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Controlling the Distance Between the Robot and Target During the Tracking Process

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Abstract
The tracking process of dynamic target has been played a significant role in industrial environment especially in military industrial, medical and surgical applications, dinger seeking and automatic control cars.In this paper implemented mobile robot and visionary system with two parts the first one is 3D Camera (Kinect) fixed on the mobile robot with computer connection . the kinect Camera installation on computer have been install series of open source software respectively . This work involves constructing integrated in MATLAB program automatically. It depends on a new approach in analyzing the robotic environment by a Kinect. The approach uses colors to detect and recognize the locations object and target.By analysis and processing the image captured by 3D Camera (Kinect) in computer are detection the target in the image, find it's center and measure the depth from robot to target .The calculated depth and angle from image processing in computer is transmitting from computer to robot by using wireless unit and finally the robot go to this location. Finally by using specific algorithm can be controlling the distance between robot and target.The second part of visionary system is a WebCamera fixed in the roof of the working environment to detect the target and robot. The instantaneous distance between robot and target in each frame is finding by WebCam.
Keywords: Mobile Robot, Object Tracking, Visionary System, 3D Kinect

I. INTRODUCTION

The controlling of distance between robot and target in the tracking process is very important factor in computer vision applications such as vehicle navigation,and autonomouse robot system. The web camera is use in many researches to detect the goal and find the distance robot and goal by extracting the target from imageand calculate it's area in the specificlocation of web camera and then create relationship between area of target and distance from webcamera.This relation is using in the tracking process to calculate the depth in the every time. Another one method is using to calculate the depth from 2d image called stereo vision method.In this method acquire two images from a pair of cameras fixed with known distance between them and by using algorithm equations can be possible reconstruction 3D imagefor the space. In this paper we are utilize 3D camera sensor called kinect [1][7]. The kinect consist of two sensors,the first sensor is IR and the second part is color camera and one IR projector produce RGB image as depth matrix . This kinect sensor is fixed on mobile robot ,where it's components are two wheels, directional wheel, dc motors and wireless unit. The target is detect by using the color camera in kinect with respect to it's color and distance between robot and target is measured by depth sensor. The depth between robot and target controlled by using Arduino controller,computer and any programming language (MATLAB).The other one camera fixed on roof for measuring the specific distance between robot and target. The roof camera is detected the robot and goal with respect to their colors and then measuring mathematically the depth between them .

II. Proposed Algorithm and Principal Components of the System

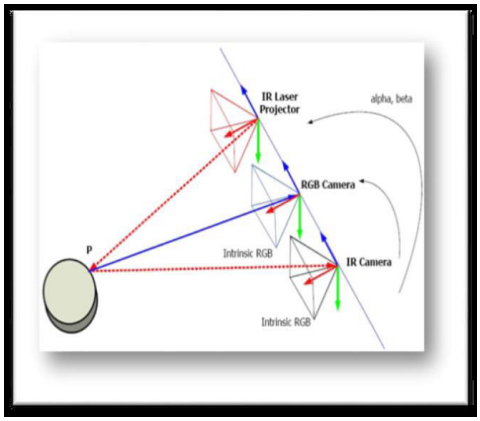
1. Visionary System

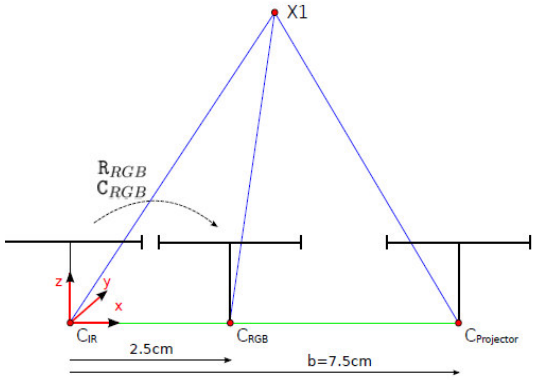
Threr are two cameras used in the system ,the first one is (3D) camera(kinect). The kinect sensor is used To measure the location of target inThree dimension at every time in the tracking process [3].

The kinect sensor are consist ofthree parts,where the middle part in device is RGB camera and the two device in the left and right in kinect are special in the depth image. The left device is transmit the light to every point in environment of view range kinect and then rejected this light is detected by right device.from this process the depth of each point in environment can be calculated.

The parts of kinect and process are Showed in **Fig.1** and **Fig.2**.

Figure(1) kinect sensor

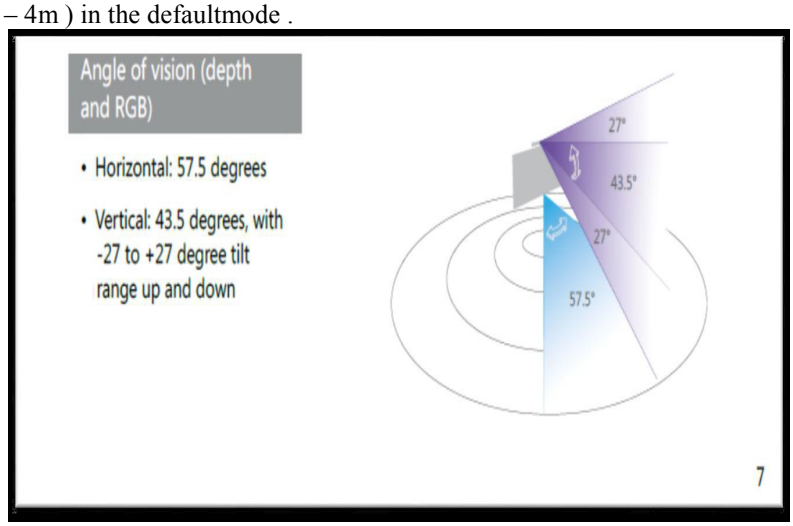




(b) **(a)**

Figure(2)(a)IR projector,IR and RGB camera (b)Geometrical model of Kinect[2]

The range of view of kinect sensorare (57.5) degree in horizontal field and (43.5) degree in vertical fieldas shown in **Fig.3**. The depth can be measured by kinect is between(0.4 m – 3m) in Near Mode andbetween (0.8m – 4m) in the defaultmode .



Figure(3) Field of view of kinect sensor in x and y axis [2]

The second camera used in system is webcamera fixed in roof to observer the environment work. This webcamis Logitech [8] type as shown in **Fig.4**.


Figure(4) Webcamera **Figure(5)** Mobile robot with kinect

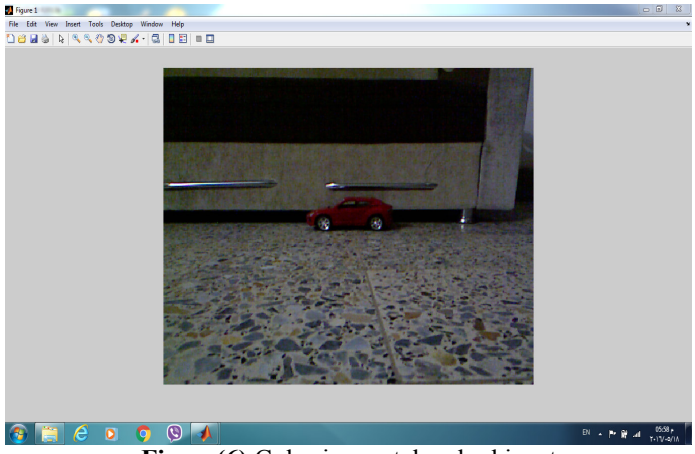
2. Proposed Algorithm

2.1 Kinect support

The first step to begin process is support the kinect sensor on the computer. The Kinect is supported on computer by installing following programs, Open NI, Sensor - kinect,Sensor-kinect092 and Nite. The next Stage is support MATLAB programon computer for processing imagesare taken by Kinect (RGB camera) and web camera. The last stage are transmit the results from computer to
robot by wireless unit (Bluetooth) for completing the tracking process [5].

2.2 Target Detection

The targe detection process is achievement with respect to it's color (red color) by processing the images are taken by RGB camera in kinect.the following **Fig.6** representing thecolor image forred color target taken by kinect.



Figure(6) Color image taken by kinect

The RGB image is convert to gray image. The gray image presented by 8-bit for every pixel. The intensity of brightness for every pixel is changingfrom 0 to 256, where 0 being black and 256 value represent white color[9].

I RGB =(FR ,FG ,FB) (1)

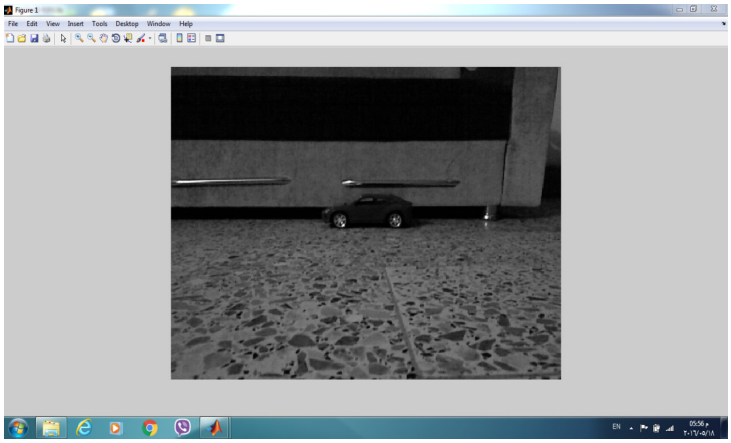
I RGB means the intensity for three Color together in specific pixel .

FR the brightness value for red color separately.

FG the intensity value for the green color separately.

FB the intensity value for blue color separately.

By choosing threshold value for each color can be convert color image to gray image as shown in **Fig.7**.

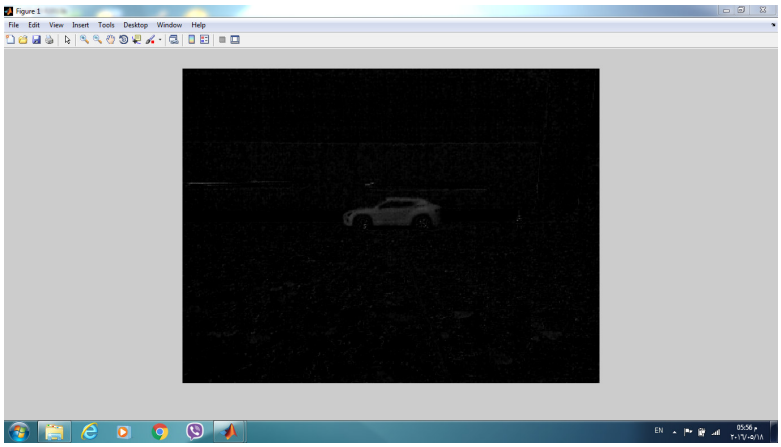


Figure(7) Gray image of target by kinect

The red channel of the RGB image can be obtained by taking only red matrix of image as shown in **Fig.8**.

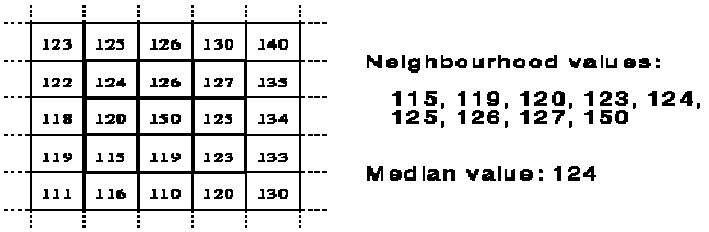
Figure(8) Red channel of target

After find the red channel and gray matrices of the same picture taken by RGB camera (kinect) subtract these matrices to calculate difference matrix as follow in **Fig.9**.



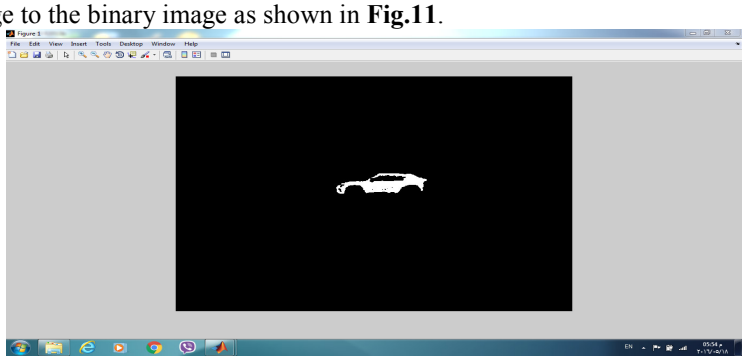
Figure(9) The difference image of target

The difference image have kinds of noise,so we used nonlinear digital filter called Median filter to remove these noise.The median filter is work by looking on the neighbors for each pixel in image to determine the value of median. The **Fig.10** represent the noise removing process by filter[5].



Figure(10) Finding the median value[4]

After removing the noise from image must be select threshold value. The value of pixel more than threshold value give it(1)white color and give (0) black if the value less than the Threshold value. This calculation is convert the gray image to the binary image as shown in **Fig.11**.



Figure(11) Binary image of target

is called region of interest[6].

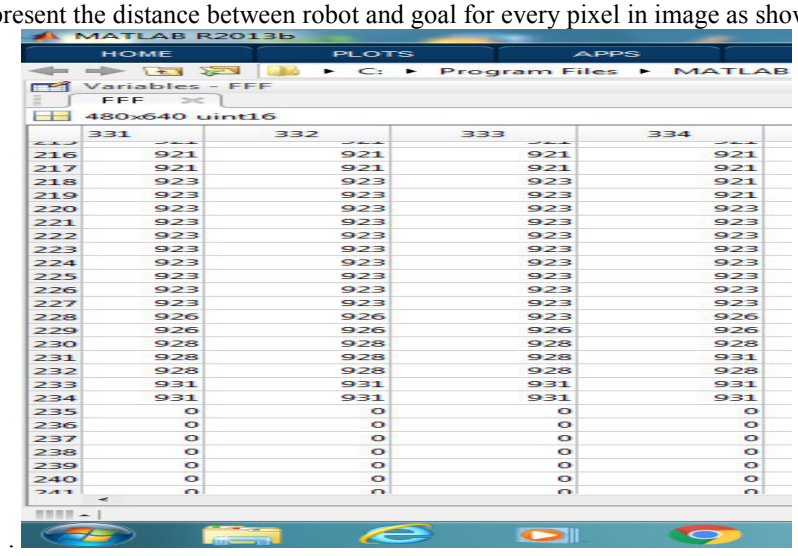
$$X = \left(\sum_{i=1}^{n} \sum_{j=1}^{m} B[i,j] * j\right)/A \qquad (2)$$

$$Y = \left(\sum_{i=1}^{n} \sum_{j=1}^{m} B[i,j] * i\right)/A \qquad (3)$$

x,y represent x-axis coordinate and y-axis coordinate of target center.
B region of interest.
i,j row number and column number.
A area of interested area.

2.3 Finding The Depth Between Robot and Target

The depth camera in kinect must be take a snapshot at the same time with the color camera. The image taken by depth camera is represent the distance between robot and goal for every pixel in image as shown in **Fig.12.**

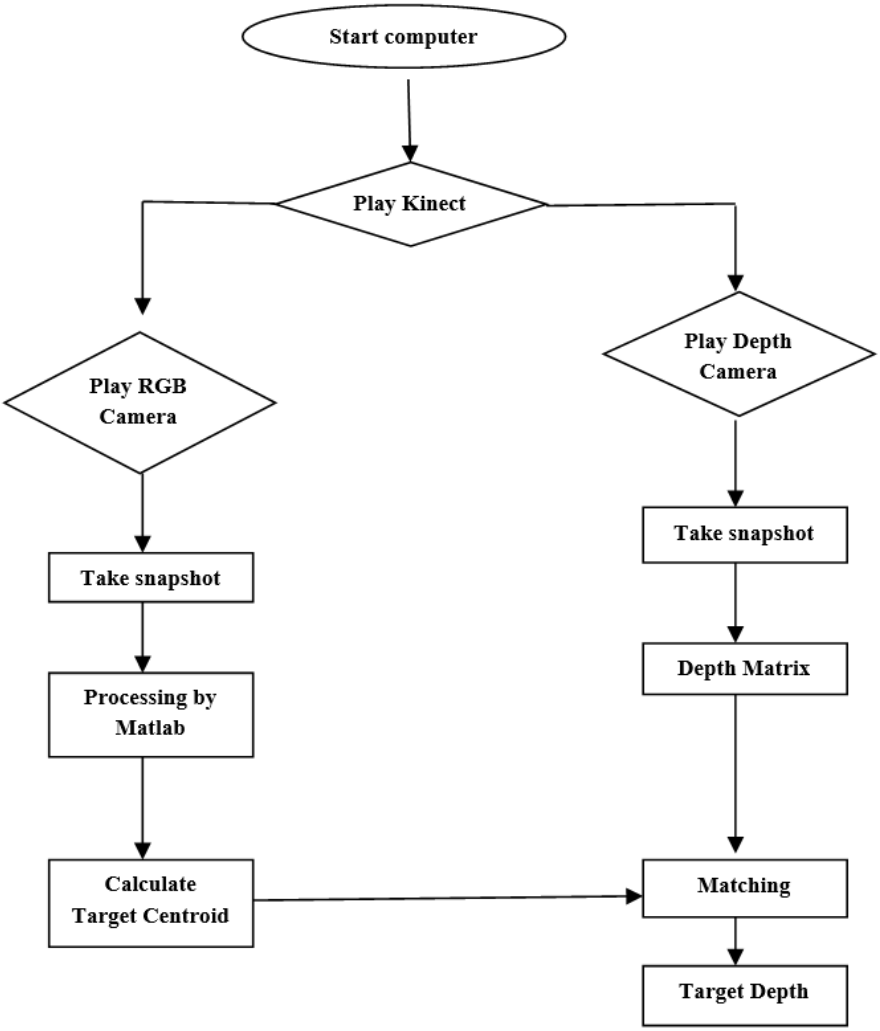


	331	332	333	334
216	921	921	921	921
217	921	921	921	921
218	923	923	923	921
219	923	923	923	921
220	923	923	923	923
221	923	923	923	923
222	923	923	923	923
223	923	923	923	923
224	923	923	923	923
225	923	923	923	923
226	923	923	923	923
227	923	923	923	923
228	926	926	923	926
229	926	926	926	926
230	928	928	928	928
231	928	928	928	931
232	928	928	928	928
233	931	931	931	931
234	931	931	931	931
235	0	0	0	0
236	0	0	0	0
237	0	0	0	0
238	0	0	0	0
239	0	0	0	0
240	0	0	0	0

Figure(12) Depth matrix

The values of depth matrix in (mm) unit. From the specification of kinect the depth camera can't able to see the objects near than 800mm for it.The values of zero in depth matrix mean the object in these pixels is less than

800mm. After finding the location of target centroid from processing the image taken from rgb camera by use MATLAB program and finding the depth matrix from depth camera must be matching the center of target with depth matrix to calculate the distance between kinect and target in the each frame as shown in **Fig.13**.



Figure(13) Target depth algorithm

2.4 Depth Controlling Algorithm

The desired depth between the mobile robot and target sets firstly. The calculated depth between robot and target in each frame from video must be compare with the desired depth in each frame so, if the depth calculated is less than or equal the desired depth must be the robot stop.The information of target location is transmitting from computer to the robot controller (Arduino) by using wireless unit (Bluetooth). The robot is move toward the location sendfrom the MATLAB.

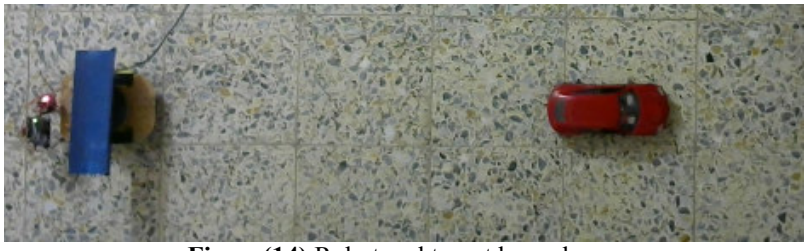
2.5 Depth Measuring Between Robot and Target by WebCam

The webcamera fixed in the roof detected the mobile robot and target with respect to their colors and their locations are calculated by Matlab language processing. The distance between robot and target locations are calculated by distance formula.

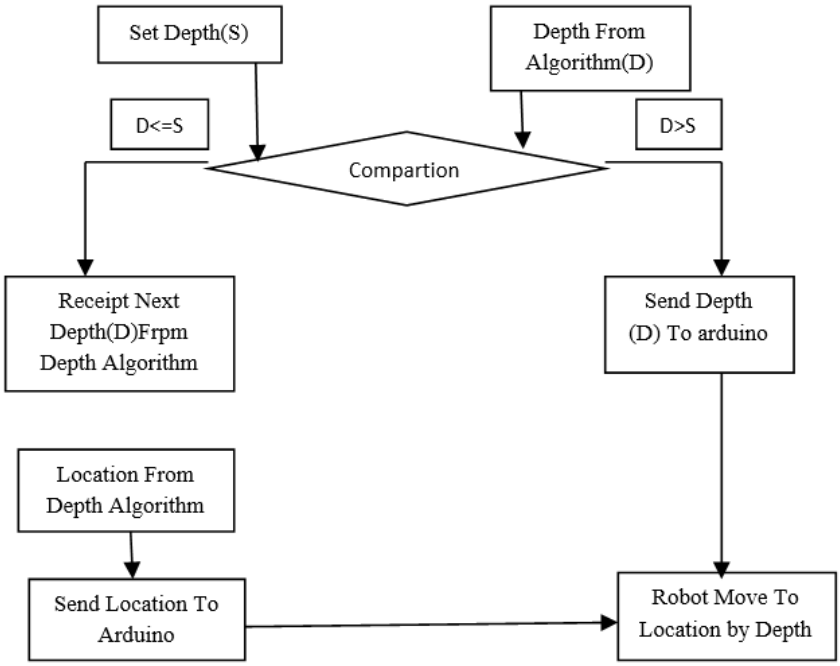
P=sqrt((x1-x2)^2+(y1-y2)^2)

Where p represent distance. x1,y1 robot location. x2,y2 target location.

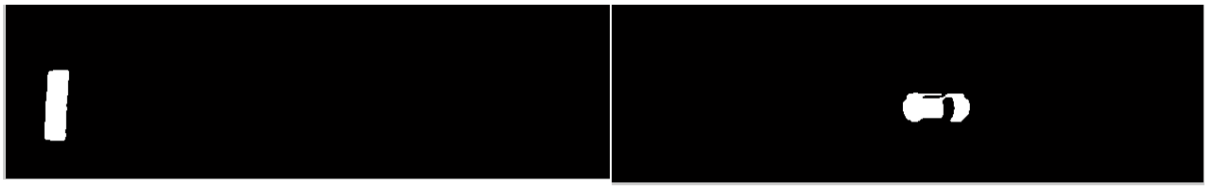
The paths of robot and target can be draw by calculating their locations in every frame as shown in **Fig.14**.



Figure(14) Robot and target by webcam



Figure(15) Depth controlling algorithm



(a) (b)

Figure(16) Robot and target binary images by webcam

III. Experimental Work

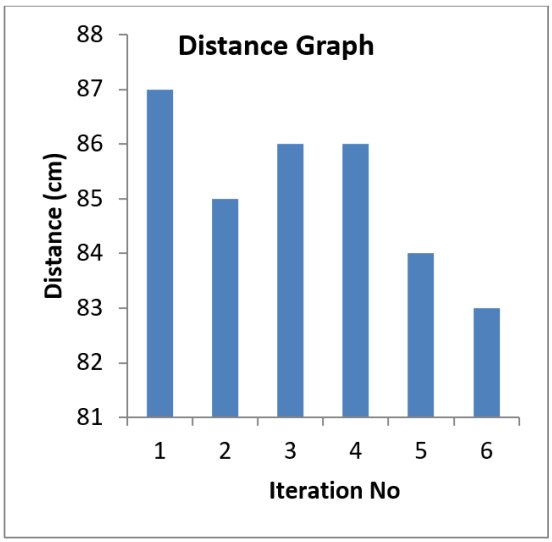
To controlling the distance between robot and target firstly set the desired distance. In this research we take three different values of control distance (850mm,1150mm and 1350mm). In the every case from three values are applying the detection algorithm to find the centroid of goalin each frame. The webcamera is used to detect the target an robot and find their locations and find the distance between them. For each case draw the paths of robot and target by using webcamera.

IV. Results and Discussion

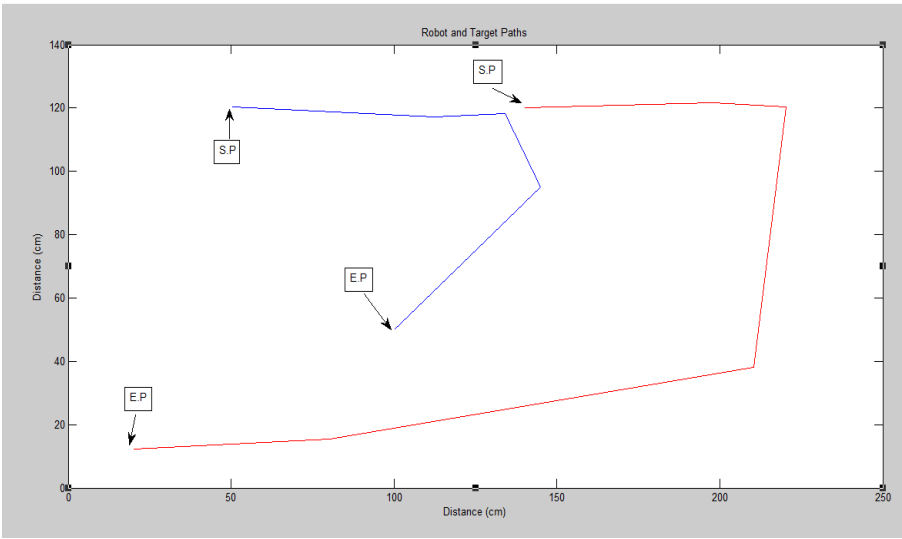
1.The controlling distance is (850mm)

Table(1) Locations of robot and target

NO	x-axis value of target in (cm)	y-axis value of target in (cm)	x-axis value of robot in (cm)	y-axis value of robot in (cm)	Distance by webcam (cm)	Actual Distance in (cm)
1	140.3	120	50.4	120.3	89.9	87
2	198	121.8	112.3	117.2	85.8	85
3	220.3	120.4	134.2	117	86.1	86
4	210.5	38	145	95	86.6	86
5	80.3	15.3	135	85	88.6	84
6	20	12.3	100	50	88.4	83



Figure(17) Distance between robot and target (850mm)

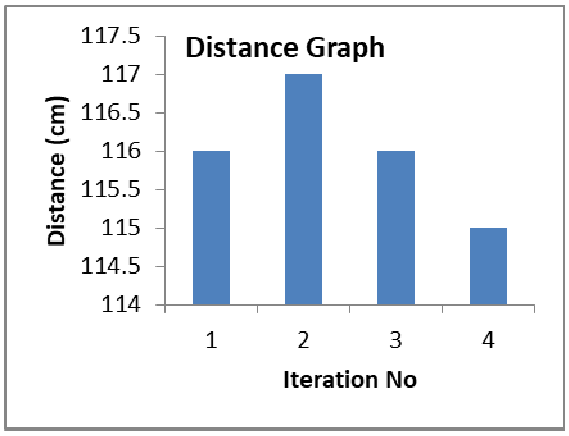


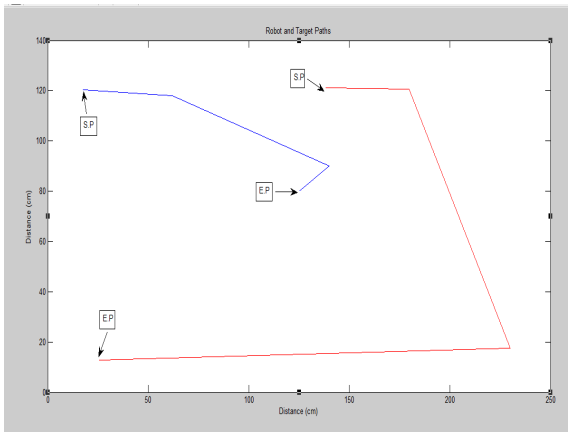
Figure(18) Robot and target paths a) red color target path b)blue color robot path

2. The controlling distance (1150mm)

Table(2) Locations of robot and target

iteration	x-axis value of target in (cm)	y-axis value of target in (cm)	x-axis value of robot in (cm)	y-axis value of robot in (cm)	Distance in cm by webcam	Actual distance in (cm)
1	138.3	121.2	17.6	120.4	120	116
2	179.7	120.6	62.1	117.9	118	117
3	230	17.5	140	90	115	116
4	25.4	12.9	125	80	120	115



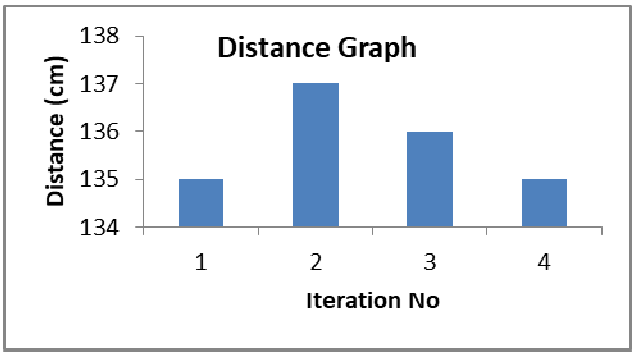


Figure(19) Controlling distance (1150mm) **Figure(20)** a) Red color target path b) blue color robot path

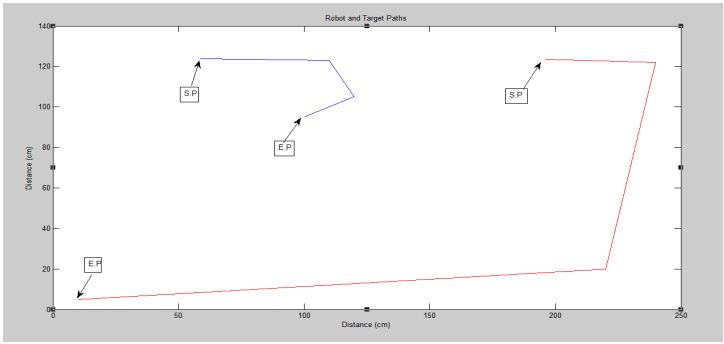
3. The controlling distance (1350 mm)

Table(3) Locations of robot and target

iteration	x-axis value of target in (cm)	y-axis value of target in (cm)	x-axis value of robot in (cm)	y-axis value of robot in (cm)	Distance in cm by webcam	Distance in cm by feta
1	195.9	123.5	58.8	123.9	137	135
2	240	122	110	123	130	137
3	220	20	120	105	131	136
4	10	5	100	95	127	135



Figure(21) Controlling distance (1350mm)



Figure(22) a) Red color target path b) blue color robot path

IV . Conclusion

Due to the study of controlling the distance between mobile robot and dynamic target by using two types of camera there are some conclusions have been obtained :

1. The distance between target and robot is calculated by using kinect sensor by matching the Two images are taken at the same time frome depth sensor and RGB camera and drawing thevariation of distance between them instantaneously by graph .

2. By using three different values of specific distance between the robot and target through the tracking process

achieve by proposed model the conclousion are :
a. When the distance between robot and target is (850 mm), the similar between robot and target paths is good.
b. When the distance between robot and target is (1150 mm), the similar between robot and target paths is decreased.
c. When the distance between robot and target is (1350 mm), the similar between robot and target paths is decreased more.
3. The instantaneous velocity of robot and target are calculated by using monitoring camera with technique that taking the moved distance for robot and target in every frame (image) separately and divided it to time of each taken from fps for camera .

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