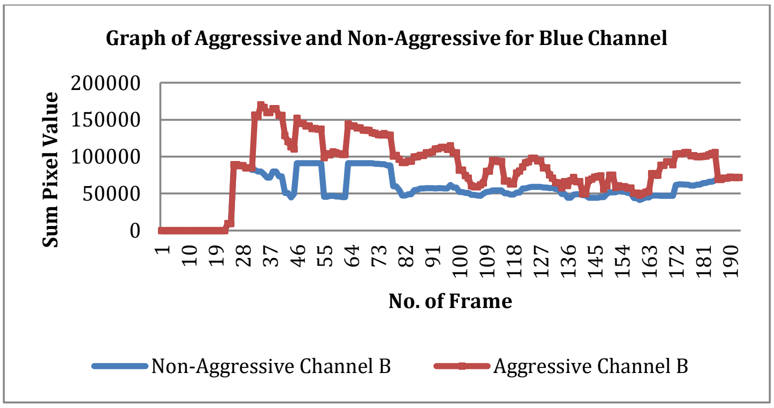


Fig. 4 Blue Channel of Normal and Abnormal (Students Fighting 3 by 1) Behavior

As shown in the graphs above, there were increase values of sum pixel value for aggressive behaviour. As we can see in normal conditions, sum pixel value were lower compared the aggressive conditions. Proven, aggressive features exist when there was an increase value and difference between both conditions normal and aggressive. The graphs show that sum pixel value result for normal is lower compare to aggressive movement which is mostly high value.

Table 3. Average of Pixels Value for Aggressive and Non-Aggressive Movements in Thermal Camera.

Color Channel	Average of Pixels value for Aggressive Movements	Average of Pixels value for Non- Aggressive Movements	Differences between Aggressive and Non-Aggressive Movements
Red	91, 135.00	51, 096.15	**40,038.85**
Green	18, 981.18	14, 624.99	4,356.19
Blue	54, 091.81	31, 773.60	22,318.21

Table 3 above shows that the average of pixels value that have been made. For average of pixels value for aggressive movements, the number of pixels in the red channel is higher than green and blue channels. For aggressive movement in thermal camera, the average of pixels value is higher than the pixels value in all channels of red, green and blue as it calculated the temperature changes that occur in the body when there is little movement. Based on the above table, the pixels value for the movement of aggressive and non-aggressive for the red channel is much higher compared to other channels which are green and blue channel. In addition, there is a very significant difference in pixels value for each channel between aggressive and non-aggressive movement. Referring to the above results, red channel has the most differences in pixel values for the movement of aggressive and non-aggressive which are **40, 038.85** while for green channel only 4, 356.19 and blue channel is 22, 318.21. Thus, it clearly shows that there are characteristics of aggressive movement shown particularly clearly on the red channel. Therefore, the average of pixels value in the red channel can be used as a feature for any recognition aggressive and non-aggressive movement.

Conclusion

In this research, our approach to human motion detection through processing video captured by a thermal camera has been presented. Surveillance can be active on the whole route or only in certain point. This paper has described all elements that are required in implementing the system. With analysis present, temperature detection result becomes more efficient and reliable.

The results are promising and with the existence of these features, tracking human in aggressive behaviour is quick, accurate and easy and luckily we can predict early and take action compare using the only ordinary CCTV. Moreover, the features that successful achieved in this research are appropriate because it can be used and adapted into the surveillance system and intelligence CCTV. Last but not least, when this system is expected to be able to detect human aggressive behaviour early, worse things can be avoided and this will guarantee the safety of the public.

References

Çelik, T., Demirel, H., & Ozkaramanli, H. (2006). Automatic fire detection in video sequences. *Proc. of the 14th European Signal Processing Conference (EUSIPCO)*, (Eusipco).

Chen, J., He, Y., & Wang, J. (2010). Multi-feature fusion based fast video flame detection. *Building and Environment*, *45*(5), 1113–1122. https://doi.org/10.1016/j.buildenv.2009.10.017

Ellis, W. E., Crooks, C. V., & Wolfe, D. A. (2009). Relational aggression in peer and dating relationships: Links to psychological and behavioral adjustment. *Social Development*, *18*(2), 253–269.

https://doi.org/10.1111/j.1467-9507.2008.00468.x

Ghali, R., Jmal, M., Souidene Mseddi, W., & Attia, R. (2020). Recent Advances in Fire Detection and Monitoring Systems: A Review (pp. 332–340). https://doi.org/10.1007/978-3-030-21005-2_32

Ibrahim, N., Riyadi, S., Zakaria, N., & Mustafa, M. (2009). Implementation of Differential Optical Flow Algorithms in Natural Rigid Video Motion. *Proceedings of the*, *I*, 18–21. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.148.6038&rep=rep1&type=pdf

Lynn, J., & Baron-cohen, S. (2014). Psychology Relational Aggression.

Ramli, S., Nurhana, S., Wahab, A., Baharon, N. A., & Zainudin, N. M. (2014). Comparison of Human Motion Detection Between Thermal and Ordinary Images, 10–12.

Ramli, S., Talib, M. L., Tuan Zizi, T. K., & Zainudin, N. (2015). Implementing Optical Flow Algorithm for Human Aggressive Movement Detection, 264–268.

Thou-Ho Chen, Ping-Hsueh Wu, & Yung-Chuen Chiou. (2004). An early fire-detection method based on image processing. *2004 International Conference on Image Processing, 2004. ICIP '04.*, *3*, 1707–1710. https://doi.org/10.1109/ICIP.2004.1421401

Tuan Zizi, T. K., Ramli, S., Ibrahim, N., Zainudin, N., & Abdullah, L. (2015). Implementing Low Level Features for Human Aggressive Movement Detection.

Xue, Z., & Blum, R. S. (2003). Concealed Weapon Detection Using Color Image Fusion, 622–627.

Yuen, P., Hong, K., Chen, T., Tsitiridis, A., Kam, F., Jackman, J., … Lightman, S. (2009). Emotional & physical stress detection and classification using thermal imaging technique. *3rd International Conference on Imaging for Crime Detection and Prevention (ICDP 2009)*, P13–P13. https://doi.org/10.1049/ic.2009.0241

Zainudin, N., Ramli, S., Ghazali, K., Talib, M. L., & Hasbullah, N. A. (2014). A Study on Implementing Physiology-based Approach and Optical Flow Algorithm to Thermal Screening System for Flu Detection, 6–9.