[Company name]  [Company address]

Library Bot documentation

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# To do

**03/05/2022**

* For collision detection, add a way to detect a *moving* object (i.e. the book rectangular prism), to avoid collision with the environment. In each frame, get the global transform of the book (visual servo opportunity?), and check its collision with any other objects (or EF arm). This could be done by passing the transform of the book each step to the ‘obsticleConstructor’, ~~making the vertices and faces, then checking those for collision.~~ Finding the 12 lines which comprise the shape (simply the vertexes of each shape, 12 lines for object edges, then an addition 6 for the faces to be triangles). Then collision detecting these with the shapes in the environment at EACH STEP in the robot movement. **Patrick**
* Add collision avoidance (check week 5). **Patrick**
* Create a class for each object (obstacle and books) which contains its global transform. This class will also plot the object into view (good for static objects like the table, shelves, stationary books). Also, for the motion of the book, we need a function which can animate the book moving along a path (the path is simply the transform of the book at each qMatrix frame). **Done**
* Plan out the path (a literal 3D line) which we \_\_\_\_ the robot to follow between set points (this will be achieved in practice using the RMRC A to B function). Then, for area’s where we must calculate the robot’s position (e.g. depending where the book goes), plan out a 3D path which is a function of the desired location. This could, for example, make the robot move from a set point to a calculated transform (and back) in order to place the book. **Nhan**
* Create the 3D models for the robot (HansCute), and figure out the PlotAndColour() function in the robot constructor. **Nick**
* Within the RMRC function, figure out *the best* way to plot a qMatrix of the robot (not what I (Patrick) did for A1, where I recursively called plot3d over and over). **Done**
* Add 3D modelling for signage and barriers. Design the workspace setup [Make it look like a library(ish) wish other shelves, coloured ground, etc. Make the robot sit on a table, which is fenced off. Have the e-stop nearby. Use a method to detect if a person (arm, head, etc) enters the robots workspace, and trigger the ‘collision detection’ emergency stop procedure. **Done - Nick**
* Include a Matlab graphical user interface (GUI) to interact with the system. The GUI should have advanced “teach” functionality that allows jogging the robot. It should include both individual joints.movements (like the Toolbox’s “teach”) plus enable [x,y,z] Cartesian movements. **Nick**
* Watch an example video of what is due in week 11. Is it the complete system? Is it simply a well put together video of the robot in action?
* Organise a day to come into uni and record the real robot, moving the books. Therefore beforehand we need to make physical (cardboard or something similar) books to be moved by the robot. Also, we should make shelves? Discuss with tutors…
* Once some more of the above is implemented, we should add visual servo-ing for the placement of the book within the shelf (i.e. the book has to move perfectly in a straight line, into the slot).

To-do this week (04/05/2022)

* Collision detection and avoidance, including moving book (is this necessary?) **Patrick**
* Move other function into class (over time) **Patrick**
* Complete GUI **Nick**
* Complete environment and robot model **Nick**
* Fix RMRC to go from an initial q position to a desired transform B. **Nhan**
* Fix up ‘object’ class (for mesh and display of object) **Patrick**
  + Done, however we need a way to rotate the object being plotted (as of now only xyz are inputted).
* Make a function for animation (of both the robot and books). **Patrick** 
  + Assumes that qMatrix has already been checked for collision
  + Need to figure out how to animate the book
* Make a basic script. **Patrick**

To-do after video 1

* Add visual servoing (camera on robot arm, to allow smooth movement of book into shelf).

Roadmap – get to end of the week, and see what we can do, then make video editing.

To-do 11/5/2022

* Make video

# Starter script (for video 1)

|  |  |
| --- | --- |
| **Script** | **Video** |
| Hi, and welcome to the initial phase testing and demonstration of our newest innovation, the library Bot. **(Patrick)** | Our logo |
| Our system is capable of moving books to and from shelves within a library setting. It uses E-tag sensing to determine the identity of any given book, allowing the robot to move the book to and from any desired shelf location. Furthermore, the user has the option to directly control the robot through our graphical user interface. **(Patrick)** | pictures of GUI, technical diagram of robot, eTag. |
| using the hans cute robot with 7 dof with integrated RMRC will allow a smooth and steady placement of book and of course with collision detection during the process. The visual servoing at the end effector will prevent damaging the book. **(Quang)** | Footage of RMRC in action. |
| In addition to collision avoidance, the robot will enter a safety shutdown mode upon any unexpected collisions. Additionally, despite the robot operating within a clearly marked safety zone, the use of thermal cameras will detect if anyone comes too close, triggering the safety shutdown mode. And to top it all off, there are emergency stop buttons located on the control panel, which allow for immediate termination of the robot. **(Dihn)** | A video of the library bot moving a book to a shelf, or vice versa. Make note of the camera and safety button.  \*Need to add camera and button\* |
| The future of book management is here, and it’s name is libraryBot **(Quang)** | Video fades to a logo of our bot(?) |
|  |  |
|  |  |
|  |  |
|  |  |

|  |  |  |
| --- | --- | --- |
| **Top view of setup** | | |
|  | Shelf 3 |  |
| Shelf 1 | Robot | Shelf 2 |
|  | Table |  |

Animation for video 1:

1. Begin in 0 pose (straight up). We move to in front of the table, then carefully grab the book. We then move this book to shelf 1 middle, and deposit. We then grab the other book on this shelf, and move it back to the table.
2. asd

# Main loop structure

1. We are initially at q = zeros(7). We will move to our first position when needed (positions are comprised of lower/upper/mid combined with shelf1/2/3/table.
2. Each book has a status (on shelf or on table), and location (transform). Using the GUI (i.e. methods in the MAIN class) we can choose to move any book to either storage (its shelf location), or the table. Each book will have a designated table and shelf location, pre-allocated (a transform).
3. There should therefore be 6 ‘action’ classes. 3 for retrieving, and 3 for putting away. Note, that triggering a put away action will return the appropriate error (something like ‘book already stored’ or ‘book already retreived’).
   1. We need 2 functions for moving the end effector. One with the book in hand (i.e. the book moves with the robot), and one without.
   2. Each of these functions should do something like this: A picture containing website

      Description automatically generated(make sure to check for estop on plotting)
4. MAKE SURE we are always updating qCurrent inside the robot model

# Code structure (needs updating)

Hans cute class:

|  |  |  |
| --- | --- | --- |
| Create robot (constructor with base location) | **Done** | HansCute(baseLocation) where baseLocation is a transformation matrix (can be left blank, to default to 0,0,0). |
| Set base location (alternative to above) | **------** | Already a model.base() function by default |
| Get current end effector position (fkine) | ------ | model.fkine(q) |
| Grab function (for end effector) | ------ | Self.gripperBool = true/false |
| Get grab status | ------ | Self.griperBool (returns true or false) |
| Get position of EVERY joint (useful for collision detection) |  |  |
| Set joint limits | ------ | Done within class constructor, in DH params |
| Collision detects with surface (input surface [by vertexes?]) (iterative to check every line of each robot arm, with each surface) |  |  |
| Stop robot movement |  | Function which stops robot movement. Used for both collision and estop. Therefore, one variable is for the stop function, and another indicates whether it was a collision or estop. |
| Move from point A to B in a linear fashion. MUST obey some predefined joint limits (defined within the function), and constantly be checking for collisions. Use RMRC |  |  |
| Start operation of robot. The flags for collision must be off for this |  |  |

Graphical user interface, text, application, letter

Description automatically generated

Graphical user interface, text, application, email

Description automatically generated

**Collision detection process DONE**

We will take a proposed q matrix (7\*n), and check if ANY of the proposed states collide with any of the triangles (objcts).

1. Have an object to represent a rectangular prism as an object. Can be constructed either with upper and lower (opposite) corners, or a centre with x,y, and z lengths. Has a function to return vertexes, faces, and face normal.
2. Also have a means to get the transform of each link of the robot (7DOF, therefore 8 links).
3. Use lineplaneintersection.m code to check for collisions.