CS365: Artificial Intelligence
Construction of ego-model of robot arm
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Abstract

My project deals with one of the most significant part of Artificial Intelligence i.e. Robotics. 2-Dimensional movement is the basic model of motion of a robot. Robots can execute a large number of activities with different motions and equipments. The purpose of this project is to analyze the visual intelligence in a robotic arm which has 2 links and a camera attached to its tip. The world is 2-dimensional in nature and square in shape with colored walls. The robot will generate the image of the part of the walls which is in its area of vision which is similar to creating a panorama image with a camera. The robot will throw rays of light to see the world and give the viewed region as an image. The robot will also display any object in its vision. Once the object is detected, the robot can be equipped in many ways to achieve the desired effects. Certainly this type of robot will face obstacles in its movement which can touch it on its surface or overap it. This robot will generate the overlapped region of the robot and the obstacles. This can be used in path planning and obstacle avoidance in necessary situations.

Introduction

The robot moves in 2-dimensional world with 2 link mechanism. The world is black in color and square in shape with size of 800x800 pixels. The walls are colored with different colors namely blue, green, springgreen and orange and the corners are colored pink.The robot has a camera attached to its movable link. The other arm has been kept fixed at a point which performs only rotational motion. The fixed arm rotates and the movable arm perform rotaion around the fixed arm's axis. The movable arm also performs rotational motion around the axis passing through the point of contact of the two links. The vision of the robot has been fixed to 180 degrees from the line perpendicular to the movable arm. Under these conditions the robot throws rays from the camera and produces the images what a normal human would have seen from his eyes. The robot also produces images of how he will see different objects in his area of vision. For avoidance of obstacles the robot gives the overlapped area between the obstacles and robot.

Previous Work

Link mechanisms have been exclusively studied for more than 250 years but its application with autonomous robots has been developed recently and artificial intelligence in robots is even more recent. With the help of many technologies, equipments and gadgets the field of artificial intelligence has developed to a very great extent. Man has reached moon and has been exploring it with mery sophisticated robots. Analyzing at a basic level, 2 link mechanisms are used in many places including factories, ships, planes, hospitals, miitary applications etc. Robots have found their usages in spying and non-human expeditions to places not excessible to humans on earth as well as in oouter spave. This field is being researched at a very large scale but seeing the scope of Artificial Intelligence much more technologies are yet to come.

Approach and Algorithm

Considering the vision of the camera as 180 degrees and the conditions of the walls and the world, three major objectives are fullfiled which have been explained below with my approach and algorithm.

1. World Visualisation: Approximately 4000 images were given as inputs having different link positions. The images are created by changing the agles or rotaion between the two links. The camera emits rays at every 0.2 degrees and hence 900 rays to cover the 180 degrees area. Some examples of the input file are as follows:

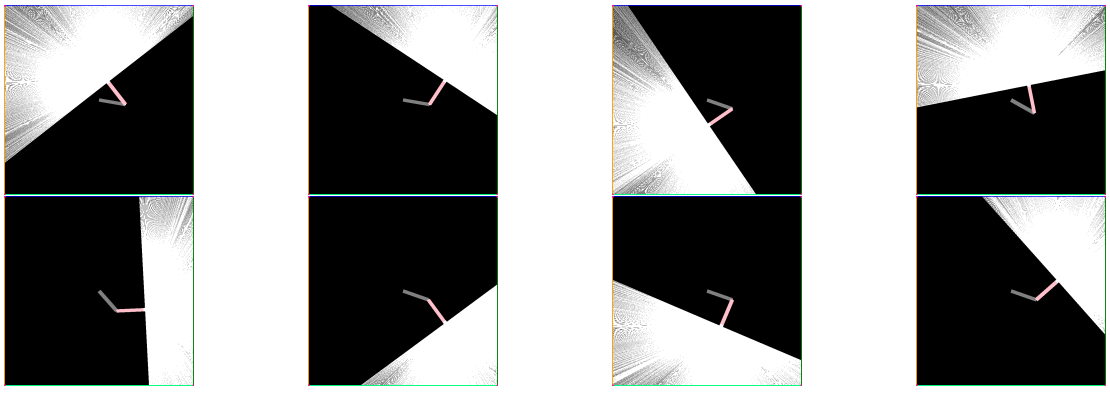

Figure 1: Examples of arm positions with the area of vision creating by throwing white color rays from the camera

Algorithm and working:

1. At regular intervals of very small angles(0.2 degrees) the camera emits rays
2. The robot selects one ray and the algorithm travels on that ray from the camera towards the walls
3. The robot gives the output of the color of the pixel whenever the ray touches an object or a wall by differentiating between the colors
4. After giving the output the robot selects the next ray and repeats the algorithm
5. Hence after the robot gives the output of the all rays we get the desired view of the world as seen by a person

2. Object Detection: A rectangular object is placed at a position. The robot sees the oject and creates the correspoding image which he sees. Some of the files given as input are shown below.

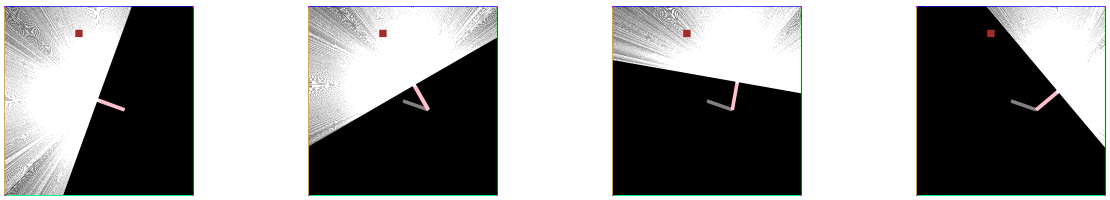

Figure 2: Examples of arm positions with the red obstacle placed

Algorithm and working:

1. The camera emits the rays as usual but this time it finds the object before the walls
2. The camera notices the change in color before the ray reaches the walls and hence detects the object
3. The robot stores the color of the object and prints it in the image
4. After noticing the change in color in one ray the robot selects the next ray and repeats the algorithm
5. Hence after the robot gives the output of the all rays we get the desired view of the object along with the rest of the view of the world

3. Obstacle visualisation and Overlapping: Here the obstacle has overlapped the robot. The robot senses the part where the obstacles have reached and gives the output of the overlapping part in the form of an image. The obstacle used here as an example is shown below.

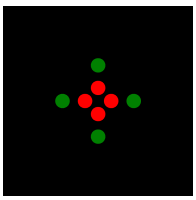

Figure 3: Example of an image with obsatacle as green and red circles

Algorithm and working:

1. The algorithm creates an image whose pixels are the pixels which are common to two images
    - The first image which is the obstacle image minus the obstacle
    - The second image which is the position image minus the robot arm

2. The left over part of the image is left blank
3. Two simultaneous images are created
    - The first image fills the blank part first with obstacle image and fills the rest with position image
    - The second image fills the blank part first with position image and fills rest with obstacle image
4. The two images are blended with keeping the interpolation constant as 0.5 , which creates an image that looks as if the two images have overlapped with the change of color in only the part which is common to both of them
5. The algorithm then deletes the uncommon part of the image from the position image and the obstacle image
6. After the completion of the algorithm we are left with only the part which is common to both of them

Results and Conclusion

The results of all the parts are shown below.

1. World Visualisation: The images of the walls as seen by the robot.
First Four of above examples

Second Four of above examples

2. Object detection: The images of the object as seen by the robot.Notice the red bar in blue color.

Figure 4: Examples of images created object detection

3. Obstacle Visualisation and Overlapping: The image output of the overlapped part of the obstacle and robot arms are:

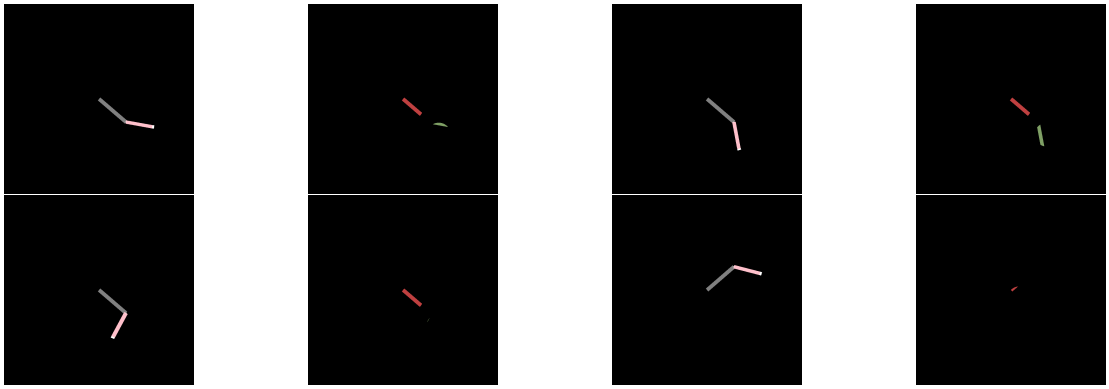

Figure 5: The image output of the overlapped part with above given obstacle

4. Isomap and Dimensionality: The isomap created from the images was:

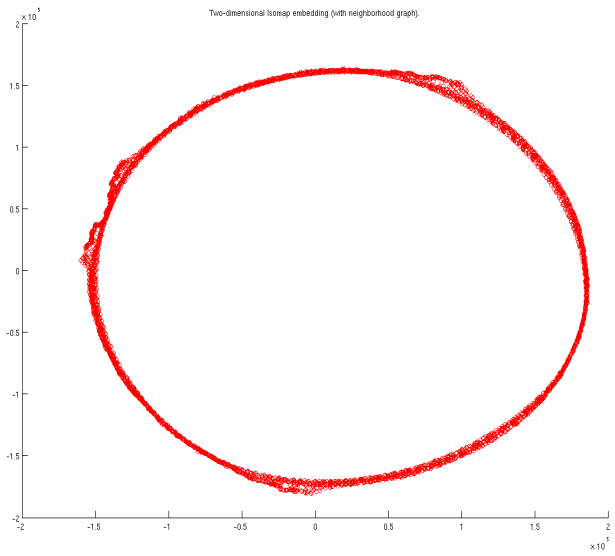

Figure 6: Isomap formed from different positions of the robot arms

Topology of the image set was:

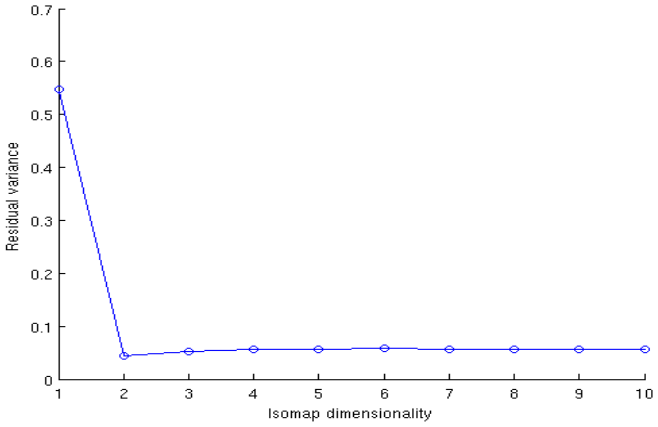

Figure 7: Topological formed from different positions of the robot arms

Future Work

In future we can add some features which can allow the robot to do following things

1. Throw the ball on a particular colored ball
2. Color the enemies and friends with two different colors.Then change the color of robot to red if it sees the enemy and to white if it sees
3. Allow it to shake hands with other robots

Bibliography

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[3] $Theadvantagesofmountingacameraonrobotarmby RaduHoraud, RogerMohr, FadiDornaika, andBoubakeurBoufam$