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AGGRESSIVE MOVEMENT DETECTION USING OPTICAL FLOW FEATURES BASE ON DIGITAL & THERMAL CAMERA

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ABSTRACT. Detection and tracking of people in digital images has been subject to extensive research in the past decades. Following the growing availability of thermal cameras and the distinctive thermal signature of humans, research effort has been focusing on developing people detection and tracking methodologies applicable to this sensing modality. Thermal imaging technology can be used to detect aggressive levels in humans based on the radiated heat from their face and body. Previous research proposed an approach to figure out human aggressive features using Horn-Schunck optical flow algorithm in order to find the flow vector for all video frames using digital camera only. However, still not strong enough to confirm and verify the existence of an aggressive movement. Then, we propose another approach using thermal videos to detect aggressive features in human aggressive movement. Video frames are collected using thermal camera and then extracted into thermal images. This research also guides and discovers the patterns of body distracted movement. Result below will show the comparison between both cameras digital and thermal camera.

Keywords: optical flow, digital image, thermal image, Horn-Schunck Technique

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 analyzed compared to ordinary normal images.

Ordinary camera normally will not be able to show a hidden object in a certain situation. Therefore, in this research, there are image processing switching between digital to thermal videos. Horn-Schunck optical flow between two consecutives frames of the digital images and thermal image sequences are also computed. From there we can classify the features that can be extracting from both conditions.

LITERATURE REVIEW

Digital Image

Digital cameras are common imaging sensing devices that have been extensively exploited for robot perception, navigation and localization. However, due to the limited range of the spectrum (visible spectrum range from $0.4 - 0.7\mu m$) that these imaging sensors operate at, they have been restricted by changing atmospheric, weather and illumination conditions in challenging environments. Recently, there has been increasing interest in using alternative imagery sensing modalities for robotics applications that are more robust to environmental conditions. Alternative image sensing modalities (e.g., thermal-infrared) can sense the environment at various electromagnetic wavelengths beyond the visible spectrum. Moreover, information from multiple modalities can be integrated to enhance the scene perception and understanding (Vinicius et al., 2014).

Thermal Image

The use of thermal imaging is beneficial, capturing more of the structure of the environment with information that is not necessarily obvious in the visible domain, depending on lighting conditions and illumination angle. 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). Using thermal imager, a pictorial representation is produced to represent the detected heat without visible light content (Ramli et al., 2015; Ramli et al., 2014; Zainudin et al., 2014; Zizi et al., 2015).The thermal image can be captured by tracking the ray signaled 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 et al.2009; Ramli et al., 2015; Zainudin et al., 2014; Zizi et al., 2015).

Optical Flow (Horn-Schunck Technique)

Optical Flow-based approach using Horn-Schunck method is also suggested in motion detection as this method can detect minor motion of objects and could provide 100% flow field (Ibrahim et al., 2009; Ramli et al., 2015; Tuan Zizi et al., 2015; Zainudin et al., 2014). In general, an object that are producing a lot of motion in the video will display a more significant optical flow compared to still object in a video (Barron et al., 1994). Horn-Schunck is the first method used in optical flow estimation. It has introduced a new framework whereby it is regarded as a solution for issues in reducing the pixel intensity in a certain image. From the previous results shown that the pixel intensity does not varied from time to time when using the optical flow method which has long been used. Horn and Schunck has introduced a new method to enhance the pixel intensity in certain image. Their method is by reducing the restraint in optical flow and the magnitude in flow variation field whereby its only resulting a flawless vector field (Barron et al., 1994; Horn & Schunck, 1981, 1993).

METHODOLOGY

The method of optical flow and image processing system used images as a key factor in solving the problem of detecting a motion. The methodology of image processing is divided into four phase as shown in the Figure 1.

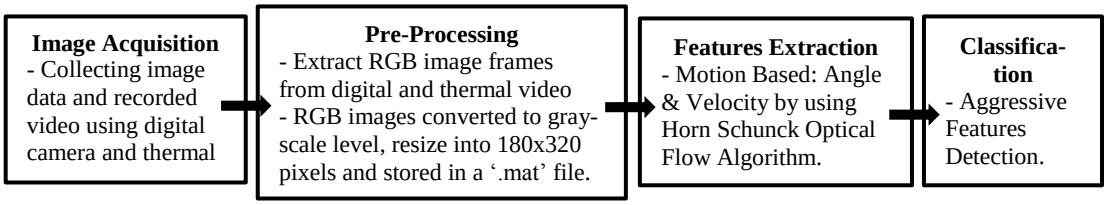


Figure 1. The Methodology of Human Aggressive Movement Detection

RESULT AND DISCUSSION

To achieve better result in detecting human aggression features, thermal data were used. From thermal data, we retrieved all the thermal image frames from thermal video. The changes were viewed by way of running the Horn-Schunk optical flow algorithm and get the flow field. Then, we can differentiate between normal and aggressive condition through the flow field just similar with the data that we retrieved from digital camera in past research.

Table 1. Example Image Frames for both Digital and Thermal Cameras and Optical Flow Field

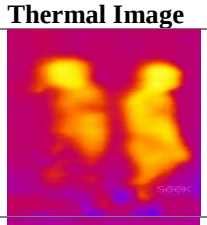
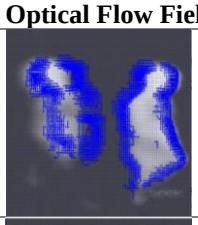
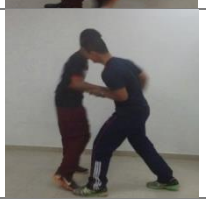
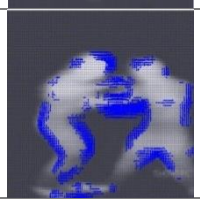
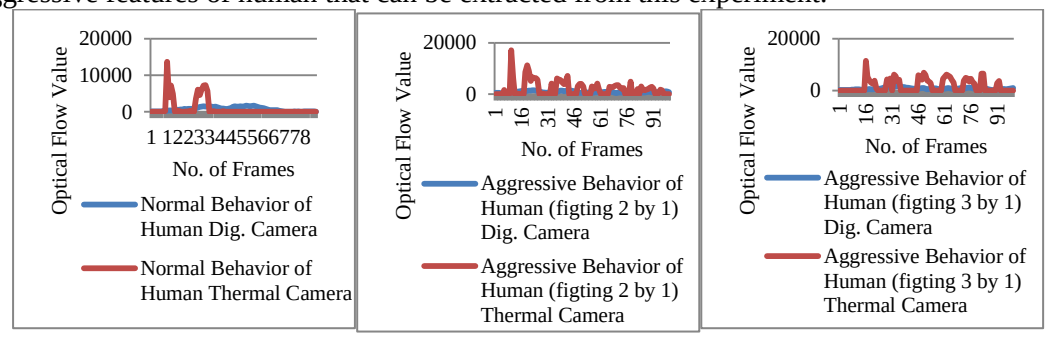
Video	Digital Image	Thermal Image	Optical Flow Field	Result
Normal				Flow field result by Horn-Schunk algorithm is consistent
Aggressive				Flow field result by Horn-Schunk algorithm is more fibrous

Table 1 above show the example of the both images from digital camera and thermal camera and also optical flow field for thermal images. As can be seen in the table above, for normal behavior, flow field result by Horn-Schunck optical flow is consistent while for aggressive behavior of human, the flow field more fibrous and not consistent. Therefore, there are aggressive features of human that can be extracted from this experiment.



(a) **(b)** **(c)**

Figure 2. Shows the Graphs of Normal Behavior and Aggressive Behavior of Human for Digital and Thermal Image Frames (a) Normal Behavior of Human for both Cameras (b) Aggressive Behavior for both Cameras (fighting 2 by 1) (c) Aggressive Behavior for both Cameras (fighting 3 by 1)

Figure 2 above show that the graphs comparison of result for both digital image and thermal image for aggressive features using Horn-Schunck optical flow. All the image data have been running using Horn-Schunck optical flow algorithm. As mention by previous research (Horn & Schunck, 1981), optical flow is the distribution of apparent velocities of movement of brightness patterns in an image. Figure 2 (a) shows the optical flow value for normal behavior of human according to digital camera and thermal camera. As shown above, from the 11th frame to the 61st frame, when the normal behavior happens for digital camera, the states of various characteristics tend to be increase because of the small movement of human has been made but still has lower optical flow value compared to the thermal camera. However from the 23rd frame to the 31st frame, when the normal behavior happens for thermal camera, the states of various characteristics tend to be increase because of the small movement of human has been made yet still it not considering that is aggressive behavior.

Figure 2 (b) shows the optical flow value for aggressive behavior of human which is human fighting 2 people against 1 people. The optical flow value appears huge fluctuations from the 13th frame to the 79th frame for thermal image as shown above, however when the abnormal behavior happens for digital camera, the states of various characteristics tend to be lower than thermal camera although it's also fluctuate. The range value of optical flow that produced using thermal camera is between 0 – 11500 but the range value of optical flow using digital camera is only below than 2000 which is between 0 – 1500. Figure 2 (C) shows the optical flow value for another aggressive behavior of human which is human fighting 3 people against 1 people. As shown above, the abnormal behavior happens for digital camera, the states of various characteristics tend to be lower than thermal camera which always appears huge fluctuations from the 20th frame to the 95th frame for thermal image. Therefore, it shows that thermal camera has ability to distinguish any movement either normal and abnormal based on temperature differences.

Apart from that, when we run the Horn-Schunk algorithm, the two values of *u* and *v* which indicate the flow velocity of the changes of two different frames was get. The experiment was conducted to differentiate the human aggressive movement between digital and thermal images. In this experiment, we recorded 10 video which can be classified as normal and aggressive condition. like previous researches have done, they use fights video as a condition for aggressive (Anderson & Bushman, 2002; Andersson et al., 2010; Borges & Nourani-Vatani, 2011; Deniz, Serrano, Bueno, & Kim, 2007; Lynn & Baron-cohen, 2014a, 2014b; Niveditha, Subhashini, & Divya, 2014; Paul, Haque, & Chakraborty, 2013; Tuan Zizi et al., 2015; Yuen et al., 2009). Then, for normal condition as proved in past research(Andersson et al., 2010; (Anenberg & Yu, 2014).; (Bhanu, 2003).; Deniz et al., 2007; Ibrahim et al., 2010; Ibrahim et al., 2009; Wan Samsudin et al., 2013; Zajdel, Krijnders et al., 2007; Zizi et al., 2015) that people just passing by among themselves were considered as normal condition.

Overall, the results shown in Figure 2 indicate that for normal behavior, little increase when people just passing by to the other without any fighting occurred. However, still the optical value is higher than aggressive value. Optical flow value for thermal image of aggressive behavior of human above is high compare to the digital image because thermal image extracted some temperature change in human body that will change the texture of images. Therefore, once again proved that flow field result by Horn-Schunk algorithm is consistent for normal movement and flow field result is more fibrous for aggressive movement. Proven, aggressive features exist when there was a fibrous flow field between both conditions normal and aggressive.

Table 2. Average Value between Normal and Aggressive Features from Digital Camera and Thermal Camera

Video	Digital Camera Average of Optical Flow Value	Thermal Camera Average of Optical Flow Value
Normal	587.778	719.875
Fights 2 by 1	792.770	1711.757
Fights 3 by 1	741.864	1851.602

Table 2 above show that the average of optical flow value that has been made. For normal behavior, the optical flow value of thermal camera is higher than digital camera. There is a little bit difference values between both cameras compare to videos which are fights 2 by 1 and fights 3 by 1 video. For normal behavior in thermal camera, the average value of optical flow is still higher than optical value of digital camera because it calculated the normal temperature changes in human because of slightly movement. That is why the differences of optical flow value between digital and thermal cameras are not much as fights videos optical flow value. For aggressive behavior, a significant difference for average of optical flow value between both cameras digital and thermal camera. It's proved that the existence of aggressive features in both videos of fights 2 by 1 and fights 3 by 1.

CONCLUSION

As a conclusion, the combination of optical flow algorithm based on both images which are digital image and thermal image able to define temperature detection. By using thermal camera, information is provide in detail and merge with the military technology; allows organizations take precautions. In this paper, our approach to human motion features detection through processing video captured by a thermal camera has been presented. There is an intelligent switching between digital images data and thermal image data depending on the platform and processing load. 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 behavior is quick, accurate and easy and luckily we can predict early and take action compare using the only ordinary CCTV. With this accomplishment, it can help to ensure a safety life and automatically can provide a safe environment for human beings. It coincided with the conference theme which is green technology. Last but not least, aggressive feature exists and noticeable at feature of the thermal camera compared to digital cameras. In future work, the experiment will be continued by using more data and several of conditions in order to create a stable and robust algorithm.

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