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**Jenga Stacking System**

**EECS 4422 Project Proposal**

Description

The proposed idea is to create a program that performs the task of stacking a tower of Jenga blocks after it has been toppled over and scattered along a plane. The plane in which the Jenga blocks will be scattered is mapped out in perspective to the robotic arm’s reach capabilities. Simply put, if the block is within the reach of the robotic arm it will pick it up and stack it, along with all the other accessible blocks, on top of each other in a designated area. The result will be all the Jenga blocks stacked on top of one another in an orderly fashion with no stray pieces on the plane. The goal is to use skillsets acquired through the course and modify them with both the use of the camera and robotic arm.

Techniques

The program will fundamentally rely on 2 techniques to work. The first is creating a plane in which the robot arm can freely move and programming the robot arm to move within this plane. This involves computing and understanding the complexities behind the angles of the robotic arm when moving it to a space on the plane. More specifically, in order for the program to work one must understand the changes in all the angles of the components of the robotic arm so that one can effectively and easily translate the robotic arm to the point on the plane containing the Jenga block.

The second technique will be discovering the locations of the Jenga blocks. The only apparatus available for doing this is the computer vision camera. This will involve not only comparing images of the plane to discover the Jenga blocks, but also deciding which of the Jenga blocks to pick up first, as well as distinguishing the stray Jenga blocks from those already being stacked.

Depending on the difficulty of distinguishing the Jenga blocks, an additional filtering technique may be necessary to more easily find them. The above will also incorporate edge detection, hand eye coordination and applying thresholds in their implementations. These techniques share similarities to the techniques used in both assignments for the course. However those techniques act only a basis for the project. Much more work and adjustment is needed.

Resources

The resources that will be used in the project are as follows:

-MediaMath

-Robotic arm

-Web camera

-Jenga Blocks

Components

The system will include the use of a computer vision camera as well as a robotic arm and will be implemented in MediaMath. The movement of the arm on the world coordinate system will be based off the algorithm used in assignment 1. However, modification is needed so that the robot can move on the z axis as well. The camera will be used to detect location of the blocks on the field based on pixel coordinates which will be converted to world coordinates for the robot arm.

This being said, the first component to build is obviously the robotic arm movement. This has to be programmed in a way that can not only move to any point on the plane, but whose angles can also be adjusted when working with the Z-axis or depth. This means making changes to the already established algorithm from the assignment.

The second component to build then is the camera component that will locate the coordinates of the Jenga blocks as well as their angles, dimensions, etc. This will be vital in figuring out where the robotic arm needs to move in order to pick up the Jenga block in the first place. From assignment 2, a basis for this technique already exists but again will need modification as it does not account for a 3-dimensional plane, nor does it account for multiple objects being in the plane at Once.

The third component to build will revolve around actually picking up the Jenga blocks. Picking up an object may be simple, but in this case, the object must be picked up properly. This means it must be picked up at the right angle and from the right sides of the block or else when stacking them together errors may ensue or even worse, the arm may topple the already stacked Jenga blocks. This may be an extremely important component to implement depending on how it is decided to stack the Jenga blocks together.

The fourth and last component to build will revolve around where the Jenga blocks are stacked. The goal of this component is simple: to ensure that the program can distinguish the Jenga blocks that have already been stacked, versus the blocks that still need to be stacked. It’s obvious that without this component, the program will create problems.

Evaluations

It is currently not entirely known how evaluation of this project will specifically occur but there are some tests that will be administered that are both simple and complex and test the reaches of the project. The first and most obvious is to take a single Jenga block and see if the program finds it, picks it up and places it in the designated area. The Jenga block can be placed at a random location and in the corners or edges of the plane, to ensure that the robot arm can successfully reach these areas. Another test is to put blocks closely together and at different angles. This will ensure that the program can properly distinguish the multiple Jenga blocks and that it won’t be tricked into thinking that 2 blocks close together is 1. In addition it will show that the blocks can be picked up at various angles. Another fairly obvious test is to simply scatter the multiple pieces along the plane and see the program execute. This will ensure that the program actually picks up and stacks all the Jenga pieces appropriately.

Challenges

This project faces its own variety of problems that will need addressing. In terms of the robotic arm, one problem will definitely be introducing a third coordinate into the coordinate system. When only using 2, this meant only moving a fixed number of angles on the robot arm. However this may no longer be the case. This means more complex algorithms for determining the angles of the robotic arm to move to a select location. In addition to this problems can occur because of the inaccuracy of the robotic arm. It’s important to keep in mind that even the slightest maladjustment when initially setting up the robotic arm can have serious consequences, especially for a task such as this. Another problem is ensuring that as the robotic arm moves, it doesn’t strike the already stacked Jenga blocks.

Another set of challenges arises from the camera itself. The biggest challenges involving the camera will be ensuring that it properly detects ALL Jenga pieces. This can be a problem if the Jenga pieces are stacked on top of one another or are very close together. If the algorithm for finding these pieces is not adequate, serious problems will occur. Another problem will be distinguishing the stray Jenga blocks from the ones that are currently stacked up. Additional problems include ensuring that the albedo and contrast of the Jenga blocks are at a level that allows them to easily be detected.

The last problem to consider is how the Jenga blocks will be stored. Obviously larger bases mean sturdier platforms to build on, but it also means that individual blocks will have to be placed in different ways. On the other hand, stacking one block on top of the other would be easier, but be far less sturdy. These are but a few of the problems that will be encountered when programming this project, all of which will be handled.