Movi-color target analysis based on using minimum distance classification

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Abstract

The demand increased last decades to modify optical photography systems and increase its quality to classify and analyze movement in a video clip. This is very important in many applications like vision computing system (Robots). The process of detection movement of a target is not easy process because it is controlled by many physical parameters like motion, image quality and filming environment. Moreover, it dose effect by the real 3D scene projection on 2D image.

This work focused to study, analyze and classify images of moving targets for different distances (D) between camera and target in the video scene with constant background. Where many statistics properties are calculated and studied like object area (A (i)), object centre (C_x, C_y) and find its function with distance (D). The distance between the target and the camera is estimated accurately depending on target's area (A) as a function of distance. It is found that there is a good match between the real and the estimated distance depending on mean square difference (MSD=0 - 160.7 x 10^{-3}).

الخلاصة

تزايدت الحاجه خلال العقود الاخيره الى تطوير انظمة التصوير البصرية وزيادة جودتها من خلال تصنيف وتحليل الحركة في المشاهد الفيديويه وذلك لتزايد الحاجة لها في العديد من تطبيقات انظة الرؤيه الحاسوبيه (الروبرتية) .ان عملية كشف الاهداف المتحركة ليست بالعملية السهله لانها محكومه بالعديد من المتغيرات الفيزيائية المهمة والمرتبطة بالحركة وجودة الصور وظروف التصوير كما انها تتاثر بمساقط المشهد الثلاثي الابعاد الحقيقي 3D على مستوي الصوره ثنائي(2D).

توجهنا في ها البحث الى دراسة وتحليل وتصنيف الاهداف المتحركه (البالونات)للمسافات المختلفه بين الكاميرا والهدف (D) في مشاهد فيديوية مسجلة ذات خلفيات ثابته ، حيث تم حساب ودراسة خصائص احصائيه متعدده لهذه الاهداف تتضمن مساحة الكائن **A(i)**) ، مركز الكائن (**Cx,Cy**))ودراستها كدالة للمسافة (D) مابين الهدف والكاميرا ، كما تم تخمين بعد الهدف المتحرك عن الكاميرا (D) بدقه عاليه من خلال اعتماد مساحه الهدف المتحرك (A) كدالة للمسافات (D) اذا تم ملاحظه وجود تطابق كبير بين المسافات الحقيقيه والمخمنه بحدود معدل مربع فرق (MSD) $(0 - 160.7 \times 10^{-3})$.

1- Introduction

Tracking and recognition motion is a challenging issue in actual reality, which have various application in medicine, teleoperations, animation and human-computer interaction [1]. Opto-electronic systems are commonly used for these applications, and most of the methods suggested calculation of kinematics [2]. Study and detect human motion considered very difficult problem to tackle. Because geometry of human body is very complex. Moreover, human action like rotations and twists occur in nearly every movement, and some parts of our body continually move or occlusion. Therefore, human body considered as a non-rigid object [3].

The tracker of an object considered by taking the trajectory of the object with recording time. This can be done by locating its position in every frame of video. Therefore, tracking over time depends on matching moving objects in serial frames. Tracking types are point tracking, kernal tracking, silhouette tracking, shapes matching. Point tracking represented by points that associated with points depended on the previous object points which include object position and motion. This approach requires an external mechanism to detect the target in every frame [4].

Aggarwal J. K. *et al.* [5] presented method to describe moving objects tracking in outdoor environment. The proposed method integrates motion, spatial position, shape and color information to track object pixels. In 2006, Kahttan A. N. [6] used algorithms to move, change size, cut and rotate target or part of image to generate a movie target. He studied the effect of these processes on the quality of image. Musa K. M. [7] introduced advanced system to detect the nature of motion and extract the information from movie images, then from these information he determined the position of moving object and determine the center of that object. In 2011, Mohammed Y. K. [8] suggests algorithms to describe the movement of a pendulum, and he used three methods to determine the center of moving object in the image in two dimensions. In addition, he measured the rate change of object dimensions (pendulum ball) shape as a function of frame number (i.e. time). Then find an estimation equation that expresses the general rate change in horizontal axis to the vertical axis.

2- Target Motion Analysis

Target motion is a sub-field within computer vision which deals with estimation and analysis of object information. This is linked with motion in image sequences or in the scene i.e. a movie clip. Mutual problems related to estimate the motion field within images sequence can be summarized as [9]:

⇒ **Egomotion –** locating the 3D rigid motion (rotation and translation) of camera comparing with an image.

⇒ **Tracking** – following movements of interest points or targets (i.e. a vehicle or a human) in the image sequence.

⇒ **Optical flow (OF)** – is describes velocities of movement of brightness patterns in an image. OF can arise from relative motion of objects and the viewer. Consequently, OF can give important information about the spatial arrangement of the objects viewed and the rate of change of this arrangement. Discontinuities in the OF can help in segmenting images into regions that correspond to different targets. Figure (1) illustrates OF [10].

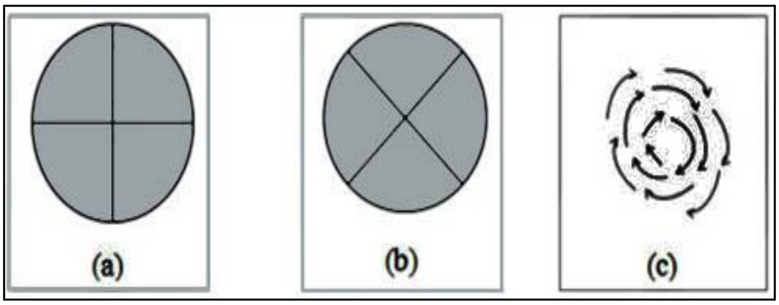

Figure (1): Optical flow (a) Time t1, (b) Time t2 and (c) Optical flow

Optical-flow processes make a distinction of these basic elements by applying a few relatively simple operators to the flow. Object motion is based on the following facts that shown in figure (2) [10]:

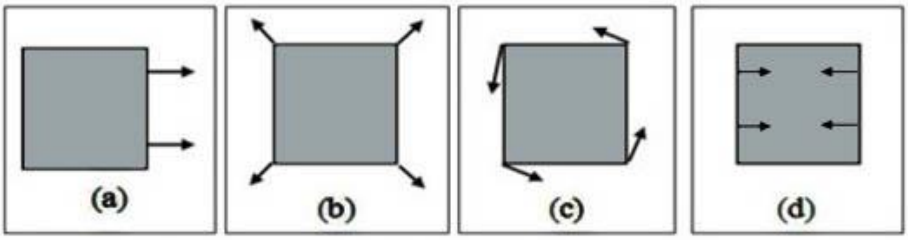

Figure (2): Motion types for an object (a) Translation at constant distance, (b) Translation Depth, (c) Rotation at constant distance, (d) Planar object rotation perpendicular to the view.

The objective of video tracking is to link object in serial video frames. However, it is very difficult to link the object when it moves very fast relative to the frame rate. Tracking process depends on using characteristics such as points, lines or blobs to make matching objects easy in consecutive frames [11].

3- **Minimum Distance Classification**

Image classification is a high level of segmentation. By using certain rules, image pixels group into a finite number of classes so that each class denotes a distinct object with specific properties. In general, image can be viewed as group of pixels sharing similar properties assigned to the same class. The minimum distance method of an image calculates the mean vectors for each class and calculates the Euclidian distance from each unknown pixel to the mean vector for each class. Then image pixels are classified depending on specific threshold to the nearest class. This method is used with image classification applications. This method considered simple mathematically and computationally efficient technique, also gives better accuracy than others classification technique. The minimum distances formula can be presents as [12]:

$$MDC = \min_c \left| \sum_{c=1}^{n_c} I_b(x,y) - \bar{\mu}_b(c) \right| \qquad (1)$$

where min_c is the minimum distance between pixel and mean of class, b represents the index of color bands (RGB), c represents index of class which have value from (1 To n_c) ,where n_c represents the number of image classes, I_b (x,y) is image pixel values, $\bar{\mu}$ is mean value of color band (b) in class (c).

4- The Utilized Tools

Within this study, the following tools are used to analyze captured images and video frames in different lighting conditions.

Digital Camera: - A Nikon (D3300) digital camera was fixed during imaging, where it has Focal length 1.5x, with lens type F, ISO (100-12800) and it's scalable to 25600. The resolution is 24 Mb and highest resolution degree (6000 x 4000).

Portable computer: - A laptop (Dell) model (INSPIRON N5110) is used for this study with process 2.2 GHz, CORE i3 and memory 4GB.

Within this study, the following tools are used to analysis the captured images and video frames to different distances

Figure (3) Nikon (D3300) Digital Camera

The Utilized Software

Within this study, there is several package software used to study movi-color image analysis.

A. Matlab software: Matlab (R2010a) software version 7.10.0 is used to write algorithms and print out images.
B. Ulead Video software: This software used to convert video clips into colorful frame images (still image) at specific time, the frame size (1080x1920) pixels.

C. Table Curve software: Table Curve software (ver. 5.01) is used to estimate appropriate and best fitting function for practical.

The Studied Targets

Color Balloons: - Three different color balloons with approximately same size are used to study distance (D) between the camera and the balloons. In addition, this target used to calculate the statistical properties to each color target and change in intensity.

5- **Video frames classification**

In this study, a video clip recorded consist of walking man carry three balloons. Camera is fixed while the motion of the target moving faraway along fixed horizontal axis for distance (D) (1m-60m) at 1:43 pm at 6-09-2014 in the Zawraa park. The light intensity recorded 48.800Lux .The video frame recorded was 60frame which assorted according to distance (D). The procedure analysis and classification steps as follow:

Stage1:

In this stage homogeneous color regions (20x20) extracted from all image classes, where the number of classes are (n=20), see figure (4). Figure (4) shows the number of selected blocks (n-blocks) from the one of balloons image frame.

Figure (4): The extracted blocks from balloons image

Algorithm (1) Compute Mean to image classes

*Inputs:- colored image (imgb) ; Number of image classes **(n blocks)** ; Block size**(BS).***
Outputs: - File to save Image Mean Vector M()
Start Algorithm
*1. Open the colored image **imgb()***
2. Open Loop for all classes For i=1 To n
*3. Determine the beginning the extracted block manually using computer mouse then clicking on the coordinated **(x_i, y_i)** which represented the beginning determining of the homogenous block .*
4. Set S=0.
5. Open two loops For x=x1 to x2 ; For y=y1 to y2 ; S=S+Img()
6. End two loops End y ; End x
7. Computed target Mean M(i)=S/(Bs x Bs)
9. End i
10. Save classes mean Vector M()
End Algorithm.

Stage2:-

In this stage, the extracted (*n blocks*) homogeneous color regions from movi- image at different distances (D) used in the classification to get a classified image with the number of n-classes.

Algorithm (2) Minimum Distance Classification

*Inputs: - colored image **imgb()** ,image classes Mean Vector M() obtain from Algorthm(3.1)*
*Outputs: - colored classified image **imgC( )** .*
Start Algorithm
*1. Open the colored block image **imgb( )** .*
2 Classify each image pixels into one of n-classes using the minimum distance technique

$$\textbf{MD=minc=k}\ \left| imgb(i,j) - M(k) \right| \Rightarrow \textbf{img(I, j)=C}$$

*Where **imgb(i, j)** Represent image pixel in place **(i, j).***
***k** the class number indices between (1 to n).*
*3. Save the classified image **imgc( )** .*

End algorithm.

Stage 3:-

Within this stage, a lot of care taken to calculate statistic of the classified image. This is useful in image processing to evaluate the image quality. From the classified image (***imgc***) ,three balloons targets are isolated and plotted in a single image for each target as shown in figure (5b).Then , the characteristic for three targets are studied like (area A and the center (C_x, C_y) for each image target as a function of distance (D). where D is 1meter to 60 meter. A new image built with three balloons targets, the walking man that carried balloons, and a white background as shown in figure (5c).

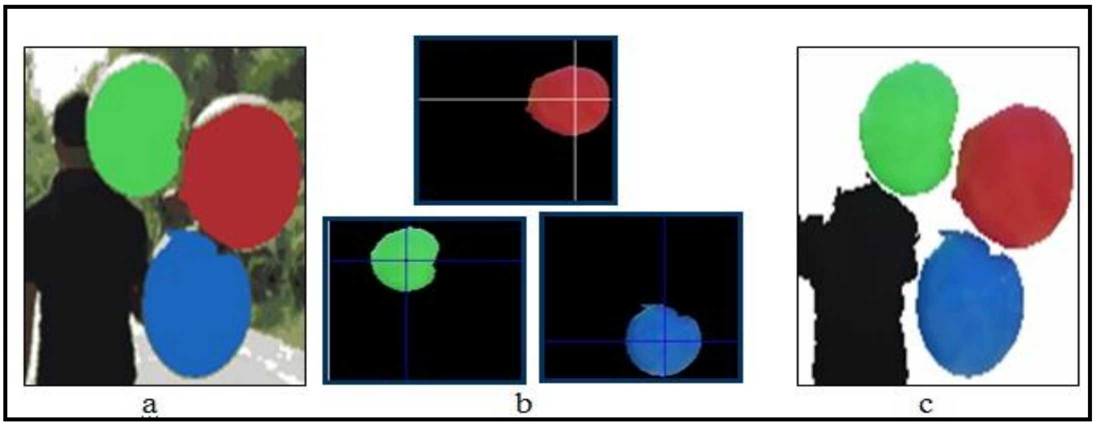

Figure (5) a - Image classified, b– Image target (balloons) plotting in single image , c - The person with three balloons on a white background

Algorithm (3) Separate movi-targets and computing targets statistics

Input: *- Color Image imgb() ; color classified image **imgc()**.*
Outputs: *- target statistics (**A, (Cx, Cy).***
- Built human and the 3-color target with white background image Imgo().
Start algorithm
*1. Open classified image **imgc().***
*2. Isolating each movi-targets from the other targets and image background in 3-Vectors **(VR, VG, VB)** where **VR, VG and VB** Represents the pixel image values of the target (Red, Green, Blue) as vector*
*3. Calculate the area of each movi- target **A (i)** based on computing no of target point . Where **A** represents the area and **i = (1, 2and 3)** for the three targets (IMR for Red Balloons, IMG for Green Balloons and IMB for Blue Balloons).*
4. Calculated the Center for each image target as follows:-

- *Convert the target image into Binary image **(0, 1)** where put target points is equal to **one** and the other image the points equal to zero .*
- *Determined all target points which is equal to one to represents the **A (i).***
- *Summing the all **x**- coordinate in target image class region A(i) using .*

$$Sx = \sum_k x_k$$

- *Summing the all **Y** -coordinate in target image class region A(i) using .*

$$Sy = \sum_k y_k$$

- *calculate the center for each target as follows: -*

$$Cyi=(Sy/A(i)) ; Cxi=(Sx/A(i))$$

Where
i = (1, 2 and 3) Represents the three colored targets (IMR, IMG, IMB)
Cx center of the coordinates X
Cy center of the coordinates Y

5. Rebuild new image for the person with three color balloons on a white background i.e imgo()=255 using the following conditions.
If index(i, index(i, j)=2 or index(i, j)=3 or index(i, j)=4
Then img() = imgc(i, j, 1:3) j)=1 or
Else Imgo() =255
End alaorithm.

6- ***Image analysis results of movi- target***

A set of images extracted from video clip using Ulead software. Presented in figure (6). A man carrying three balloons walked away from a fixed camera at distances from 1m to 60m in AL- Zawraa Park at 6/9/2014.

Figure (6) extracted video frame image from a video clip recorded for man walking a long a straight street, for different distances

The images shown in figure (6) classified into 20 classes distributed among the image using minimum distance classification algorithm (2). From these 20 classes, it is focused only on the three balloons and the Walked man. Figure (7) shows the classified images for distances (D).

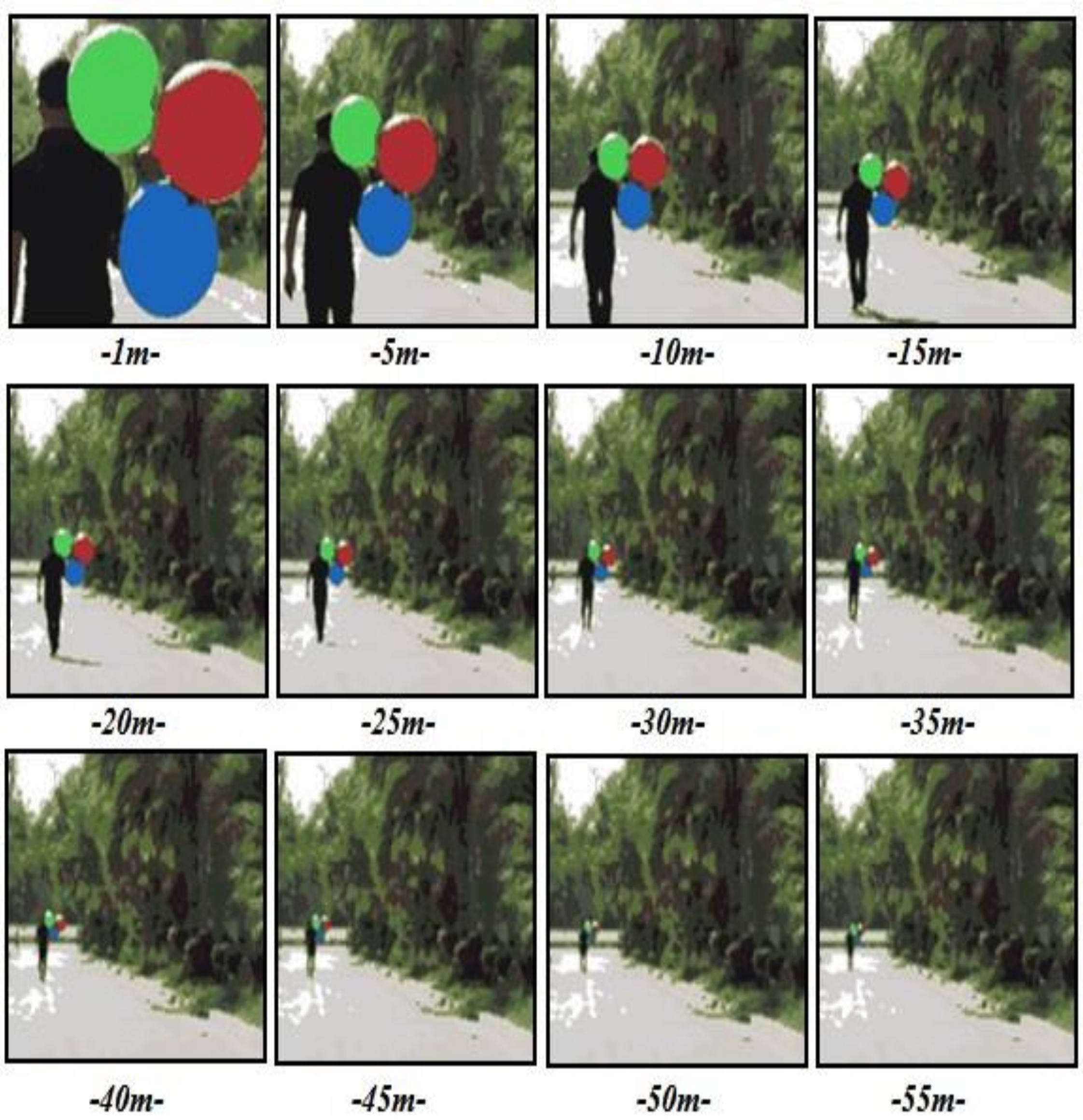

Fig (7) Classified images for different distances

The statistical properties for the colored targets that obtained by applying algorithm (3) was used to study properties each movi- target individually as a function of distance (D). Algorithm (3) used to isolate the colored target (red, green, blue) individually after using classification method. The area of move target (A) is computed and plotted as a function of distance (D). This data is used to estimate a mathematical model by table curve software. From this model it is possible to find a distance for any movi-target from camera by using any area of three movi-target (Red, Green and Blue). Three balloons assumed to be circular and symmetric. Therefore, the relationship between area and distance has the same behavior for the three balloons (Red, Green and Blue). As a result, the three balloons have the same mathematical model, and it can be used to estimate the distance for a movi-target with high accuracy after find the area of movi-target in pixel. Table curve used to find best relationship between the area (A) and distance (D) for the movi-target, where equation that used is:-

$$\ln(A) = a + b\sqrt{D} \qquad (2)$$

Where

a , b are constant

A area of each targets

D distance (1:60) m

Figure (8) illustrates the best fitting function for appropriate curve for the relationship between the area (A) and the distance (D) for each target balloons.

Eq. (2) adopted to compute distance (D) depending on the know area (A) for each movi-target. Then estimated distance (De) that extracted from eq. (2) which compared with real distance (Dr) as shown in table (1). Table (1) shows high matching between the real and the estimated distance (De).

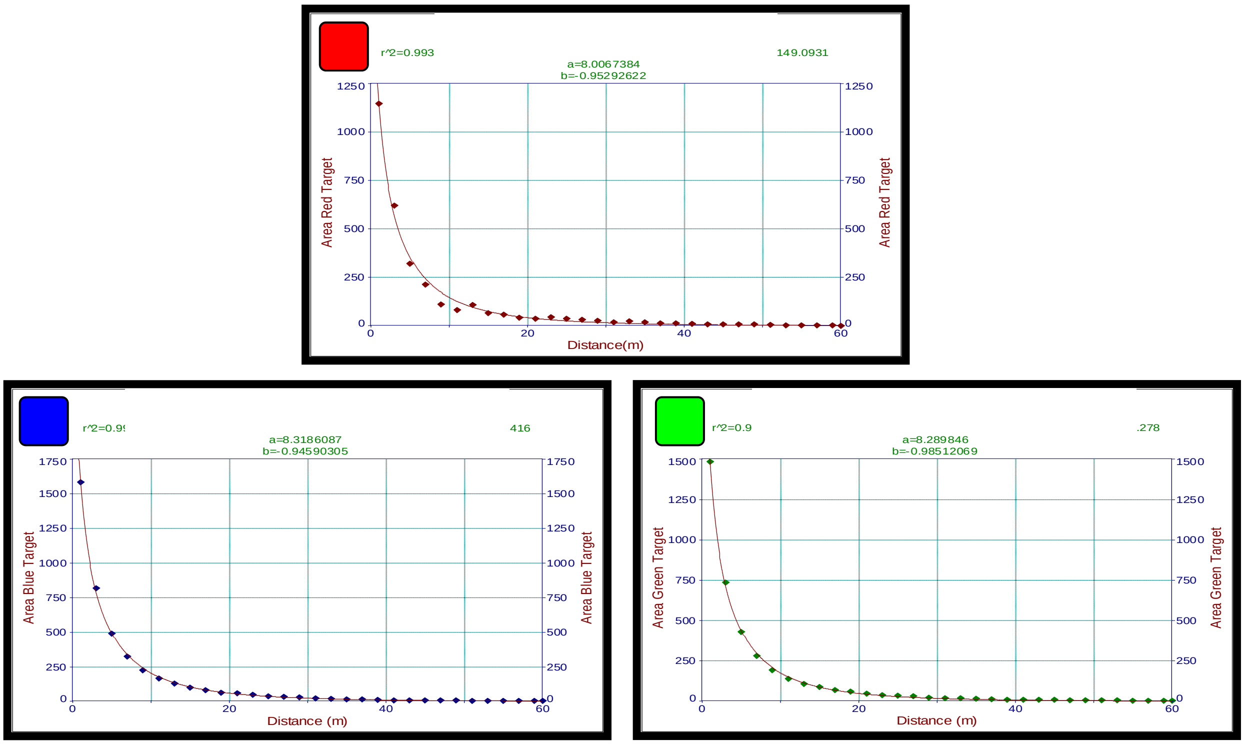

Figure (8): the preoperative curve between area and distance where the model is extracted using table curve software

Table (1) Estimated distances resulted from eq. (2) and the MSD

$\ln(A) = a + b\sqrt{D}$	r2= 0.99305903 a=8.0067 b=-0.9529		r2= 0.99955081 a =8.2898 B=-0.9851		r2= 0.9996234 a = 8.3186 b=-0.9459	
Real Distance(m)	De -R-Target	MSD x 10^{-3}	De-G-Target	MSD x 10^{-3}	De-B-Target	MSD x 10^{-3}
2	**2.00**	**0.00**	**2.00**	**0.00**	**2.00**	**0.00**
4	**4.00**	**0.00**	**4.00**	**0.00**	**4.00**	**0.00**
8	**8.00**	**0.00**	**8.00**	**0.00**	**7.90**	**0.00**
16	**16.00**	**0.00**	**16.00**	**0.00**	**16.00**	**0.00**
24	**24.00**	**0.00**	**24.00**	**0.00**	**24.00**	**0.00**
34	**34.00**	**0.00**	**35.42**	**160.7**	**34.00**	**0.00**
38	**38.00**	**0.00**	**38.00**	**0.00**	**38.00**	**0.00**
44	**44.00**	**0.00**	**44.72**	**25.00**	**44.00**	**0.00**
54	**54.00**	**0.00**	**54.00**	**0.00**	**54.00**	**0.00**
58	**57.90**	**0.19**	**57.90**	**0.29**	**57.90**	**0.29**
60	**60.00**	**0.00**	**59.90**	**0.28**	**59.90**	**0.28**

Algorithm (3) used to find the center coordinate (x,y) of the shape of the movi-target after it isolated. The center of the movi-target depends on the location of this target in the real world (3D space) which may be moved up or down when it convert to the computer world (2D system). The center of target is changed with distances as shown in figure (9).

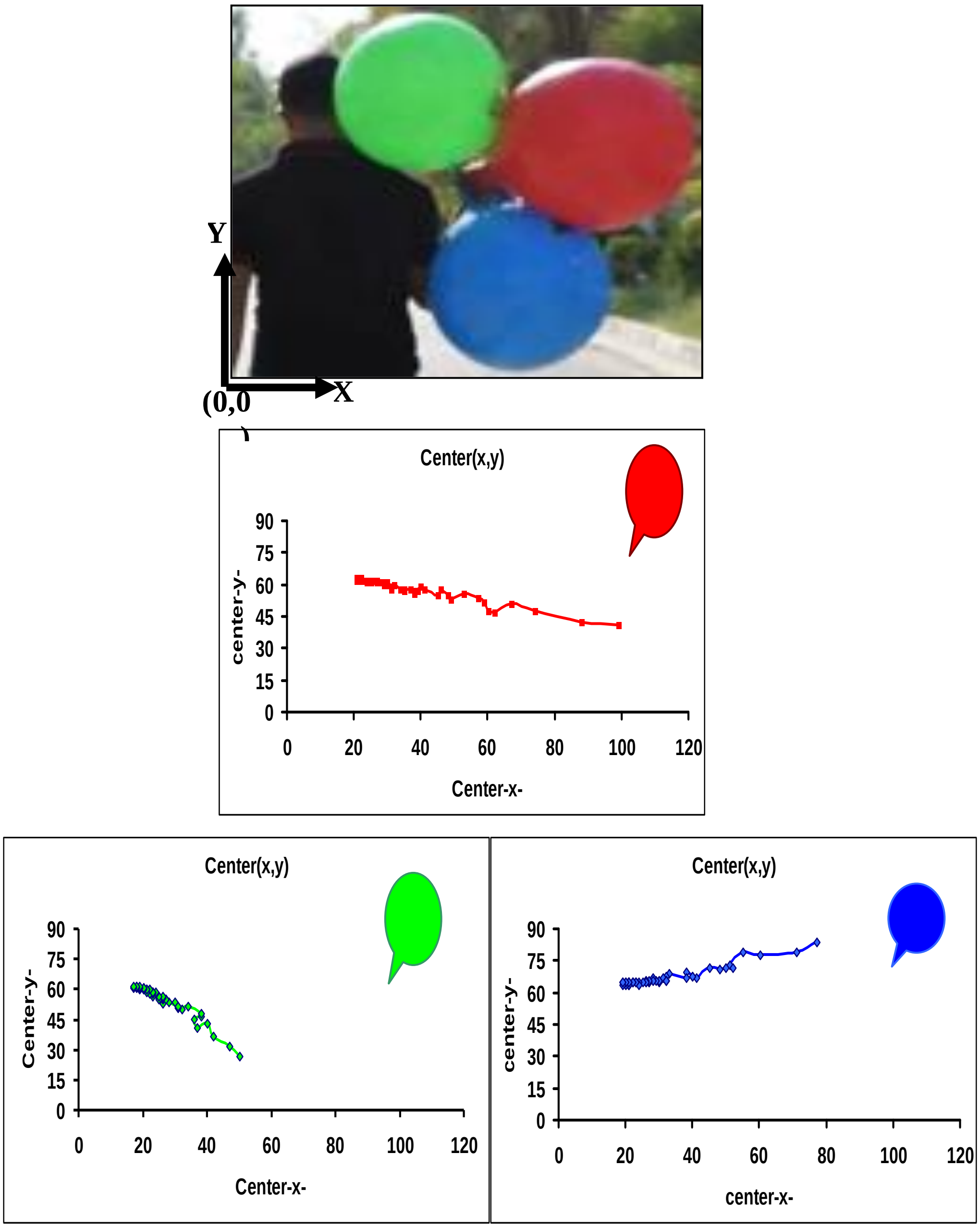

Figure (9) Center of the colored three balloons targets

When the distance is increased, the area of each movi-target decreased, therefore it is difficult to find the center of the movi-object, as shown in figure (10).

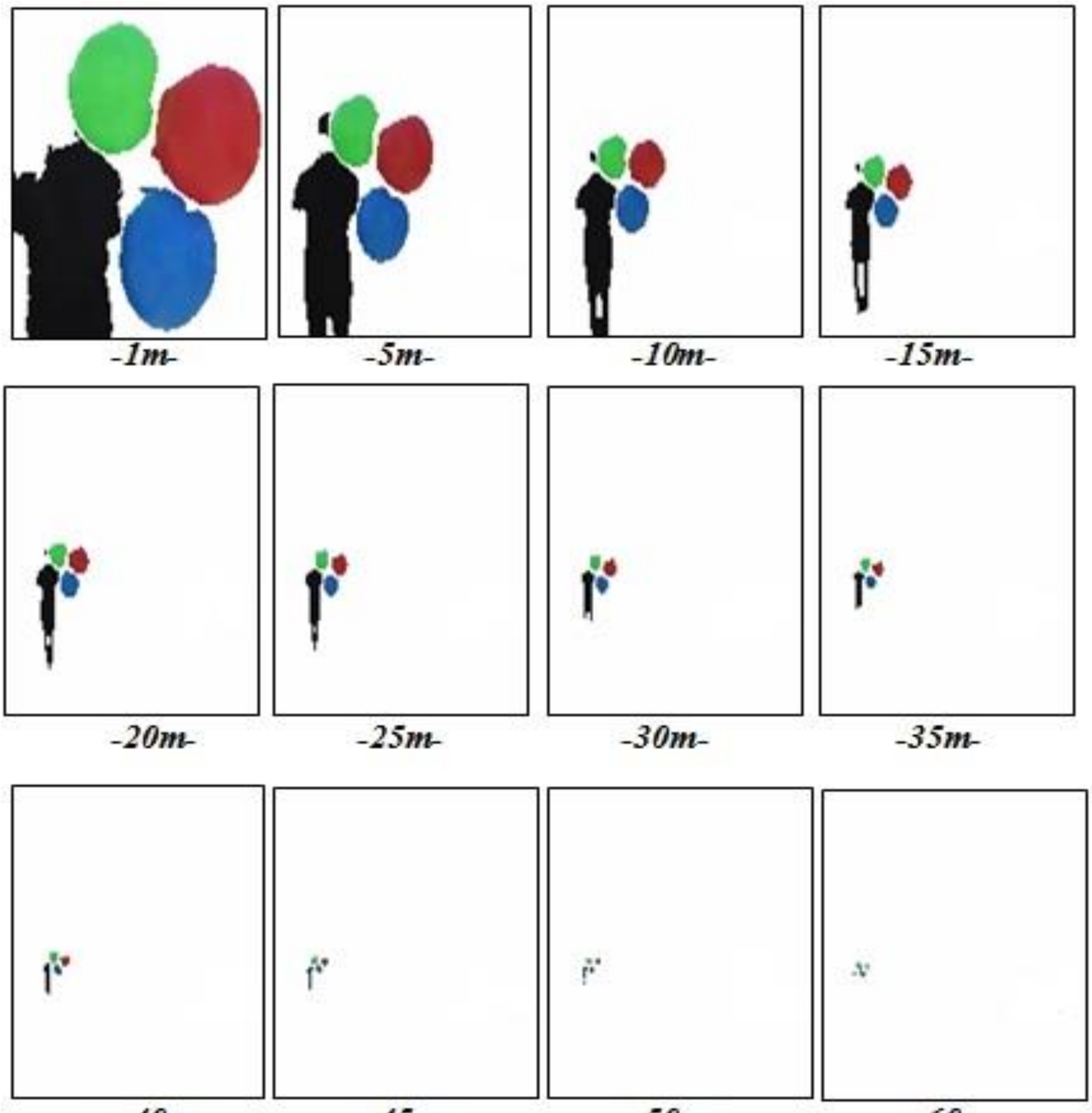

Figure (10): Images of the man with 3- balloons on white background at different

7- ***Conclusions***

The distance between movi- target and the camera (D) is estimated with high accuracy depending on the target area (A) in image plane. Where the distance (D) is estimated with high accuracy depending on MSD between the estimated and real distance.

References

1- Micheal J. Black, Yaser Yacoob, Shanon X. Ju, "Recognizing Human Motion Using Parameterized Models of Optical Flow", Academic Publishing, 2007.

2- Nugroho H. et. al, "Tracking Human Motion In A Complex Scene Using Textural Analysis", Industrial Electronics, Control and Instrumentation,IEEE, Vol. 2, 1994 .

3- Sapana K.Mishra.," A Survey on Human Motion Detection and Surveillance", International Journal of Advanced Research in Electronics and Communication Engineering, IJARECE, Vol.4, No. 4, 2015.

4- Rajput S. J. and Oza S. D. ," A New Algorithm for Tracking of Multiple Moving Objects" , International Journal of Scientific Engineering and Technology, Vol.2, No.7, 2013.

5- Aggarwal K. and Quming Z.," Tracking and Classifying Moving Objects from Video ", Computer and Vision Research Center Department of Electrical and Computer Engineering, The University of Austin, TX 78712, USA, 2001 .

6- Kahttan N., " Algorithm of image operation that using in still image " , PhD. Thesis College of Science, Al- Mustansiriya University, 2006.

7- Musa K. "A Study of Simulation of Motion and Orientation of Moving Object by Using Moving Images", PhD. Thesis College of Science, Al-Mustansiriya University, , 2006.

8- Mohammed K., "object analysis using digital image processing", PhD. Thesis College of Science, Al- Mustansiriya University, (2011).

9- Ali A .," Improving Motion Detection Using a Hybrid Method" MS.C Thesis , Iraqi commission for computer and informatics, informatics institute, 2013.

10- Shafie A., Hafiz F., and Ali M., "Motion Detection Techniques Using Optical Flow", World Academy of Science, Engineering and Technology 56, 2009.

11- Abbas H., Sawsan A., Mohammed M and Abeer A., "Hydrodynamic Interaction between Two Spheres in Newtonian and non Newtonian Fluid", Journal of Applied Sciences Research, Vol.7, No.7, 2011..

12- P. Mishra and D. Singh and Y. Yamaguchi "Land Cover Classification of Palsar Images By Knowledge Based Decision Tree Classifier and Supervised Classifiers Based on SAR Observables", Progress in Electromagnetic Research B, Vol. 30, Page 47-70, 2011.