CHAPTER THREE

FULL FRAME BASED IMAGE ANALYSIS

3.1 Introduction

The term full frame refers to a continuous period of time represented by a sequence of successive frames, this period starts when a certain object appears in the camera view and finished when the particular object leaves the scene. While the full frame based analysis is defined as extracting a set of features from object motion during its appearance in the current scene. However, each new frame carries updated values for the set of these attributes. An obvious example of this type of attributes is an object trajectory. Through the appearance of the object in the camera view, each new frame defines an updated position for the particular object under study. Three motion attributes need online updates from the successive arriving frames, the following list shows the full frame attributes:

- Moving object Trajectory.
- Pixel Frequency Distribution.
- Time Parameter.

The next sections discuss the concepts of full frame based analysis in more details, starting from the moving objects trajectory, followed by the pixel frequency distribution as a powerful tool for analyzing the objects motion and finally illustrating the impacts of the time parameter in understanding the objects motion.

3.2 Moving Objects Trajectories

There are different ways to specify the position of a certain object in a sequence of images such as using its enclosing rectangle or the center of the object area. In order to construct the trajectory; the position of the object during the frame set is required. In this study, the position of an object in a particular frame is defined based on the center of the object region. The center of the white pixels area in binary images is the same as the center of mass if we consider the intensity at a point as the mass at that point. To calculate the position of the object, we used a set of equation mentioned in [11] is used:

$$\bar{x} \sum_{i=1}^{n} \sum_{j=1}^{m} B(i, j) = \sum_{i=1}^{n} \sum_{j=1}^{m} j\, B(i, j) \tag{3.1}$$

$$\bar{y} \sum_{i=1}^{n} \sum_{j=1}^{m} B(i, j) = \sum_{i=1}^{n} \sum_{j=1}^{m} i\, B(i, j) \tag{3.2}$$

Where $\bar{x}$ and $\bar{y}$ are the coordinates of the center of the region. Thus, the position of an object is:

$$\bar{x} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} j\, B(i, j)}{\sum_{i=1}^{n} \sum_{j=1}^{m} B(i, j)} \tag{3.3}$$

$$\bar{y} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} i\, B(i, j)}{\sum_{i=1}^{n} \sum_{j=1}^{m} B(i, j)} \tag{3.4}$$

The position calculated using first order moments is not necessarily an integer and usually lays between the integers values of the image array indices. So the calculated values are rounded to the nearest integers. Each new next frame describes an updated version of the object position in the image plane. This position is defined based on the variation in the object area over the time, which in turn is a direct result of the object motion. However the variation occurred in the rows and columns of pixels in the image plane and corresponding the x-coordinates and y-coordinates in the trajectory plane. The time unit per variation event is an image frame, so each frame defines the object location at a particular time instance. The equation below lists the x and y coordinates for the center of mass, starting from the first frame (where the object appears in the camera view for the very first time) till the last frame (where the object leaves the camera view). Capital x refers to the x coordinates and capital y refers for the set of y coordinates:

$$X = \{\overline{x_1},\ \overline{x_2}, \overline{x_3}\ \ldots\ \overline{x_n}\}$$
$$Y = \{\overline{y_1},\ \overline{y_2}, \overline{y_3}\ \ldots\ \overline{y_n}\} \tag{3.5}$$

Where X & Y is the set of x and y coordinates of the object trajectory over the time and n is the number of simulated frames. The rest of this section is dedicated to illustrate the experimental results gained from the different simulation scenarios.

3.2.1 Case Study I

This case study is coped with a ball hanged by string and moved freely in the space. The attempt is to extract the ball trajectory during 20 second, 500 frame of video stream. As discussed in the previous section the trajectory constructed based on the variation of the center of mass for the white pixels area during the frame set. The figure below illustrates the variation of x and y coordinates for the center of mass over the frame sequence [Altahir A. Altahir et al, 2007].

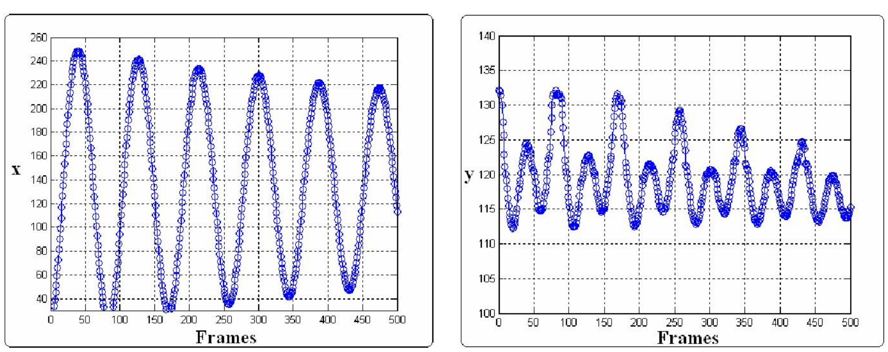


Figure 3.1: X & Y coordinates variation for the ball trajectory.

These variations contribute to the process of forming the object trajectories. The density of the points in the graph has a direct proportion with the frequency, where the term frequency stand for the amount of time spent by the object of interest in a particular location in the image plane. High density points in the trajectory plane refer to high frequencies in the image plane, while low density refers to low frequencies. From the figure; we observed that the high and low peaks, high frequencies denoted the event of changing the ball direction which it occurred after a short period of time where the ball is remained fully static.

Another type of representation of objects trajectories appears when we consider the variation of x coordinates versus y coordinates. This type of trajectory symbol expresses the actual track caused by the ball during its motion. Figure 3.2 shows the actual ball trajectory with respect of the image plane.

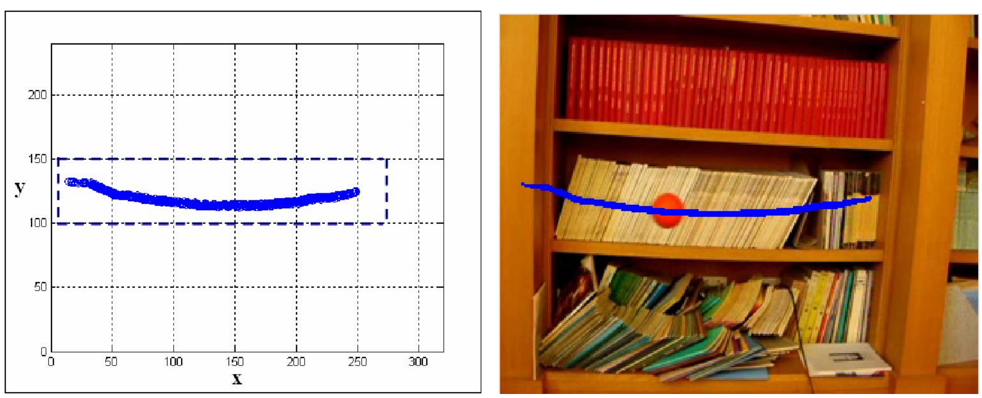


Figure 3.2: The ball trajectory**.**

The dashed lines up in the figure implemented to draw attention to the area used by the ball during its movement, where we are able to perceive the following:

- The ball started its movement from the highest point at pixel (30,130).
- The minimum level for the movement occurred in pixel (150,113).
- Finally the ball started to change its direction for the first time in pixel (250,125).

The last type of representation expresses the object trajectory in three dimension graphs, where x coordinates corresponds to the x coordinates in the images plane, y coordinates corresponds to the y coordinates in the images plane and z coordinates refer to the number of frames. The three dimension graph has an ability to examine the variations in the x and y coordinates with respect to the time. Unfortunately these types of plots do not effort a detailed description for the single axis's variation like what the single axis graph can do. The next paragraph discusses an example of the three dimension graph presented in Figure 3.3.

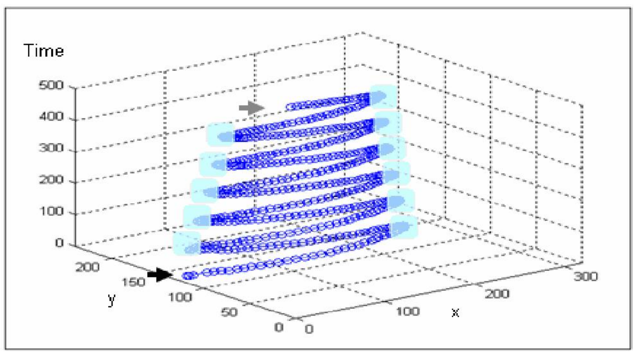


Figure 3.3: The three dimension ball trajectory.

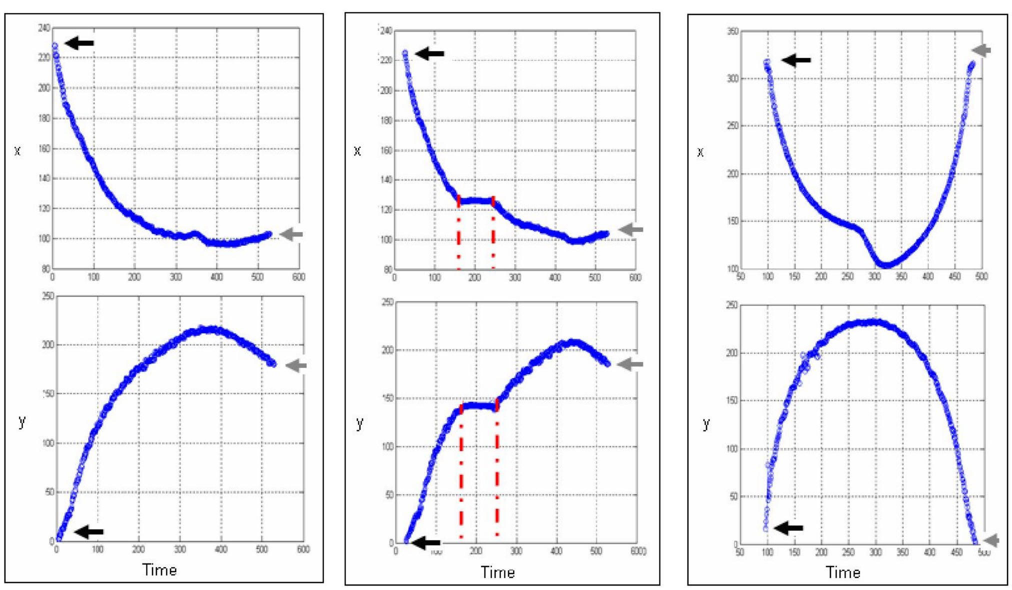
The black arrow refers to the point where the ball started its motion, while the gray arrow refers to the location of the ball when the simulation finished. The light blue squares show the high frequencies which in this case study stands for the event of changing the direction of the ball motion.

3.2.2 Case Study II

Three different video sequences are used in this case study to describe different motion aspects; each one of these video samples contains 530 frames. The total time for each video sample is 20 second [Altahir A. Altahir et al, 2008a]. The first video sample dedicated to describe a single human walking, the second sample describes a single human walking then he stopped for a while after that he started walking again, while the last video sample talks about a single human running. The next sections provide a detailed description regarding the trajectories extracted from these three motion aspects.

The first type of trajectory representation graph in this case study is considers the variations of the x and y coordinates for the center of mass of the white area over the frame sequence.

Figure 3.4 consists of three sub graphs and illustrates the variations occurred to x and y coordinates over the frame sequence, where the black arrows refer to the very first arrival of the object while the gray arrows refer to the point where the particular agent leaved the camera view or the end of simulation time. Figure 3.4(i) describes a single agent walking, the trajectory started with low density which refer to low frequency, after that and with the simulation time going the trajectory points density started to increase which stands for high frequencies. From the same figure we are able to observe that the object did not leave the scene till the end of simulation time. Figure 3.4(ii) discusses a single agent walking and stopped for awhile, the part of the trajectory assigned by a dashed in red line correspond to the frame indexes for this period of time, then he started walking again. Figure 3.4(iii) illustrates the trajectory of a single human running, where it's so obvious that the density of the trajectory points increased when the agent turn a round and it started to decrease again when he started running.



(i) (ii) (iii)

Figure 3.4: X - Y coordinates variation for the three single human motion aspects.

From the previous figures we able to conclude by the following the x and y coordinate variation graphs had the ability to differentiate between static objects and dynamic objects, but it hadn't such ability to evaluate the exact motion velocity.

The last trajectory representation in this case study is shown in Figure 3.5 below; where Figure 3.5(i, ii, iii) illustrates the two dimension trajectory for the same motion aspects, while Figure 3.5(iv, v, vi) shows the three dimension trajectory for the three motion.

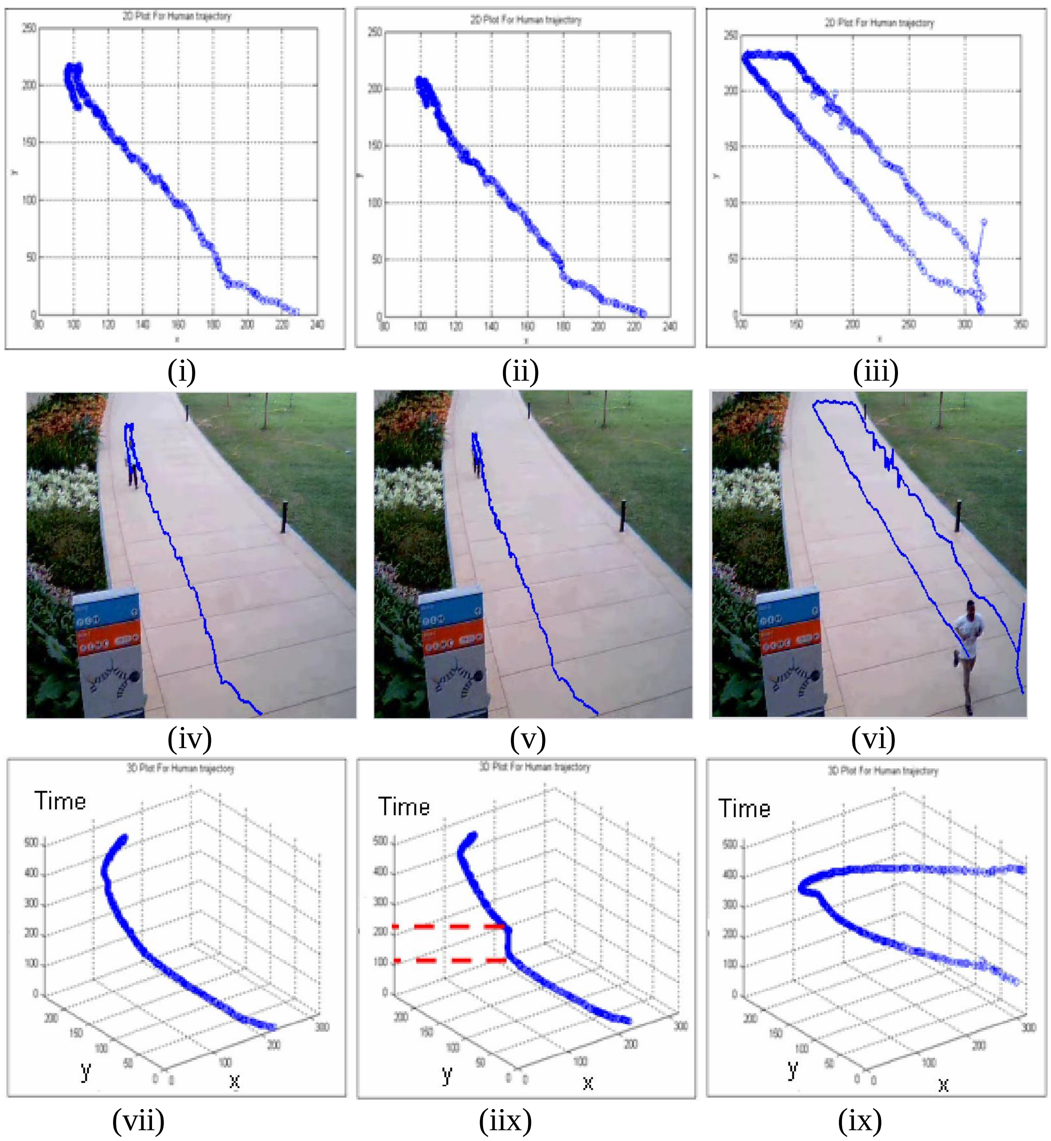


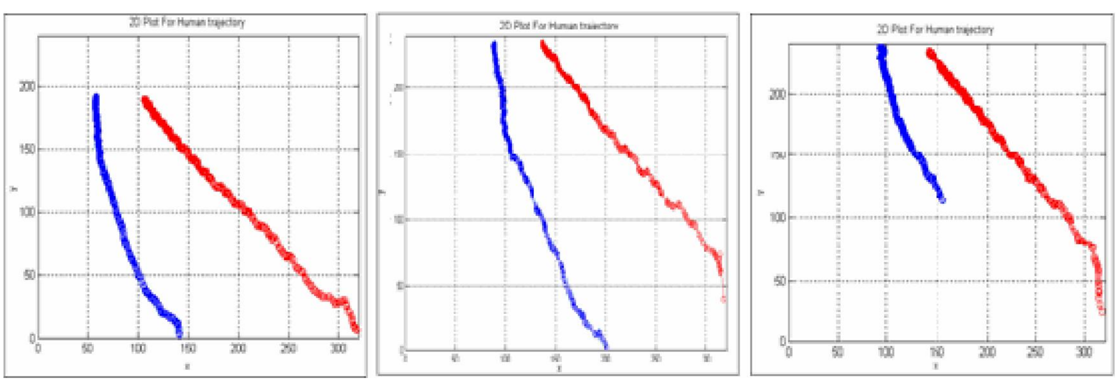
Figure 3.5: Two & three dimension trajectory for the three single human motion aspects.

The two dimension representation provides comprehensive information about the actual location of the object of interest; in the other hand, the three dimension representation reflects the relation between x and y coordinates and the frame sequence.

The presented result introduces new evidence about the ability of the two dimension object trajectory to differentiate between static and dynamic objects in real time manner. Further discussion regarding the moving attributes which allow us to differentiate between static and dynamic objects will hold in the next sections.

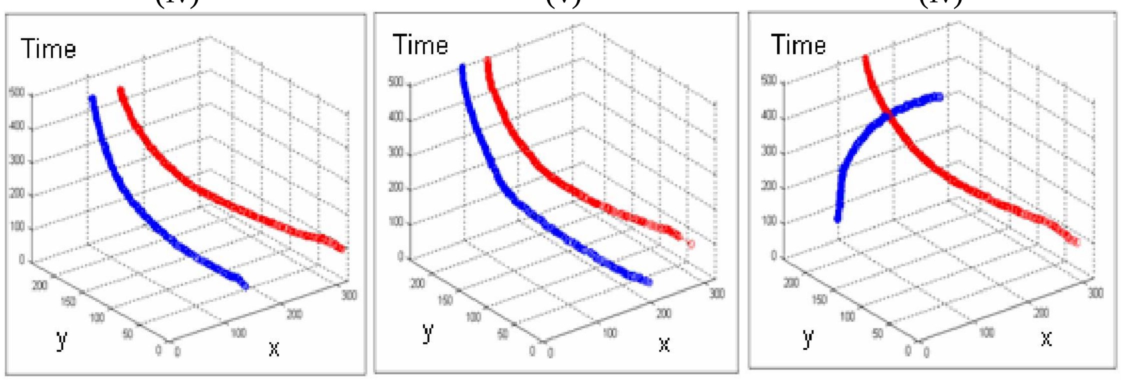
3.2.3 Case Study III

Three different video sequences are used in this case study to describe various motion behaviors for two agents walking; each one of these samples consists of 530 frames. The total time for each sample is 20 second [Altahir A. Altahir et al, 2008d]; the first video sample dedicated for two humans walking slowly in the same direction. The second sample describes two humans walking with slight velocity differences compared to the first one; the last samples took two agents walk toward each other and present the requirement for the motion direction attribute which it discussed in the next chapter. Figure 3.6 paves the way for discussing the two and three dimension trajectories for the video samples mentioned above:



(i) (ii) (iii)

(iv) (v) (iv)



(vii) (iix) (ix)

Figure 3.6: Two and three dimension trajectory for the three two human motion aspects.

The blue trajectory refers to the first agent trace while the red trajectory stands for the second agent trace in the three video samples. Figure 3.6(i, iv) illustrates the trajectory results for two agents walking slowly, figure 3.6(ii, v) expresses two agent walking fast compared to the first video sample. Figure 3.6(iii, iv) shows two agents walking towards each other in normal velocity. The observation from the first and the second pairs of figures is that Figure 3.6(i) has high frequency than Figure 3.6(ii).

From the presented results, two dimension trajectories failed to determine the motion direction, while by considering the frame values; the direction of the motion in the three dimension trajectory can be estimated. Both of the trajectory graph types are failed to evaluate the velocity differences between these video samples which support the requirement for new tools to evaluate the velocity and the motion direction.

3.3 Pixel Frequency Distribution

The objects motion can be described by relating spatial image features to temporal changes [9]. Based on that, human motion could be well represented in terms of a combination of spatial and temporal variations. Throughout this study, these variations are called pixel frequency distributions. Unfortunately these frequencies occur in unpredictable manner according to the realistic motion patterns. So what is needed is real time visualization for the current motion patterns for all the objects participated in the current scene. However, visualizing these frequencies, require an attribute capable of considering the spatial and temporal variations.

The pixel frequency distribution is used to fulfill the requirements described in the previous paragraph. This attribute is formed through the accumulation of pixel intensities during the frame sequence. The result of the accumulation process is well represented in three demission graph, X and Y coordinates correspond to the image coordinates, while Z axes stands for the number of accumulated pixel values and it represents the switching from frame to another. Consequently, this attribute is regarded as online descriptor for the human events. The equation below illustrates the pixel frequency distribution from a mathematic point of view:

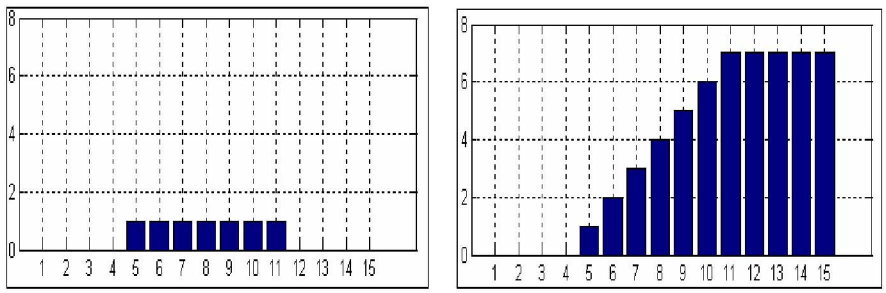
$$F(i, j) = \sum_{t=1}^{K} \sum_{i,j=1}^{M,N} I(i, j) \qquad (3.6)$$

Where F stands for the accumulation of pixel intensities; $I(i, j)$ is a pixel value corresponding to the location i, j in a digital image, M and N the number of rows and columns and K the number of frames.

The accumulation of the pixels intensity occurs for the binary image version of the current scene. The object region in binary images is represented by a value of one while the background of the image is represented by zero. Regarding that, an example of the intensity accumulation during 15 successive frames for a single pixel is shown below.

Table 3.1: Intensity values for a single pixel taken from15 successive binary images

Frame index	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Intensity value	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0



(i) (ii)

Figure 3.7: Understanding the pixel frequency distribution. (i) Intensity values for a single pixel taken from 15 successive binary images. (ii) The accumulation of these intensities.

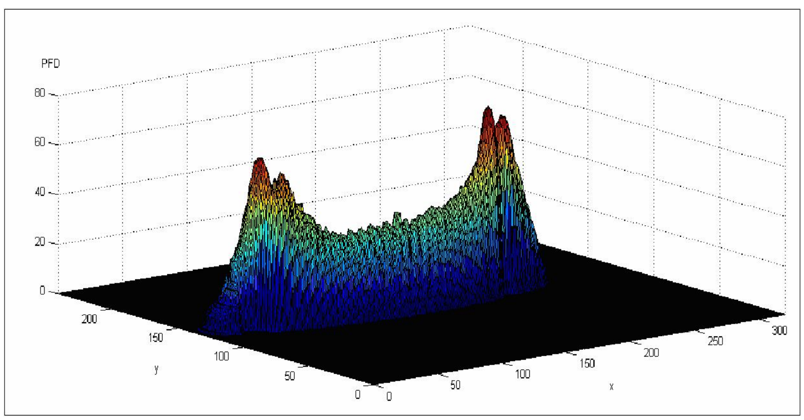
The table shows the intensity values for the particular pixel, while the figure presents the actual and accumulated intensity values. From the table and the associated figure above the following can be observe:

- If the value of the pixel frequency distribution for a particular pixel equal to zero this will refers to the pixel is not a part of any region construct an object.
- If the value of the pixel frequency distribution for a particular pixel steady for more than one frame this will refers to the departure of the existence object.
- If the value of the pixel frequency distribution increases, this will refers to high frequencies and this indicates slow motion, which in turn refer to low activity.
- If the value of the pixel frequency distribution decreases, this will refers to low frequencies, this indicates fast motion, which in turn refers to high activity.

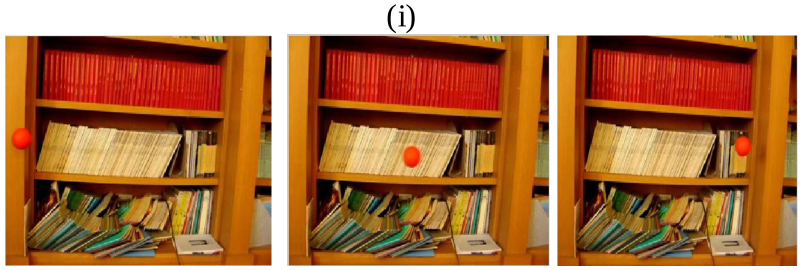
So by generalizing the concepts gained from observing the behavior of a single pixel accumulation, the four observations are valid for the whole image pixels. This leads to the following conclusion; the pixel frequency distribution is capable of determining the motion status and has an ability to recognize the object arrival and departure events and presenting this information in visual understandable manner. The rest of this section is dedicated to illustrate the results gained from the different simulation scenarios.

3.3.1 Case Study I

This part is donated to illustrate the experimental result gained from generating the pixel frequency distribution for a ball hanged by string and moved freely in the space. The pixel distribution is calculated based on accumulating the sequence of the binary images over the time. These binary images describing the ball motion as a white group of pixels moves from one location to another. Figure 3.8 shows the pixel frequency distribution for the ball motion:



(i)



(ii) (iii) (iv)

Figure 3.8: Pixel frequency distribution for the ball motion. (i) The pixel frequency distribution. (ii) High distribution level. (iii) Low distribution level. (iv) The highest distribution level.

Figure 3.8 describes the ball motion, where, the high peaks indicate high accumulation of pixel intensities, in other word high frequency and the low peaks refer to low frequency. The maximum frequency gained during the simulation is 80 and it refers to the most location frequented by the ball motion. The difference in the graph color refers to the variations of the frequency values.

3.3.2 Case Study II

This part shows the experimental results gained by generating the pixel frequency distribution for three agents participated in single human motion case study. The attempted here is to differentiate between these motion aspects. As mentioned earlier, the motion is described as a cluster of white group of pixels moves over the image sequence.

Figure 3.9 shows a gradual increase in the frequency values due to the slightly gradual decrease in the agent velocity. The very high frequency value occurred in the range of 160 – 230, for X coordinates and 210 – 240, for Y coordinates. The high frequency peak in the location stated by the coordination's mentioned earlier is due to the slow velocity exhibited by the particular agent. The overall range of the frequency distribution is 0 – 140, which is considered as normal range for a single agent walking.

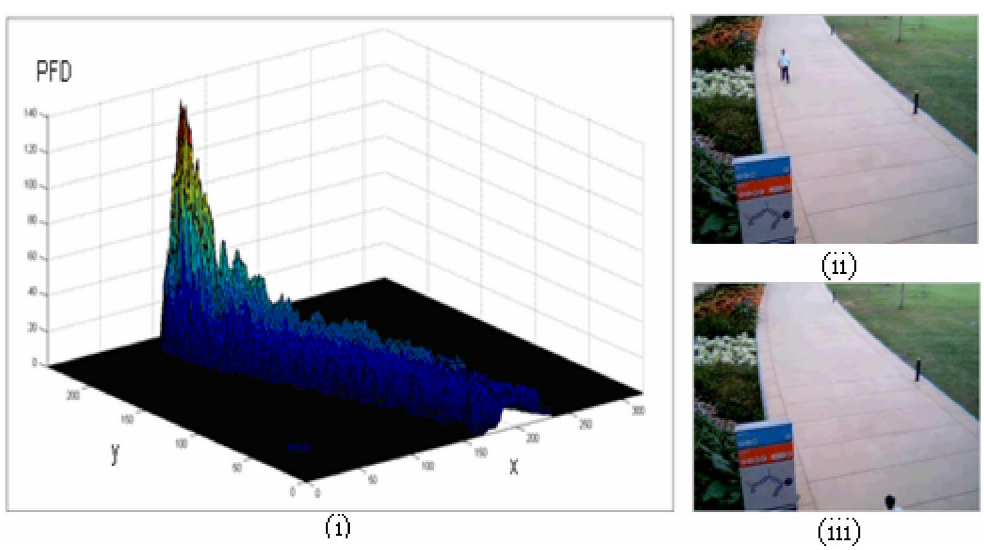
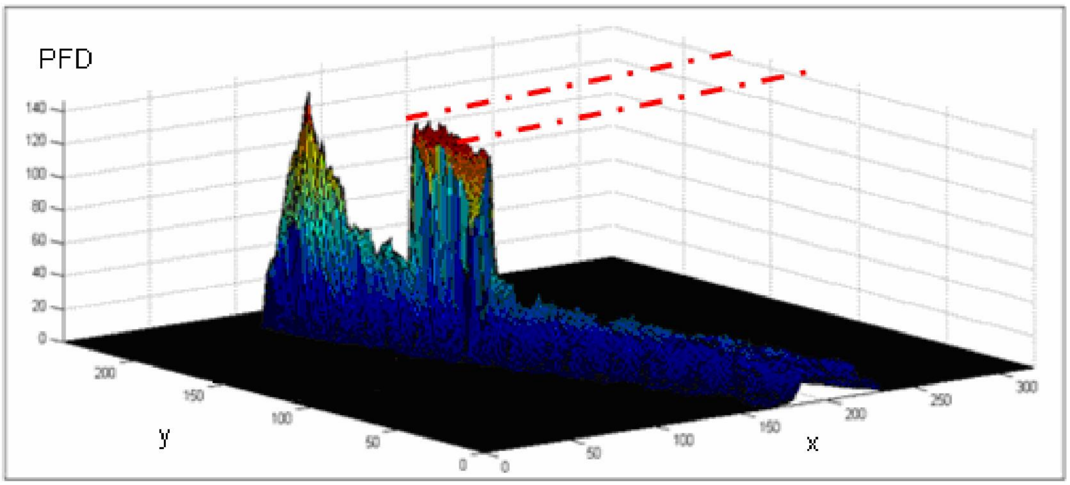
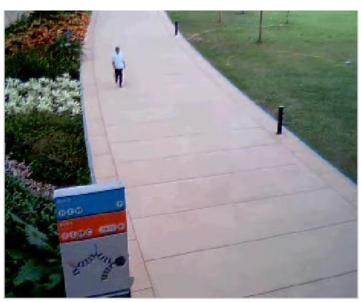
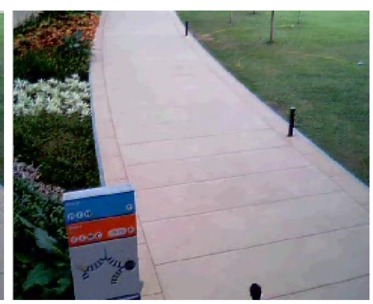


Figure 3.9: The pixel frequency distribution for the first video sample in case study II.

Figure 3.10 shows a gradual increase in the frequency values due to the slightly gradual decrease in the agent velocity. The jump in the frequency values in the middle of the figure where the red dashed line refers is due to static period. The reason for the high frequency value occurred in the range of 160 – 230, for X coordinates and 210 - 240, for Y coordinates is that, at this location, the agent registers slow velocity values. The frequencies for this case study fall in normal range between 0 – 140, however, the sudden jump in the frequency values in the middle of the graph, is considered a security concern.



(i)

(ii) (iii) (iv)

Figure 3.10: The pixel frequency distribution for the second video sample in case study II. (i) The pixel frequency distribution. (ii) High distribution level. (iii) High distribution level. (iv) Low distribution level.

The gradual increase of the frequency values in Figure 3.11 is due to the slightly gradual decrease in the agent motion. The maximum frequency registered for this case study is 43 where its very low frequency value compared to the other two scenarios. The low frequency value introduces strong evidence about the motion velocity which will lead to consider the action in this scenario is an abnormal human behavior.

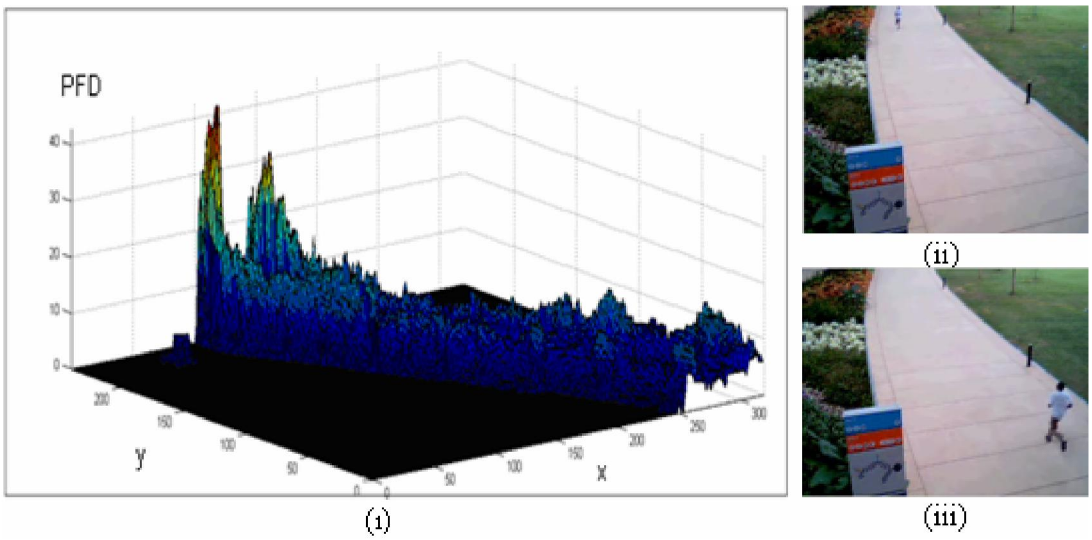


Figure 3.11: The pixel frequency distribution for the third video sample in case study II. (i) The pixel frequency distribution. (ii) High distribution level. (iii) Low distribution level.

3.3.3 Case Study III

This section is denoted to analyze the experimental results gained from generating the pixel frequency distribution for three different motion aspects for two agents walking. The attempted here is to provide extensive description for each on of these aspects. As mentioned earlier, the pixel distribution is generated based on accumulating the sequence of the binary images over the time. These binary images are describing two agent's motion as a cluster of white group of pixels moves from one location to another over the frame sequence.

Figure 3.12 shows two agents walking at normal velocity in the same direction and this case study stands for a normal human behavior, while Figure 3.13 describes two humans walking in the same direction with slight velocity differences compared to the first one. The question here is about the ability of the pixel frequency distribution attribute in sensing and differentiating between the slight differences between the second and the first video samples. The pixel distribution for the last video sample is presented in figure 3.14 and illustrates the pixel frequency distribution of two agents walking at a normal velocity toward each other. The promise here is to examine the pixel distribution capability toward determining motion direction.

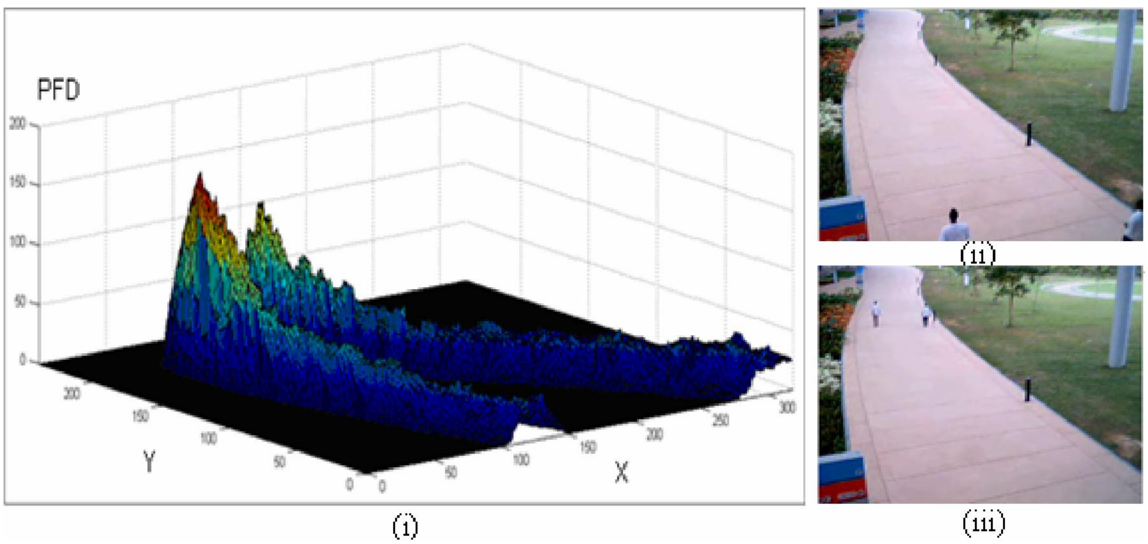


Figure 3.12: The pixel frequency distribution for the first video sample in case study III. (i) The pixel frequency distribution. (ii) Low distribution level. (iii) High distribution level.

The gradual increase of the frequency values in Figure 3.12 is due to the slightly gradual decrease in the agent's velocity. The very high frequency value occurred in the range of 150 – 230, for X coordinates and 210 – 240, for Y coordinates for the both agents. The high frequency values in the location mentioned above is a result of exhibiting low velocity values by the agents.

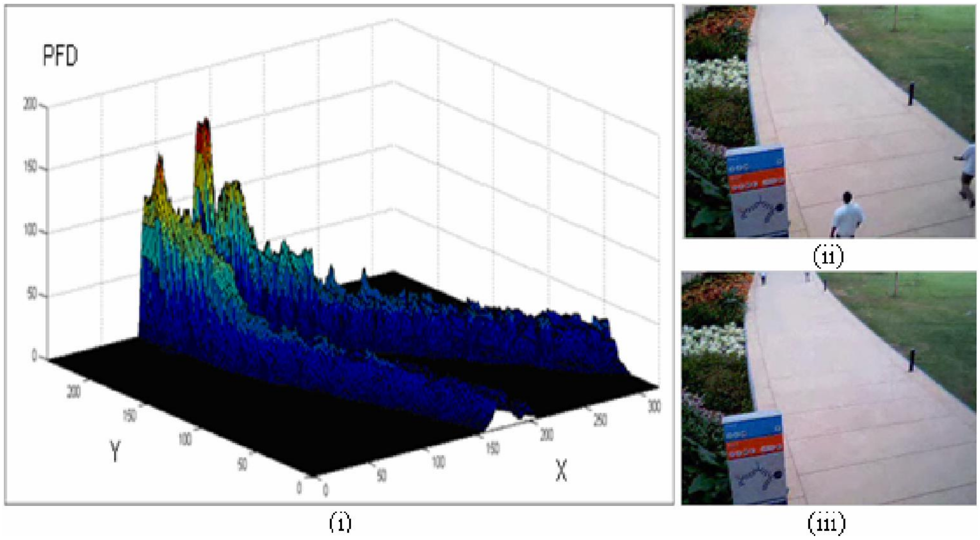


Figure 3.13: The pixel frequency distribution for the second video sample in two agent case study. (i) The pixel frequency distribution. (ii) Low distribution level. (iii) High distribution level.

The gradual increase in the frequency values in Figure 3.13 for the first agent is due to the slightly gradual decrease in the agent's velocity and the gradual decreases in the values for the second agent is due to the slightly gradual increase in the agent velocity.

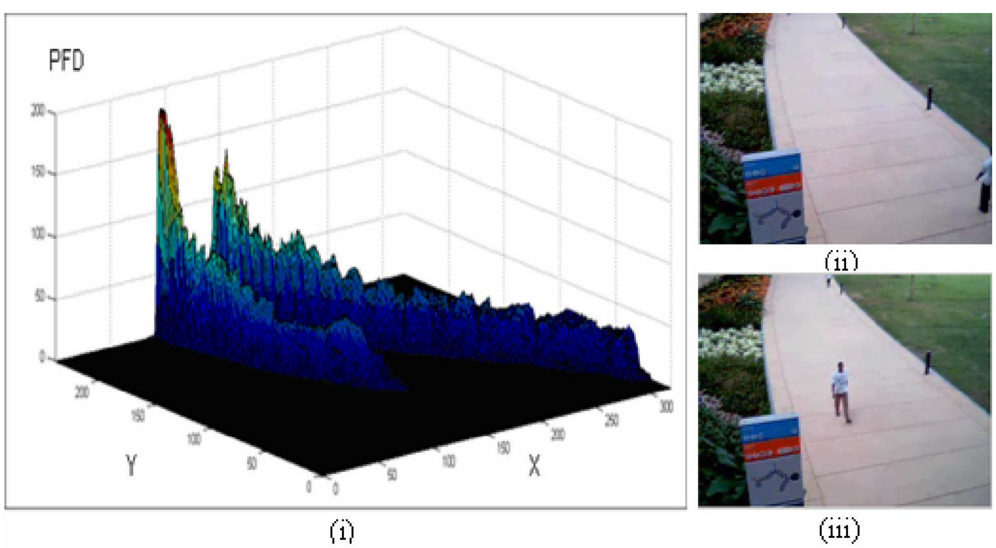


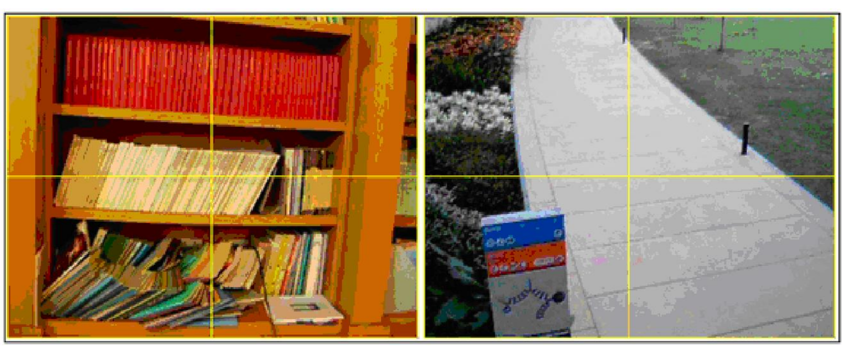
Figure 3.14: The pixel frequency distribution for the third video sample in two agent case study. (ii) Low distribution level. (iii) High distribution level.

The very high frequency value occurred in the range of 150 – 230, for X coordinates and 210 – 240, for Y coordinates for the both agents. Both agents recorded the minimum velocity a value at the location stated by the coordination's mentioned above. The overall range of the frequency distribution is 0 – 180, which is prescribed as normal range for a single agent walking. The differences between the agents motion velocity is represented by the differences between the pixel frequency distribution for each one of them. The gradual increase in Figure 3.14 of the frequency values for the first agent is due to the slightly gradual decrease in the agent velocity, and the gradual decreases of the frequency values for the second agent is due to the slightly gradual increase in the agent velocity.

This case study introduces the need for new motion attributes capable of describing the direction of the human motion. This need appears due to the failure of the pixel frequency distribution to determine the motion direction.

3.4 Time Parameter

Extracting the details of the temporal characteristics of the object of interest from a sequence of images is considered in this work. This process is implemented via calculating the time spent by the object of interest in particular regions in image plane during the simulation time.



(i) (ii)

Figure 3.15: Examples of segmenting the image plane into four zones.

The idea behind segmenting the image plane into zones is that, the entire image plane is not at the same level of the importance from a security point of view (e.g. there are walls, high places or any other areas out of the range of security consideration). As a result of the segmentation process the efforts of observing the moving objects will be concentrated in a highly sensitive area in the camera view. The system in consideration implements a based pixel segmenting algorithm to perform this task. The region based analysis concept is realized by segmenting each new next frame into four equal zones. Figure 3.15 shows an example of two different scenes, each one of these scenes is detached into four segments. The image segments are labeled as follows:

- The upper left zone is labeled as zone one.
- The upper right zone is labeled as zone two.
- The lower left segment is labeled as zone three.
- The lower right zone is labeled as zone four.

Consequently, with the intention of calculating the time spent by the object of interest in a particular image zone, the system examines the existence of the object of interest in the dedicated zone. The result of examination process is well represented in the form of four time/zone vectors. The length of each one of these vectors is equal to the number of frames. The elements of each vector are a sequence of zeros and ones. The equation below shows the constructing of the time/zone vectors:

$$Z_M^K = \begin{cases} 1 & if\ (\bar{x}, \bar{y}, K) \in Z_M^K \\ 0 & if\ (\bar{x}, \bar{y}, K) \notin Z_M^K \end{cases} \tag{3.7}$$

Where, Z is the time spent by the object of interest in a particular image zone in a certain frame, M is the zone index, and K is the frame index and finally $(\bar{x}, \bar{y}, K)$ is the location of the center of mass for the object of interest at frame K.

The overall time spent by the object of interest in a particular zone during a set of frames is given by the equation below:

$$T_{M,K} = \sum_{j=1}^{K} Z_M^J \; / \; f \tag{3.8}$$

Where, T is the time spent by the object of interest in a particular zone during the simulation time, f is the frame rate of the capturing device, Z is the time spent by the object of interest in a particular image zone in a certain frame, M is the image zone index, and j is the frame index.

Minimizing the area of each zone provides more deterministic results about the time spent by the object of interest in this particular segment. This concept achieved via segmenting each zone mentioned in the previous section into new four sub zones and then examining the existence of the object of interest in these sub zones. For example zone 1 in turn is divided into 4 sub zones labeled as follows:

- Zone 1.1 for the upper left zone.
- Zone 1.2 for the upper right zone.
- Zone 1.3 for the lower left zone.
- Zone 1.4 for the lower right sub zone.

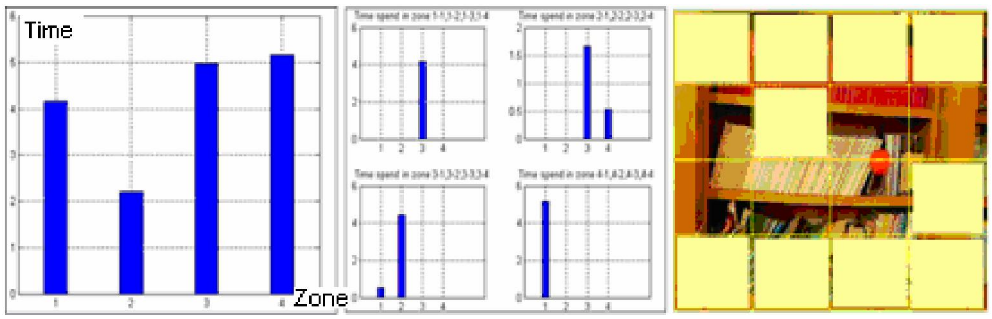
Determining the number of zones and zones boundaries is a supervised operation based on the topology of the observed view and the security requirements. The next sections demonstrate the experimental results gained from the different simulation scenarios.

3.4.1 Case Study I

The length of this video sample is 20 second and the number of the frames contained in this video is 500 frame captured at 25 frame per second. The concern of this section is to determine the time attributes according to the ball motion. Firstly, the image plane is segmented into four regions. The segmenting process is followed by examining the existence of the ball in each one of these regions during the arrival of the new frames. The table below shows the time spent by the ball in the different predefined regions, in the same context, the two dimension plot of the ball timing is presented in Figure 3.16 which will allows better understanding for the information illustrated in the table.

Table 3.2: Time spent by the ball in the four image zone

Region	Zone 1	Zone 2	Zone3	Zone 4
Time	4.1667sec	2.2000 sec	4.9667 sec	5.1667 sec



(i) (ii) (iii)

Figure 3.16: The time attributes for the ball case study. (i) The time spent by the ball in four predefined zones. (ii) The time spent by the ball in sixteen predefined zones. (iii) The active and inactive zones in the image plane.

As it shown in Figure 3.16 (i), the horizontal axes stands for the zone index while the vertical axes represent the time spent by the ball in a particular segment. From the figure above one can observe that the ball spent less time in region 2, while it spent the much time in region 4. The total time spent by the ball during the simulation is 16.5 sec with error equal to 3.5 sec from the actual time. The error comes from the effects of the background subtraction where the background subtraction failed to determine the object existence in 85 frames out of 500 frames. The percentage of the background error is equal to 17 % and the static background subtraction is totally responsible for the high error rate. Figure 3.16 (ii) contents four sub plots, the upper left plots shows the time spent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments, the lower left sub plots shows the time spent by the ball in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the time spent by the ball over four sub zones constructing zone four. Figure 3.16 (iii) shows the active and inactive sub zones during the simulation time, where starting from zone one only one active sub zone in this region corresponds to sub zone 1.3. Zone two registers two active sub zones 2.3 and 2.4. Zone three sub zones listed as follows:

- Sub zones 3.1 and 3.2 are listed as active zones while sub zones 3.3 and 3.4 are listed as inactive zones.
- Zone four recorded only one active sub zone 4.1.

From Figure 3.13 it can be concluded that there are six (6) utilized sub zones out of sixteen zones. These sub zones are used through the ball motion and correspond to the ball trajectory discussed in section 4.2.1.

3.4.2 Case Study II

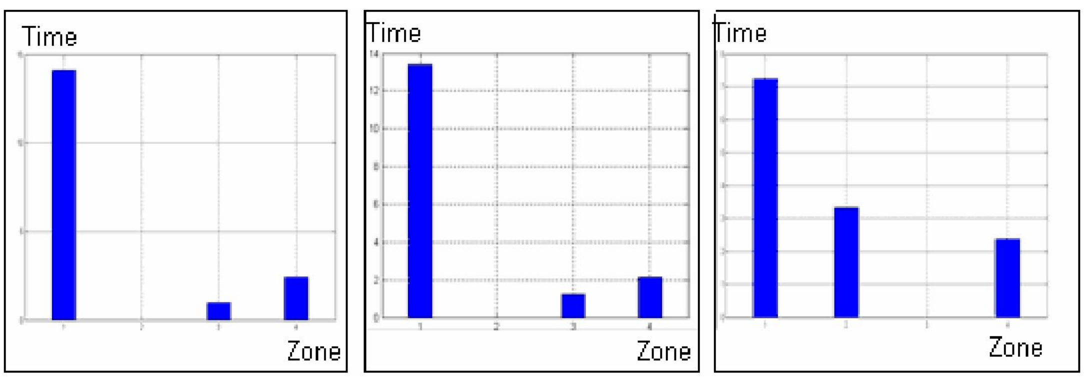
Three video samples are considered in this case study. Each one of these samples describes a different aspect of human motion. Hence, each video sample has a unique time characteristics. The total time for each one of these samples is 20 second and the number of frames is 530 frames captured at 25 frame per second [Altahir A. Altahir et al, 2008a]. Based on examining the existence of the object of interest in the predefined image regions, the table below shows the time spent by the different agents during the simulation time:

Table 3.3: Time spent by the three agents in the predefined image zones.

Region	Zone 1	Zone 2	Zone3	Zone 4
Agent1 timing	14.1000	0	0.9667	2.4333
Agent2 timing	13.4000	0	1.2667	2.1667
Agent3 timing	7.2333	3.3333	0	2.3667

By observing the data presented in Table 3.3, the details of the timing characteristics is constructed. For the agent1, he didn't joint zone 2 same as agent 2, while agent 3 did not happen to join zone 3.

The two dimension plot of the agents timing allows better understanding comparing the data expressed in Table 3.3. This plot is presented in Figure 3.17, where Figure 3.17 (i) considers the timing characteristics for a single agents walking, Figure 3.17 (ii) dedicated to discusses the timing characteristics for a single agent walking then he stopped for a while after that he started walking again, while Figure 3.17 (iii) shows the time behavior for a single agent running. The total appearance time for agent one is 16.0334 second out of 20 second the length of the video sample, for agent two is 16.8334 while the last agent spent 12.9333 seconds out of 20 seconds total video length.



(i) (ii) (iii)

Figure 3.17: The time spent by the three agents in four predefined zones.

As it shown in Figure 3.17, the horizontal axes stands for the zone index while the vertical axes represents the time spent by a particular agent in the different regions. From the figure the following can be observe:

- Agent one did not join zone 2, same as agent two while agent three did not join zone 3.
- Agent one spent the much time in zone 1 same as agent two and three.

By comparing the total time for the three agents it can be observe that agent three spent the less time in the camera view, while agent two spent the much time in the camera view. The time spent by the objects of interest in the camera view is governed by two factors the motion trajectory and the particular agent's velocity. Based on the observation conclusion can be reached that agent 2 spent the much time in the camera view due to the low motion velocity or because he remained static for a period of time. By recalling the results from the previous sections it is obvious that agent 2 spend around 2 second static in region 3. Agent 3 spent less time in the camera and by recalling the same factors we are able to justify that by the high motion velocity which we are going to illustrate it in the next chapter.

The detailed description of the temporal behavior of the different agents is given by Figure 3.18. This description is realized via implementing the concept of minimizing the area of each one of the predefined image zones.

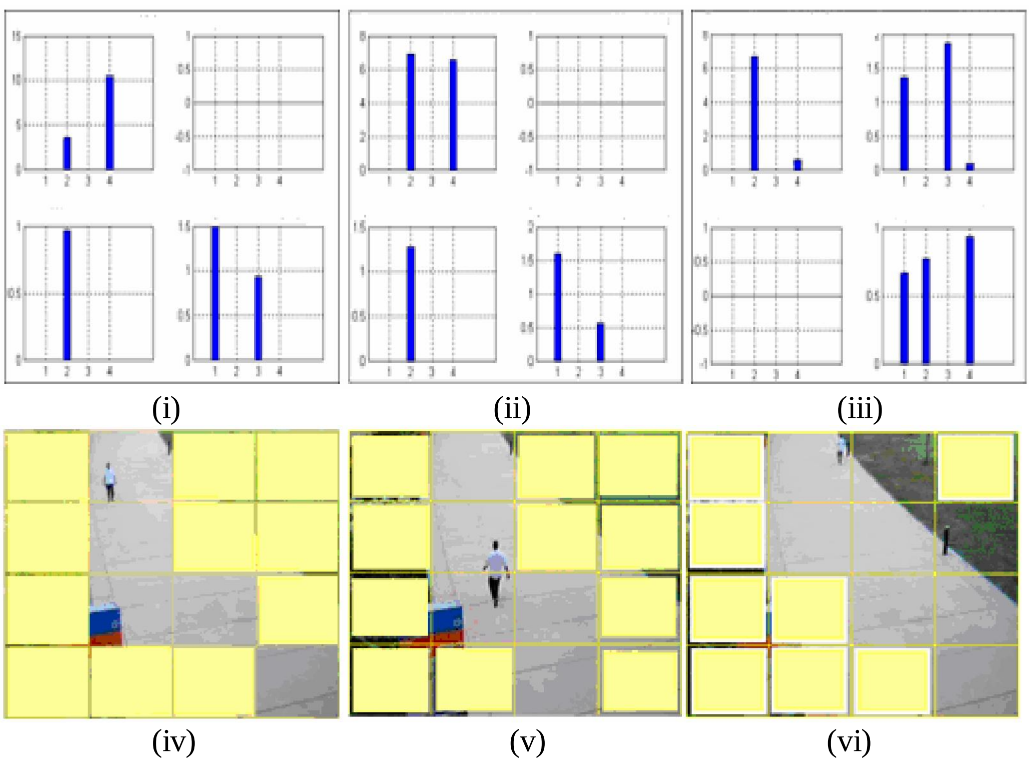


Figure 3.18: The time spent by the three agents in sixteen predefined zones and the actual zone locations in image plane.

Figure 3.18 (i, ii, iii) contents four sub plots, the upper left plots shows the time spent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments, the lower left sub plots shows the time spent by the ball in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the time spent by the agents over four sub zones constructing zone four. Figure 3.18 (vi, v, iv) shows the active and inactive sub zones during the simulation time. Active region is the region which was part of the track of the particular agent under study. The yellow bold sub zones refer to the inactive areas and it means that the particular agent didn't join this area during his movement. From the statement above and by considering agent one the following observations are gained:

§ Agent no. 1 utilized the following sub zones 1.2, 1.4, 3.2, 4.1 and 4.4 during his motion, that's means he utilized 5 sub zones out of 16.

§ Agent no. 2 utilized the following sub zones 1.2, 1.4, 3.2, 4.1 and 4.3 and that's means he utilized 5 sub zones out of 16.

§ Agent no. 3 utilized the following sub zones 1.2, 1.4, 2.1, 2.3, 2.4, 4.1, 4.2 and 4.4 and that's means he utilized 8 sub zones out of 16.

The strength of the extracting the time spent by a particular agent in a predefined zones; is came from the ability to provide an accurate measures for the time spent by the agent in that region.

3.4.3 Case Study III

Three video samples are considered in this case study. Each one of these samples describes a different aspect of two human walking. The total time for each one of these samples is 20 second and the number of frames is 500 frames captured at 25 frame per second.

Figure 3.19 explains the gained results from the first video sample. The video contents two agents walking in the same direction.

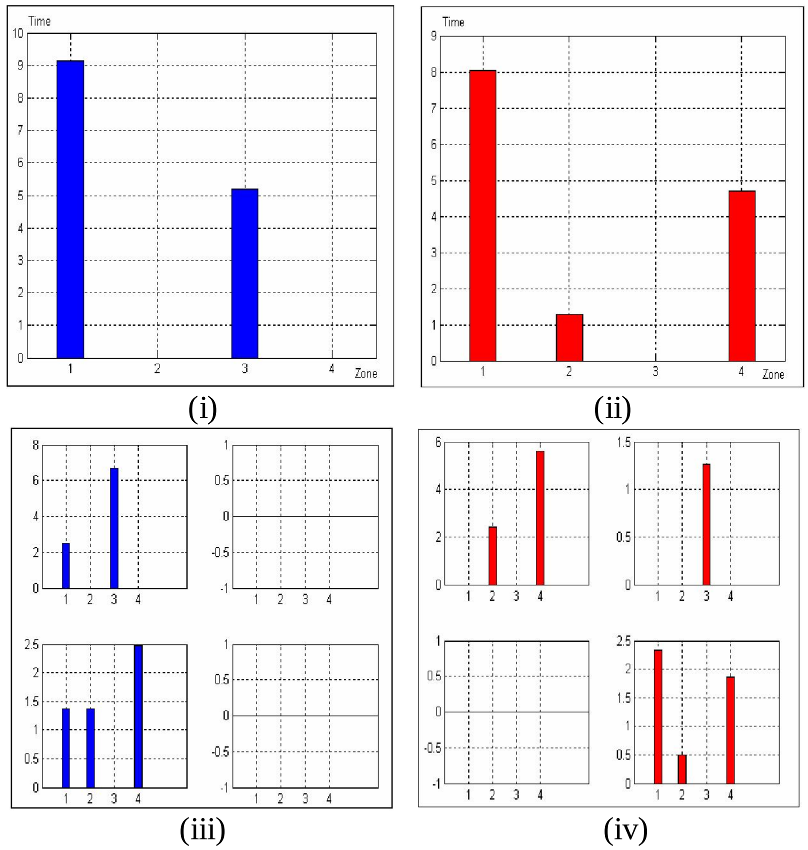


Figure 3.19: The first video sample timing characteristics.

By considering the results gained from the previous sections, Figure 3.19 (i) shows that, the first agent started his motion from zone three and he spent the less time in this zone, then he continued his walking through zone one and he spent the rest of his time in the camera view in this zone before he leave after spending around 14.3 second out of 20 second in the camera view. Regarding the second agent and from Figure 3.19 (ii) he started his motion from zone four and he spent around 4.8 seconds in this zone, then he continued his walking through zone two and he spent the less time in this zone, after that he continued his walking through zone one and he spent the rest of his time in the camera view in this zone before he leave after spending around 14.2 second out of 20 seconds.

Figure 3.19 (iii) contents four sub plots, the upper left plots shows the time spent by the first agent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments, the lower left sub plots shows the time spent by the ball in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the first agent time over four sub zones constructing zone four. Figure 3.19 (iv) contents four sub plots, the upper left plots shows the time spent by the first agent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments, the lower left sub plots shows the time spent by the ball in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the first agent time over four sub zones constructing zone four.

Figure 3.20 shows the gained results from the second video sample. The video contents two agents walking in the same direction.

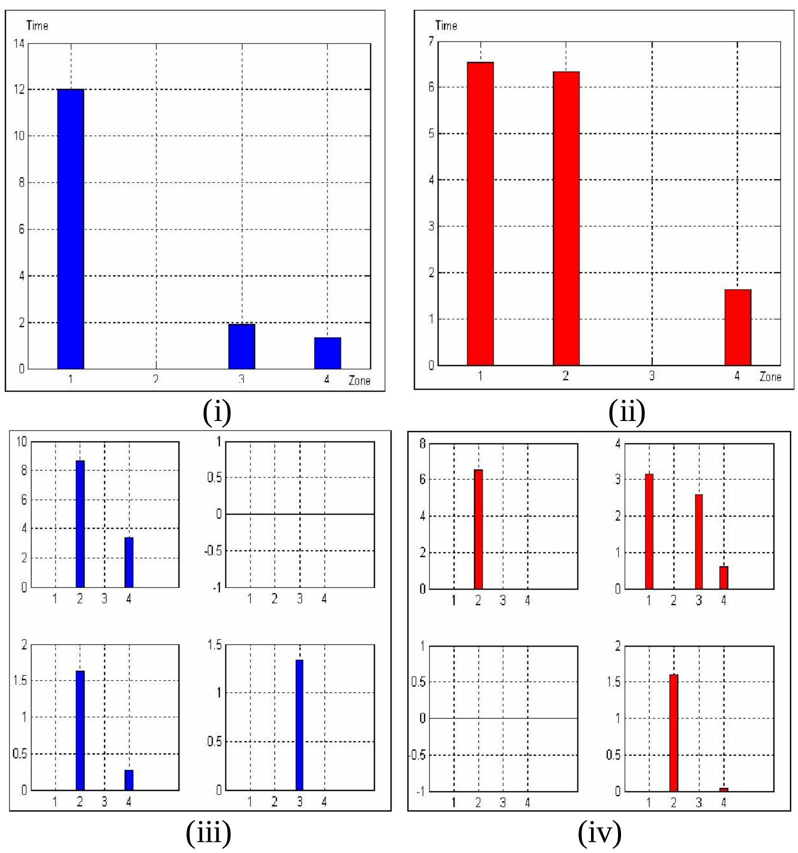
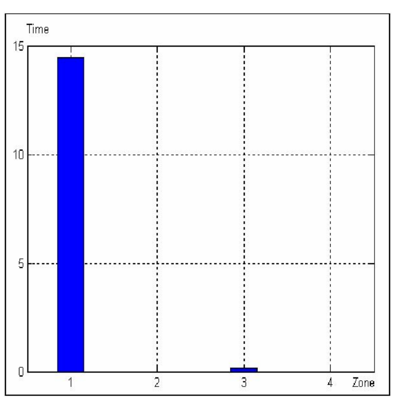
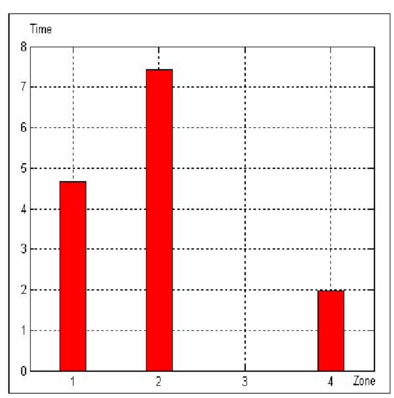


Figure 3.20: Second video sample timing characteristics.

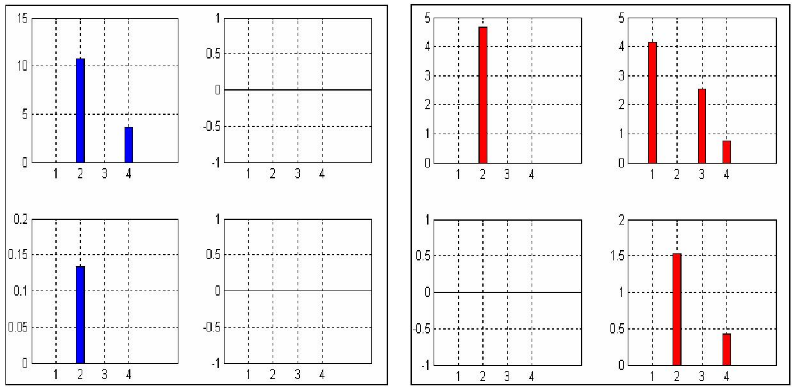
By considering the results gained from the previous sections and Figure 3.20 (i), the first agent started his motion from zone three and he spent the less time in this zone, then he continued his walking through zone one and he spent the rest of his time in the camera view in this zone before he leave after spending around 14.3 second out of 20 second in the camera view. Regarding the second agent and from Figure 3.20 (ii) he started his motion from zone four and he spent around 4.8 seconds in this zone, then he continued his walking through zone two and he spent the less time in this zone, after that he continued his walking through zone one and he spent the rest of his time in the camera view in this zone before he leave after spending around 14.2 second out of 20 seconds. Figure 3.20 (iii) contents four sub plots, the upper left plots shows the time spent by the first agent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments. The lower left sub plots shows the time spent by the particular agent in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the first agent time over four sub zones constructing zone four. Figure 3.20 (iv) contents four sub plots, the upper left plots shows the time spent by the second agent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments. The lower left sub plots shows the time spent by the second agent in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the second agent time over four sub zones constructing zone four.



(i)



(ii)



(iii) (iv)

Figure 3.21: The third video sample timing characteristics.

Figure 3.21 shows the gained results from the third video sample, where the video contents two agents walking toward each other, and by considering the results gained from the previous sections and Figure 3.21(i) the first agent started his motion from zone three and he spent the less time in this zone, then he continued his walking through zone one and he spent the rest of his time in the camera view in this zone before he leave after spending around 14.3 second out of 20 second in the camera view. Regarding the second agent and from Figure 3.21(ii) he started his motion from zone four and he spent around 4.8 seconds in this zone, then he continued his walking through zone two and he spent the less time in this zone, after that he continued his walking through zone one and he spent the rest of his time in the camera view in this zone before he leave after spending around 14.2 second out of 20 seconds.

Figure 3.21 (iii) contents four sub plots, the upper left plots shows the time spent by the first agent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments, the lower left sub plots shows the time spent by the ball in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the first agent time over four sub zones constructing zone four. Figure 3.21 (iv) contents four sub plots, the upper left plots shows the time spent by the first agent in zone one after segmenting this zone into four sub zones, the upper right sub plots illustrate the time attributes regarding zone two sub segments, the lower left sub plots shows the time spent by the ball in zone three after segmenting this zone into four sub zones, while the lower right sub plot illustrates the distribution of the first agent time over four sub zones constructing zone four.

3.5 Summary

This chapter illustrated the term of full frame analysis as a continuous period of time represented by a sequence of successive frames, it also presented the extraction of the attributes belong to this board. Finally the experimental results gained from the simulation scenarios are explained and interpreted from a surveillance application point of view. The next section will look into inter frame analysis by segmenting (or dividing) the frames to smaller block of time domain rather than the default 20 seconds.