ISSN 2348-1196 (print)
International Journal of Computer Science and Information Technology Research ISSN 2348-120X (online)
Vol. 4, Issue 4, pp: (10-21), Month: October - December 2016, Available at: www.researchpublish.com

Reflex Action Incidents Detection for Intelligent Video Surveillance

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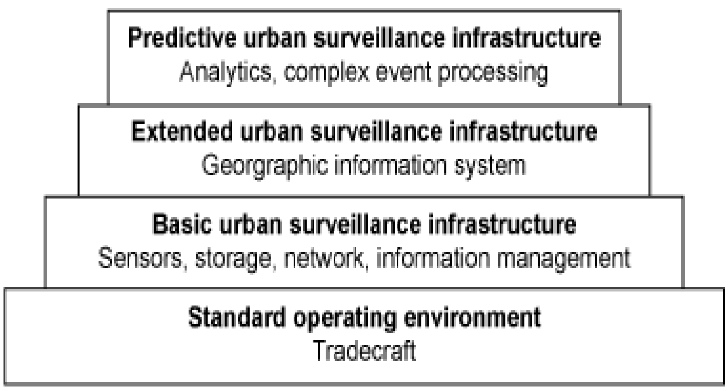
Abstract: **A reflex is an involuntary muscle reaction in response to sensory stimulation that brings about a change. Some changes are clearly visible while others are not, depending on the distances between the surveillance camera and subjects. Incidents are unexpected occurrences that could cause harm or destroy the property being protected. Intelligent video surveillance system requires fast and robust methods of moving object detection, tracking, and event analysis. They are more useful if they can report reflexes that result from critical incidences. There are incidences that happen in solitude and the subjects may need assistance. A combination of thresholding and frame differencing proved to be a simpler method for object detection and event analysis for automatic reflex action incidents detection. The "knee jack" response of limbs is normally caused by unexpected reaction or presence of an unexpected frightening item or occurrence in a scene. Unlike other incident detection methods, this is not based on predetermined and classified human behavior. The identification of reflex action incidents in the scene can then be used to raise an alarm or notification to the human operators for necessary security action.**

Keywords: **Security, video surveillance, reflexes, incidents.**

I. INTRODUCTION

The video surveillance systems are very critical not only for security reasons but also in helping enhance efficiency in management and coordination of activities. The video surveillance applications and systems have improved over the years [1].Of interest in most surveillance systems is the foreground detection. The background features like walls, trees, electric poles among others are considered to be static and part of the environment.

Infrastructure of surveillance systems is very critical as it helps assure proper and timely transmissions of both audio and video signals from the sensors. According to [2], to access the maturity of an urban surveillance infrastructure, there is a dependency of some logical building blocks as shown in figure 1.



(Source: IBM, 2013)

Fig. 1. Urban Surveillance Infrastructure Architectural building blocks

II. RELATED WORK

Incidents detection in any video surveillance systems is very important as it determines reporting and response. Incidents detection can be very useful in different spheres of life. It begins with background subtraction [3][4][5]. This is followed by feature detection [6][7][8] that uses different recognition techniques such as edges, shape and contours [9][10].One of the spheres is the transport traffic management. The critical point in the traffic incident management chain is the procedure of detecting the incident and the appropriate verification thereof [11]. Other applications may include behaviour monitoring [12][13]. The experiments performed by Johansson in the 1970s demonstrated that the motion of the limbs contain enough information to infer the presence of a human. Figure 2 shows filmed moving humans in a pitch-black room, the only visual indicator being a white point of light attached to each limb. A viewer watching the film could easily identify human motion, despite the absence of visual cues such as shape, texture, brightness, and color [14].

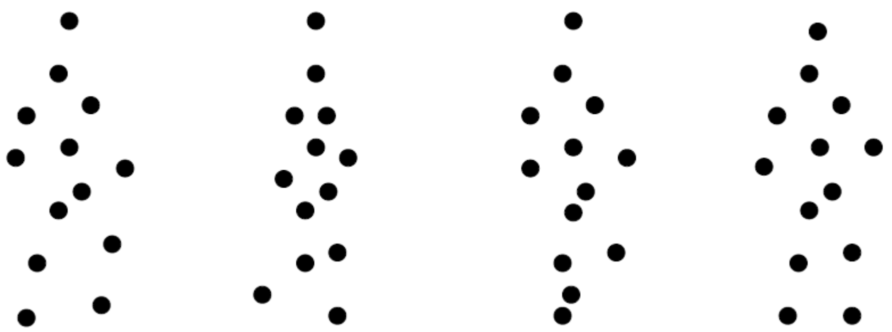


Fig. 2. Johansson Points

Motion detection plays a fundamental role in any object tracking or video surveillance algorithm, to the extent that nearly all such algorithms start with motion detection [15][16][17].

Motion detection is therefore very important in video surveillance systems. Many different approaches including frame difference [18] where classification is based on target shape and not contents, while maintaining multiple hypothesis of target's classification over time which allowed the system to disambiguate in cases of occlusions or background clutter and double frame difference [19][20].

Object classification is important in object detection. The purpose of moving object classification is to precisely extract the region corresponding to people from all moving blobs obtained by the different motion segmentation methods. It can be done based on the motions or shape [21] [22][23][24]. However, this step may not be needed under some situations where the moving objects are known to be human.

Accurately detecting and identifying features in a scene can be challenging. It may require complex algorithms and higher computational capability. A pedestrian detection system was developed that integrates image intensity information with motion information [25]. They used a detection style algorithm that scans a detector over two consecutive frames of a video sequence. The detector was trained to take advantage of both motion and appearance information to detect a walking person. This was ingenious as they combined both sources of information in a single detector. A system that automatically detects frontal faces in the video stream and codes them with respect to 7 dimensions in real time: neutral, anger, disgust, fear, joy, sadness, surprise was developed [26]. The face finder employs a cascade of feature detectors trained with boosting techniques which greatly improved performance. Bayesian approaches have also been used [27][28]. These methods were able to detect features handle noise effectively. However, there are human reflex actions that are random, happen rapidly and cannot be easily determined [29][30][31]. These are also important in incident detection. Many algorithms have analysed and estimated human behaviour for video surveillance among others [32][33][34]. However, this thesis devices a simpler approach.

This study looks into the visual human responses and analyses human reflex actions in critical incidents. The live video streaming, recording, motion detection and classifications of human actions in security systems has greatly improved security surveillance. Combining these achievements with interpretation of human reflexes will help locate and mitigate critical incidences. Figure 3 shows the context diagram.

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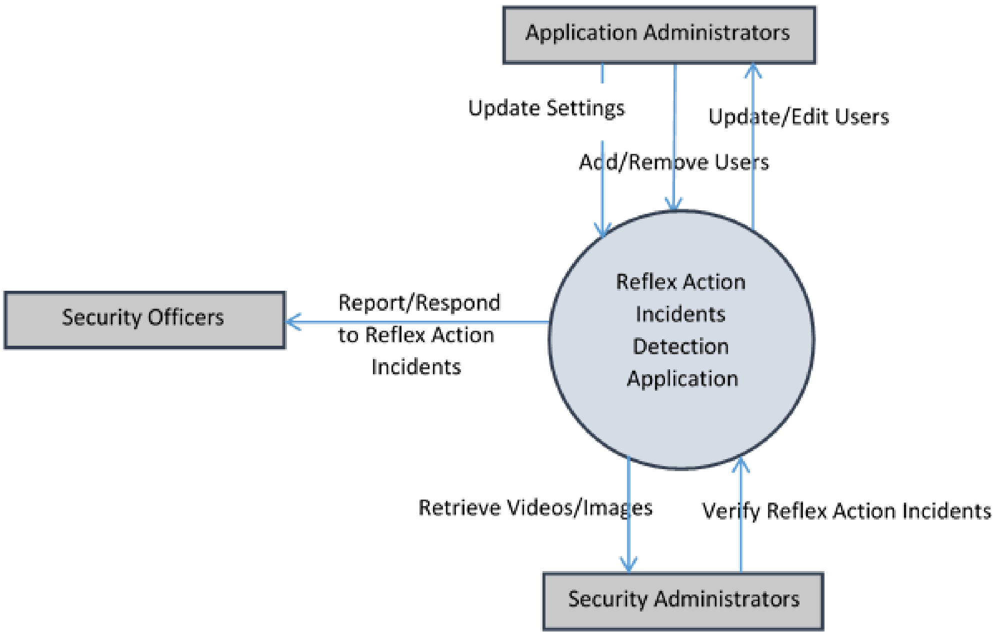

Fig. 3 Context Diagram

III. METHODOLOGY

There are three key steps in video analysis, detection of specific moving objects, tracking of such objects from each frame to frame, and analysis of object tracks to recognize their behaviour. Our main aim is to design, implement and analyze a reflex action incidents detection framework that demonstrates the importance of reflex actions incidents detection for intelligent video surveillance.

A framework that detected and reported of reflex action incidents was designed, implemented, tested and the results analysed as shown in figure 4.

Reflex actions in live or recorded video normally results to a rapid movement of limbs. Reflexes are the visual or non-visual actions that are random in nature and cannot be easily determined. They are dependent on the nature of stimuli. The motion field is a two dimensional (2D) representation in the image plane of a generally three dimensional (3D) motion of points in the scene. To detect the reflex actions, first, the live or recorded video frames are analysed then classification of pixel changes based on set threshold and frame differencing is done. The threshold value will be based on the speed of change of pixels and calibration data. Secondly, the appropriate response is determined. On analysing the behaviour of these pixels, a conclusion can be made on whether actually there is incident or not for the necessary action. Lastly, finding out if a framework can effectively and reliably detect reflex action incidents and raise notification or an alarm to the human operator for the necessary action.

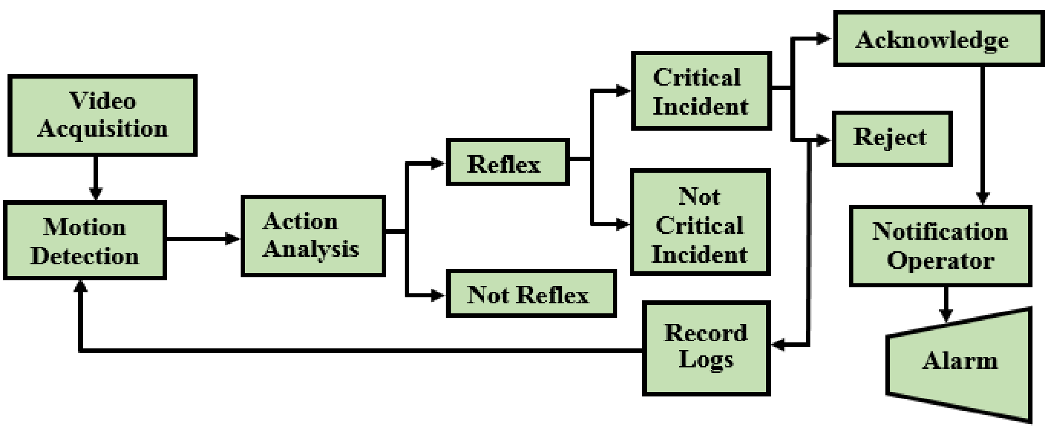

Fig. 4 Reflex Action Incidents Detection Framework

IV. IMPLEMENTATION AND ANALYSIS

Implementation:

The reflex action incidents detection framework used recorded or live video streams generated from the surveillance cameras. The video frames are acquires, converted to binary to reduce computational complexity, threshold to determine foreground detection and frame differencing as shown in figure 5. With a given thresholding and frame differencing determined through calibration to detect reflex actions, reflex action incidents and reporting.

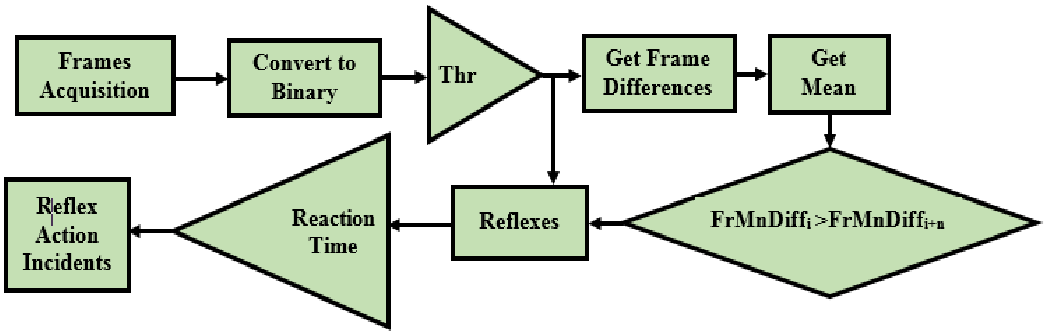

Fig. 5 Reflex Action Incidents Detection

The changes in video frames were studied. These videos were then analyzed for different detections at different combinations of thresholding values and frame differences. We studied visible human actions in their daily undertakings. It was observed that reactions could generate reflex characteristics that could help give insights about a security issue. This was observed in different working environments, both outdoors and indoors. There are physical reactions such as sneezing can result from human body functions responding to an internal body state. However, there are frightening and exciting reactions too that resulted from other factors external to the body that may result to reflex actions. These are reactions to critical incidences that took short time and the responses were observed to be random and unpredictable.

The data was then analyzed to determine if there were any patterns or common behavior in human reactions that can be considered reflex actions. These were then analyzed further to determine if these reflex actions could give information about incidences related to security concerns of the individuals.

To determine efficiency and reliability, findings were recorded from different scenes to determine the nature of actions, whether reflexes or not, and if they can be used to determine incidences.

The time to respond to stimuli varies under different conditions. The human reaction time is a complicated behavior and it is affected by a large number of different variables. These factors could include the nature of stimuli, time of occurrence, the human sensory sensitivities and the emotional and physical state of the individuals as discussed in chapter two. Figure 4 shows some common and easily visible arm, leg and head movements.

Fig. 6 Common arm, leg and head movements

Heat load test was among others, done to students to determine their reaction time which showed closer relationship [35]. with [36], in which human responses to light, sound and skin stimuli vary. Whenever there are incidences, especially critical incidences, there are involuntary flexion or extension motions in limbs. For different subjects, the observation reaction time ranged from 0.124 to 0.184 seconds. There were slight differences in skin stimulation and hearing. Some other reactions that results in slight movements may not be clearly visible hence difficult to distinguish from the normal behaviour. Other sensors may be used to analyze the effects of critical incidences such as heart rates, blood pressure and eye blinking.

It was observed that the time it takes for flexion and extension depended on a number of factors.

Age:

Age depicts different characteristics for both young and old. An example is the deterioration of senses and weakening of muscles with the elderly. Infants exhibit primitive and simple reflexes that may respond differently to the same of different stimuli. Postural reflexes may exhibit different characteristics too, for example responses during slippage on slippery grounds.

Physical and Emotional State:

Reaction time is affected by the physical and emotional state of the subjects. A critical incidence may not be interpreted as critical and hence the reaction tends to be normal. An example is when a security officer is a sleep and then ambushed by robbers. The officer has to sober up first before making any rational decision. Other instances include fatigue and sickness. Sickness may impair senses such that the stimuli may not be interpreted clearly.

Training:

Reaction time decreased with increased training [35]. When a critical incident happens, the trained personnel tend to take charge and manage the reaction. Subjects are respond faster to fight or flee. However, the training mostly becomes effective when the subjects have already thought of the situation.

Past Experiences:

Having experienced past frightening incidents may influence the reflexes. An example is when someone appears in the scene suddenly may be interpreted by a robbery survivor as a thief.

Drug Use and Abuse:

The use of drugs may reduce anxiety and pain when inflicted with pain. These when taken may hinder normal response in situations that exhibit critical incidents.

There are many algorithms that can handle effectively image segmentation, both in static and dynamic environments. Building on the existing algorithms, reflex action incidents detection uses active learning approach. It exploits the capabilities of foreground detection and frame differencing. The information in the first frames and the frames preceding the current frame, are used to determine the framework response.

Frame Difference = |abs (Frame F_{i+n} – Frame Fi)>Threshold|

FrameDifferenceMean = the average of pixels of Frame Difference

FrameDifferencesMean = ((FrameDiff1Mean+FrameDiff2Mean)/2)

Reflex Detection = |abs (FrameMean F_{i+n} – FrameMean F)>ReflexThreshold|

Reflex Action incidents detection = Reflex Detection<=SpecifiedReactionTime

Where n=0, 1, 2, 3, 4, 5, 6 or 7 is the frames difference

F_i= the ith video frame.

Threshold= Foreground Detection threshold

ReflexThreshold= reflex Action Incidents Detection Threshold

FrameDiff1Mean = the mean of first set of frame differences.

The framework was able to achieve foreground detection in static and dynamic backgrounds. It is possible to eliminate noise to some degree based on a given set of scene constraints. Figure 7 shows a computer lab class session.

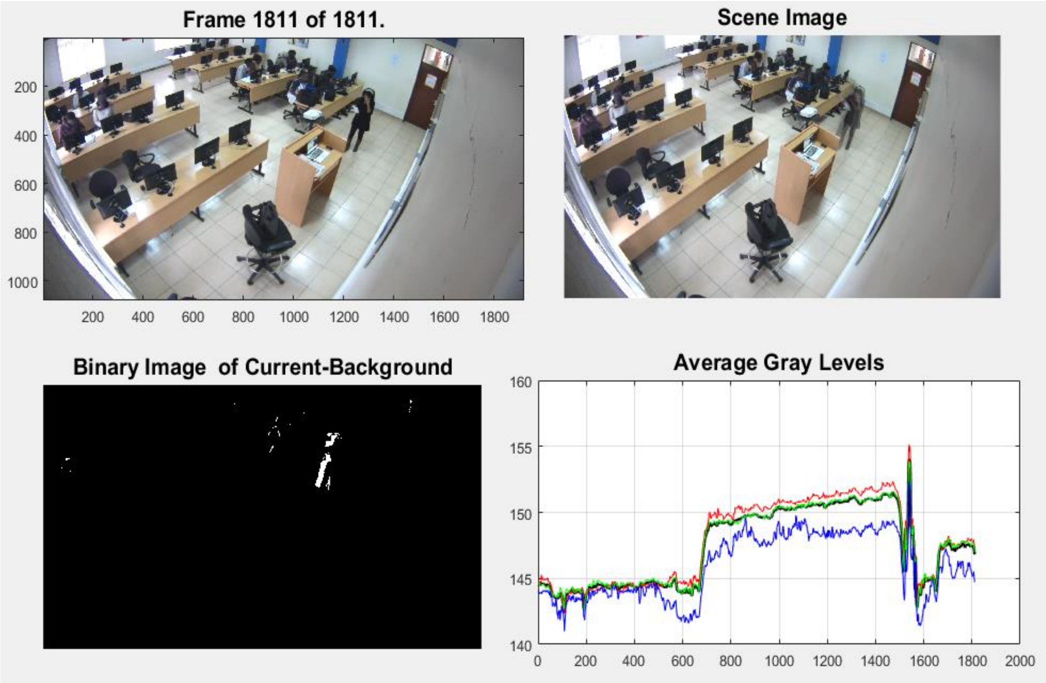

Fig. 7 Motion Detection

One of the surveillance video recordings was analyzed as shown in table I. The average frame differences at an instant of frame 60 of 1501, when the background image is captured from the first frames.

Table I: Mean Values of Frame 60 at Different Frame Differences and Threshold Values

		Frames Differences							
Threshold	Image	0	1	2	3	4	5	6	7
0	145.7427	246.7337	27.1563	28.7627	29.0657	29.4648	29.4395	27.9266	29.0567
10	145.7427	25.8657	34.2915	31.1574	30.8745	30.7737	31.2685	34.9868	31.8520
20	145.7427	6.3335	8.6332	7.8078	7.8598	7.8646	7.9024	9.1575	8.2516
30	145.7427	2.8145	3.2177	3.0045	3.1193	3.1289	3.0478	3.5049	3.3001
40	145.7427	1.5237	1.5383	1.4505	1.5640	1.5340	1.5027	1.6590	1.6206
50	145.7427	0.8900	0.8384	0.7793	0.8685	0.8298	0.8357	0.8357	0.8921
60	145.7427	0.6052	0.5837	0.5217	0.6198	0.5679	0.5783	0.6006	0.6072
70	145.7427	0.4262	0.4124	0.3711	0.4358	0.3995	0.3979	0.4183	0.4311
80	145.7427	0.2875	0.2578	0.2685	0.3062	0.2804	0.2758	0.3005	0.3237
90	145.7427	0.1918	0.1238	0.1777	0.1994	0.1843	0.1543	0.1766	0.2114
100	145.7427	0.1193	0.0601	0.1046	0.1201	0.1117	0.0885	0.0970	0.1257
110	145.7427	0.0655	0.0358	0.0484	0.0521	0.0494	0.0403	0.0568	0.0684
120	145.7427	0.0184	0.0135	0.0159	0.0188	0.0146	0.0160	0.0227	0.0198
130	145.7427	0.0031	0.0023	0.0038	0.0038	0.0026	0.0028	0.0082	0.0081
140	145.7427	0.0011	0.0013	0.0013	0.0032	0.0019	0.0013	0.0030	0.0051
150	145.7427	0	0.0011	0.0011	0.0022	0.0011	0.0011	0.00052	0.00077
160	145.7427	0	0	0	0	0	0	0	0
170	145.7427	0	0	0	0	0	0	0	0
180	145.7427	0	0	0	0	0	0	0	0
190	145.7427	0	0	0	0	0	0	0	0
200	145.7427	0	0	0	0	0	0	0	0
210	145.7427	0	0	0	0	0	0	0	0
220	145.7427	0	0	0	0	0	0	0	0
230	145.7427	0	0	0	0	0	0	0	0
240	145.7427	0	0	0	0	0	0	0	0
250	145.7427	0	0	0	0	0	0	0	0
255	145.7427	0	0	0	0	0	0	0	0

It was observed that the frame differences at zero thresholding and zero frame difference was very sensitive to interferences and therefore recorded larger mean values as represented in the figure 8.

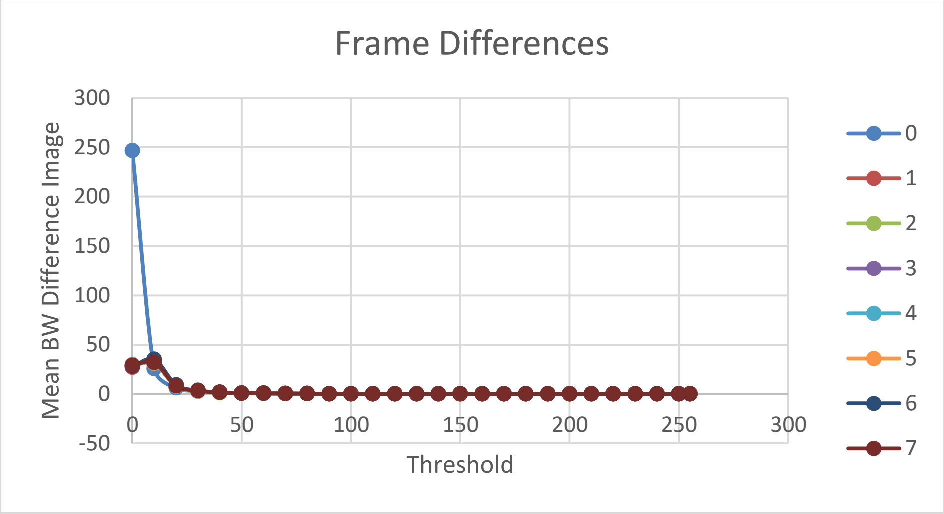

Fig. 8 Mean of Difference Images

With higher thresholding values, the mean values of the frame differences decreased until zero. It was therefore observed that for a given frame, a behavior could be predicted with increasing values of frame difference and thresholding for the mean values of the difference image. This observation is very critical in analyzing video frames for reflex actions incidents detection.

A mean of frame differences was also taken to ascertain the behavior.

Fig. 9 Frame Difference Mean at threshold 50

The mean values at threshold 50 and 4 frames difference were shown in the figure 9. It is uniquely observed that the mean value changes are not instantaneous but gradual.

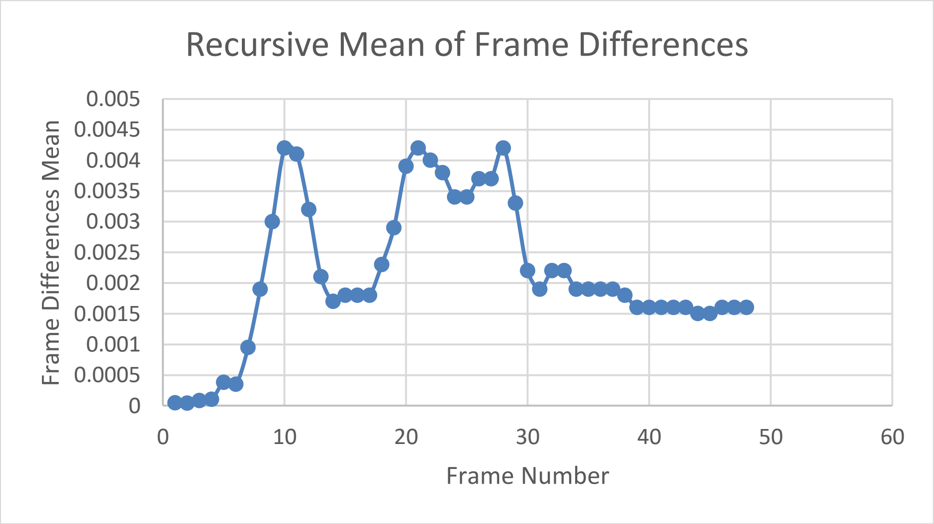

Fig. 10 Recursive Mean of Four Frame Differences

Analysis:

On analysing the results, some trends were observed and could guide reflex action incidents detection, generalization and future studies after the threshold values were captured for different scenes and distances that depicted different reactions. It was possible to detect objects in motion as shown in figure 11.

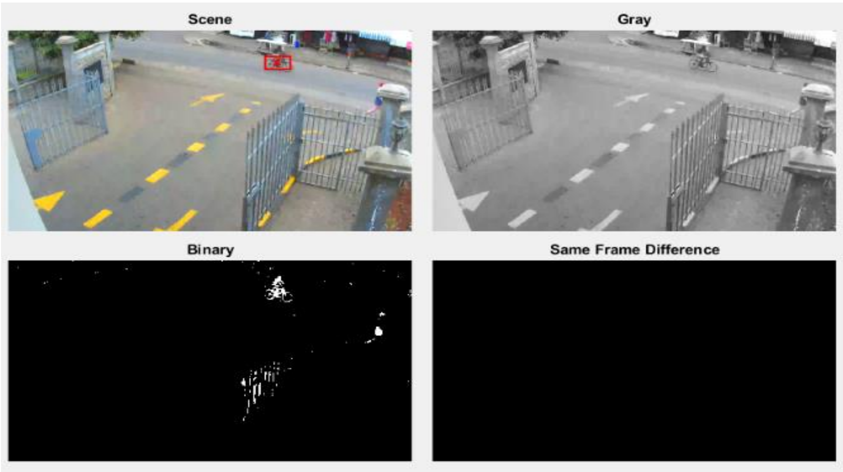

Fig. 11 Object Detection

The difference between two frames was very useful in detecting motion. Thresholding enabled foreground detection. The figure 11 shows a frame with thresholding value 20 and a five frames difference. From the implementation of the framework, it was observed that nonconsecutive frame differences could provide additional information that was useful. This is because, when an object is in motion, there are slight differences in the scene, lighting and object behavior. Furthermore, the slight angular view changes during motion could influence the images.

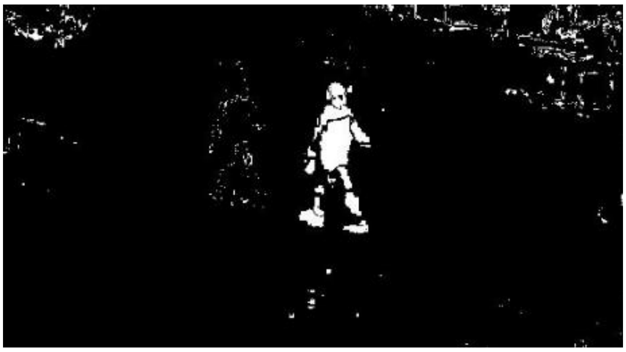

Fig. 12 Thresholding and five frame difference

Different combinations of thresholding and frame differencing was then used to test the detection of visual reflex actions in an office environment that exhibited different characteristics.

Reflexes and Incidents Reporting:

It was possible to detect motion. Using different combinations of frame differencing and thresholding in combination with specific values of reaction time, it was possible to detect reflex action incidents.

Whenever reflexes are determined to be caused by critical incidences, the framework could report immediately through a popup message or audible alarm signal. This information is critical for intelligent video surveillance and operator could then verify the incident on whether critical or not by observing the scene, play back recorded videos or looking at snapshot of images. Both false positives and false negatives were recorded for analysis.

Efficiency and Reliability:

Using the frame work in a reception desk that exhibited a lot of human traffic with different behavior, it indicated that there was great improvement in incidents detection especially reflex action incidents that will improve video surveillance.

There were more accurately detected incidences than both false and negative positives.

Therefore, the framework proved to be a simpler option in improving security surveillance through reporting reflex action incidents. However, integrating complex algorithms that eliminate illumination and classification may improve the results.

It was also observed that the framework can also be used in other areas that require monitoring of unexpected human behavior such as hospitals to monitor and report patients with different medical conditions and offices.

Experiment Challenges:

Lighting:

Camera directly facing a light source may not clearly determine all the object movements. Varying luminance made it harder to determine these motions especially for objects further from the camera. Camera installation positions are very critical in determining how well you capture the images of the scene.

Camera Properties:

Different cameras have different properties. Some that have night vision capabilities and are able to record scene activities even at night when it's totally dark. Higher motion speeds could not be detected. This requires machines that can achieve higher frames per second display and recording.

Cameras with lower frame rates may not easily capture reflexes that are normally random and quick while the ones that have higher frame rates captured even finer motion details.

Furthermore, the quality of the images analyzed greatly depended on the camera resolution as well as magnification capabilities.

Detection misinterpretation:

Feature detection could be misinterpreted. An example is face detection. A picture of the human face may not be clearly determined with a single camera from the actual human face. A stereo system may be needed in such a case where two or more cameras can help capture the depth information. An example is the use of Kinect Sensor with RGB camera and 3D depth sensors. This will help distinguish between an actual human face and a picture. Furthermore, other sensors may be integrated with the surveillance cameras such as access control and infrared systems although these technologies also have their inherent inadequacies. An example is an unethical problem where an individual can register different fingers in the biometric system as two or more individuals in the cases where not all fingers are registered.

Mischief:

Humans may act in mischievous ways that may be interpreted and detected as reflexes as their activities have emotionally strong properties of extreme fear and excitement. Hitting someone with a ball is mischief while hitting someone with a rock is very dangerous. A simple handshake is a greeting and so too a vigorous handshake that may include hugging depending on the level of excitement. This may happen in critical and always calm places such as reception desks, library circulation desks and data centers among others.

Misinterpretation:

Based on the camera calibration, some actions initially considered as reflexes may appear in the scene. An individual sneezing may demonstrate the properties of sneezing and this will be reported as an incident. However, it could be argued that it is better to report a false incident than not to report at all. This is not encouraged; the framework should reported minimal false alarms.

Computing Capability:

The computer processor speed and memory could play a major role in the implementation. We used a system that uses Intel processors, Core™ i3 4005U at 1.7GHz with 4GB RAM. This is dependent also on other services or applications the computer could be running at the time of testing.

V. CONCLUSIONS AND RECOMMENDATIONS

There are benefits of surveillance systems especially if you can detect the rapid and random human reflex actions incidents for intelligent video surveillance.

Conclusions:

Improved Reporting:

Surveillance systems will be able report reflexes, happens very fast. The incidences that result into reflex actions can easily be concealed or go unnoticed especially in secure places by the authorized persons such as offices and datacenters. The framework will be able to raise a notification in form of a pop up message or siren that will alert the operators that there is an incident in a certain location hence needs to be checked out. Reporting can be integrated with other communication channels such as short message service (SMS) and emails in addition to activity logs that ensures proper documentation.

Sense of Responsibility:

Authorized persons will be willing to take responsibility of their actions in secured places. The conduct of individuals and not just their presence is monitored. Carelessness, negligence or incompetence can be detected through reflexes and incidents detection. This is achieved by continuous analysis of live video streams from the surveillance cameras.

Accidents Alerts

Unexpected incidents like electrocution can be reported and the victims rescued and treated in a better time. Rapid change of pixels that exceed a predetermined threshold means that there is unusual activity and immediate action by operators needs to be taken.

Quicker Response:

Random actions as a result of panic can be detected again by determining the rate of pixel changes. Panic due to other alarms going off such as fire extinguisher alarm that discharges after 30 seconds can quickly be addressed, as the replacement of extinguisher cylinders are usually very costly. Especially if caused by an incompetent act or poor installation. It can be disabled or allowed to discharge to extinguish fire.

Enhanced Security:

Incidents notifications can be raised by the system even with authorized persons accessing the secured areas. The owners and administrators will fill more secure as the authorized persons are in the secure places. This is because; they can be able to get notifications on any unexpected incidents that result to reflex actions which may not be intrusions.

Recommendations:

Reflex Action Incidents Detection application has been able to detect and report reflex action incidents for intelligent video surveillance. But it could have been much better if the researcher could access the installed surveillance systems of organizations. The researcher also recommended the use of other research approaches other than experimental and exploratory methods, such as explanatory or descriptive methods.

Integrating this concept with other concepts in video surveillance system such as feature detection and stereo can help in identification of object as well as knowing the distance from the cameras hence the system will be better in analyzing reflex action incidents in different objects and distances as the researcher only studied the rate of change of pixels.

Integration:

Integration of different algorithms could improve reflex actions and incidents detection as many algorithms work optimally in specific conditions.

Camera Resolution:

Higher resolution cameras are better placed to detect reflexes. These cameras are able to detect smaller changes in the scene. The scene features will be clearer hence better computer vision and analysis.

Frame Rate:

Higher frame rates would help detect even shortest-timed reflex reflexes. Higher frame rates will be able to detect smaller changes in the scene. It can also be able to detect very fast reflexes and hence better incidents detection.

Adaptive Motion Detection Algorithms:

Using adaptive motion detection algorithms, just like the feature detection, could improve reflex action incidents detection for both near and far reflexes.

REFERENCES

[1] Cisco Systems IP Network-Centric Video Surveillance. (2006, May 30). Retrieved May, 12, 2016, from http:// www.cisco.com/c/en/us/products/collateral/physical-security/video-surveillance-servicesplatforms/prod_white_ paper0900aecd804a3e89.html

[2] http://www.ibm.com/developerworks/security/library/se-ind-urban-surveillance-infrastructure/index.html, Access to Urban Surveillance (2013).

[3] Li, L., Huang, W., Gu, I. Y., & Tian, Q. (2003, November). Foreground objects detection from videos containing complex background. In Proceedings of the eleventh ACM international conference on Multimedia (pp. 2-10). ACM.

[4] Collins, R. T., Lipton, A. J., Kanade, T., Fujiyoshi, H., Duggins, D., Tsin, Y., & Wixson, L. (2000). A system for video surveillance and monitoring (pp. 1-6). Technical Report CMU-RI-TR-00-12, Robotics Institute, Carnegie Mellon University.

[5] Javed, O., Shafique, K., & Shah, M. (2002, December). A hierarchical approach to robust background subtraction using color and gradient information. In Motion and Video Computing, 2002. Proceedings. Workshop on (pp. 22-27). IEEE.

[6] Lienhart, R., & Maydt, J. (2002). An extended set of haar-like features for rapid object detection. In Image Processing. 2002. Proceedings. 2002 International Conference on (Vol. 1, pp. I-900). IEEE.

[7] Senthilkumaran, N., & Rajesh, R. (2009). Edge detection techniques for image segmentation–a survey of soft computing approaches. International journal of recent trends in engineering, 1(2).

[8] Tian, Y. L., & Hampapur, A. (2005, January). Robust salient motion detection with complex background for real-time video surveillance. InApplication of Computer Vision, 2005. WACV/MOTIONS'05 Volume 1. Seventh IEEE Workshops on (Vol. 2, pp. 30-35). IEEE.

[9] Arbelaez, P., Maire, M., Fowlkes, C., & Malik, J. (2011). Contour detection and hierarchical image segmentation. IEEE transactions on pattern analysis and machine intelligence, 33(5), 898-916.

[10] Maire, M. R. (2009). Contour detection and image segmentation (Doctoral dissertation, University of California, Berkeley).

[11] Škorput, P., Mandžuka, S., & Jelušić, N. (2010). Real-time detection of road traffic incidents. PROMET Traffic & Transportation, 22(4), 273-283.

[12] Lofca, I. (2002). A case study on police misconduct in the United States of America and an applicable model for the Turkish National Police.

[13] Champion, D. J. (2001). Police misconduct in America: A reference handbook. ABC-CLIO.

[14] G. Johansson, “Visual perception of biological motion and a model for its analysis,” Perception and Psychophysics, vol. 14, pp. 201–211, 1973.

[15] David Moore “A real-world system for human motion detection and tracking”, California Institute of Technology, June 5, 2003

[16] Panda, D. K. (2012). Motion detection, object classification and tracking for visual surveillance application (Doctoral dissertation).

[17] Rahman, J. (2008). Motion detection for video surveillance.

[18] A. Lipton, H. Fujiyoshi, and R. Patil,"Moving target classification and tracking from real-time video. Pages 8-14, Oct 1998

[19] Yoshinari, K. and Michihito, M., "A human motion estimation method us using 3- successive video frames Proc. Of Intl. Conf. on Virtual Systems and Multimedia, 1996, pp. 135-140.

[20] Li, L., Huang, W., Gu, I. Y., & Tian, Q. (2003, November). Foreground objects detection from videos containing complex background. In Proceedings of the eleventh ACM international conference on Multimedia (pp. 2-10). ACM.

[21] Martin, D. R., Fowlkes, C. C., & Malik, J. (2004). Learning to detect natural image boundaries using local brightness, color, and texture cues. IEEE transactions on pattern analysis and machine intelligence, 26(5), 530-549

[22] Belongie, S., Malik, J., & Puzicha, J. (2002). Shape matching and object recognition using shape contexts. IEEE transactions on pattern analysis and machine intelligence, 24(4), 509-522.

[23] Berg, A. C., & Malik, J. (2001). Geometric blur for template matching. InComputer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on (Vol. 1, pp. I-607). IEEE.

[24] Lowe, D. G. (1999). Object recognition from local scale-invariant features. InComputer vision, 1999. The proceedings of the seventh IEEE international conference on (Vol. 2, pp. 1150-1157). IEEE.

[25] Viola, P., Jones, M. J., & Snow, D. (2003, October). Detecting pedestrians using patterns of motion and appearance. In Computer Vision, 2003. Proceedings. Ninth IEEE International Conference on (pp. 734-741). IEEE.

[26] Bartlett, M. S., Littlewort, G., Fasel, I., & Movellan, J. R. (2003, June). Real Time Face Detection and Facial Expression Recognition: Development and Applications to Human Computer Interaction. In Computer Vision and Pattern Recognition Workshop, 2003. CVPRW'03. Conference on (Vol. 5, pp. 53-53). IEEE.

[27] Oliver, N. M., Rosario, B., & Pentland, A. P. (2000). A bayesian computer vision system for modeling human interactions. IEEE transactions on pattern analysis and machine intelligence, 22(8), 831-843.

[28] Fei-Fei, L., & Perona, P. (2005, June). A bayesian hierarchical model for learning natural scene categories. In 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) (Vol. 2, pp. 524-531). IEEE.

[29] Fiorentino, M. R. (1974). Reflex Testing Methods for Evaluating CNS Development. American Journal of Physical Medicine & Rehabilitation, 53(6), 300.

[30] Goddard, S. (2002). Reflexes, learning and behavior: A window into the child's mind. Fern Ridge Press.

[31] Zeng, Z., Fu, Y., Roisman, G. I., Wen, Z., Hu, Y., & Huang, T. S. (2006). Spontaneous Emotional Facial Expression Detection. Journal of Multimedia, 1(5), 1-8.

[32] Yoshinari, K. and Michihito, M., "A human motion estimation method us using 3- successive video frames Proc. Of Intl. Conf. on Virtual Systems and Multimedia, 1996, pp. 135-140.

[33] Martin, D., Fowlkes, C., Tal, D., & Malik, J. (2001). A database of human segmented natural images and its application to evaluating segmentation algorithms and measuring ecological statistics. In Computer Vision, 2001. ICCV 2001. Proceedings. Eighth IEEE International Conference on (Vol. 2, pp. 416-423). IEEE.

[34] Lawrence, S., Giles, C. L., Tsoi, A. C., & Back, A. D. (1997). Face recognition: A convolutional neural-network approach. Neural Networks, IEEE Transactions on, 8(1), 98-113.

[35] Mohan Chandra, A., Ghosh, S., Barman, S., Iqbal, R., & Sadhu, N. (2010). Effect of exercise and heat-load on simple reaction time of university students. International Journal of Occupational Safety and Ergonomics,16(4), 497-505.

[36] Donders, F. C. 1868. On the speed of mental processes. Translated by W. G. Koster, 1969. Acta Psychologica 30: 412-431.