**DRL-Studio Doosan Object Positioning Erudition (DOPE)**

A library for DRL-Studio

ME-HMVT22-RVD

GERSA Group

***DOPE***

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09 June 2023

**DRL-Studio Doosan Object Positioning Erudition (DOPE)**

A library for DRL-Studio

By

GERSA Group

|  |  |
| --- | --- |
| Name student | Student number |
| Jimmy Scheltema | 20172419 |
| Michael van Weelde | 20071639 |
| Simon Svisčiauskas | 20168640 |
| Yannick van den Arend | 20070756 |
| Martijn van Berge Henegouwen | 19148720 |

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Coach: Mr. M.J.A.J. Schrauwen (The Hague University of Applied Science)

Client(s): Mr. P.R. Fraanje (Lectorate Smart Sensor Systems)

Mr. T. Castelijn (The new makers)

Location: Delft, Rotterdamseweg 137

Department(s): ME-HMVT22-RVD

Involved stakeholder(s): The Hague University of Applied Sciences

Lectorate Smart Sensor Systems

The New Makers

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***DOPE***

|  |  |  |
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# README

## Overview

Normally a Doosan cobot is programmed with the software developed by Doosan (DART-studio). This software however is behind a paywall. This library is developed with freeware in mind. That is why this library has been made with DRL-Studio.

The goal of the DOPE library is to simplify future development of code for Doosan cobots. Functions in this library are meant to be as generic as possible so that they can be reused by other users for their own applications. The DOPE library is meant to be expanded by future contributions.

The DOPE library is specifically meant to be used with the Doosan cobots. However some of the mathematics performed by the functions in this library might be useful for other robotics applications.

## Used technology

As mentioned before the DRL-Studio was used for the development of this library. For the Doosan cobot to work with DRL-Studio some additional steps are needed. For example a Homberger hub needs to be available. The Homberger hub is the link between the Doosan cobot and DRL-studio.

The programming language for this library is python 3.8.

## Install

1. Download dope.py.

2. Create library folder in DRL-studio.

3. Add the dope.py to the desired library folder.

4. In your main file use import dope as dp.

## Dependencies

In combination with DRL-studio, multiple libraries were also used:

- DRCF - 2.10 (This is a library from DRL-Studio itself)

- Motion lib - 1.3.3 (internal in DRL-Studio using powerup library function)

- Numpy - 1.24.2

# Main modules

## Poscam. Position calibration modules

### Functions

#### CreateRadialPropePoints():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def CreateRadialPropePoints ( | | Centerpoint | , | posx: float[6] |
|  | | Radius: | , | float |
|  | | Points: | , | float |
|  | | IncludeCenter | =True |  |
| ) | |  |  |  |
| Creates a radial pattern of probe points around a center for Z axis probing.  The center can be included in the output array using the include center parameter. | | | | |
|  | | | | |
| **Parameters** | | | | |
| Centerpoint | Center point of planar probing array. | | | |
| Radius | Radius of probe points around center. | | | |
| Points | Number of points to generate around center. | | | |
| IncludeCenter | Include center in return array | | | |
|  |  | | | |
| **Returns** | | | | |
| PointArray | (Array containing the probe points) | | | |

#### ProbePoint():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def ProbePoint( | | ToolAxis | , | str |
|  | | Displacement | =200.0, | float |
|  | | ForceThreshold | =20.0, | float |
|  | | MoveAcceleration | =400.0, | float |
|  | | MoveVelocity | =100.0, | float |
|  | | ProbeAcceleration | =8.0, | float |
|  | | ProbeVelocity | =15.0, | float |
|  | | ReturnProbetoStart | =True | bool |
| ) | |  |  |  |
| Moves the toolhead [Displacement] mm's in X,Y,Z cardinal directions relative to the base and returns the final location if the threshold was reached. If ReturnProbetoStart is set to true the probe will return to its starting location after probing. | | | | |
|  | | | | |
| **Parameters** | | | | |
| ToolAxis | The movement direction ["X","Y","Z"]. | | | |
| Displacement | The distance we move before we consider the probing failed. | | | |
| ForceThreshold | The maximum measured Force before move is considered complete. | | | |
| MoveAcceleration | The acceleration of the return movement. | | | |
| MoveVelocity | The velocity of the return movement. | | | |
| ProbeAcceleration | The acceleration of the probing movement. | | | |
| ProbeVelocity | The velocity of the probing movement. | | | |
| ReturnProbetoStart | [True-> return movement enabled, False-> return movement disabled]. | | | |
|  |  | | | |
| **Returns** | | | | |
| ProbePos | Tool position-> Force threshold reached. | | | |
| None | Final position reached. | | | |

#### ProbeYaw():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def ProbeYaw( | | ProbePointList | , | list |
|  | | DisplacementX | =-200, | float |
|  | | DisplacementY | =200, | float |
|  | | ForceThreshold | =20.0, | float |
|  | | MoveAcceleration | =400.0, | float |
|  | | MoveVelocity | =100.0, | float |
|  | | ProbeVelocity | =15.0, | float |
|  | | ProbeAcceleration | =10.0, | float |
|  | | Z\_off | =100.0 | float |
| ) | |  |  |  |
| Probes panel sides 4 times and returns Coordinates of probed points. | | | | |
|  | | | | |
| **Parameters** | | | | |
| ProbePointList | Probe starting points. | | | |
| DisplacementX | The distance we move in X direction. | | | |
| DisplacementY | The distance we move in Y direction. | | | |
| ForceThreshold | The maximum measured Force before move is considered complete. | | | |
| MoveAcceleration | The acceleration of the return movement. | | | |
| MoveVelocity | The velocity of the return movement. | | | |
| ProbeVelocity | The velocity of the probing movement. | | | |
| ProbeAcceleration | The acceleration of the probing movement. | | | |
| Z\_off | Approach of probe starting points offset in Z direction. | | | |
|  |  | | | |
| **Returns** | | | | |
| ProbedLocations | (ProbedLocations - posx: float[6] list) | | | |

#### ProbePlane():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def ProbePlane( | | ProbePointList | , | list |
|  | | ToolAxis | ="z", | str |
|  | | Displacement | =-200, | float |
|  | | ForceThreshold | =20, | float |
|  | | MoveAcceleration | =50.0, | float |
|  | | MoveVelocity | =100, | float |
|  | | ProbeAcceleration | =10.0, | float |
|  | | ProbeVelocity | =15.0 | float |
| ) | |  |  |  |
| Measures the probe height at each probe point and returns the measured points in an array. At least three points which aren't in line with one another must be given to determine a plane otherwise the results will not be accurate. | | | | |
|  | | | | |
| **Parameters** | | | | |
| ProbePointList | list[>2] - Array containing posx: float[6] positions to determine plane alignment minimum. | | | |
| ToolAxis | The movement direction. | | | |
| Displacement | The distance we move in the given ToolAxis. | | | |
| ForceThreshold | The maximum measured Force before move is considered complete. | | | |
| MoveAcceleration | The acceleration of the return and movement. | | | |
| MoveVelocity | The velocity of the return and movement. | | | |
| ProbeAcceleration | The acceleration of the probing movement. | | | |
| ProbeVelocity | The velocity of the probing movement. | | | |
|  |  | | | |
| **Returns** | | | | |
| (float Roll, float Pitch, posx: float[6] FinalProbeLocationList)-> Force threshold reached, None -> Final position reached. | | | | |

#### CompYaw():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def CompYaw( | | ProbePointList |  | list |
| ) | |  |  |  |
| Calculates a yaw angle of the first measured side and returns the result in degrees. | | | | |
|  | | | | |
| **Parameters** | | | | |
| ProbedLocation | List containing probed locations. | | | |
|  |  | | | |
| **Returns** | | | | |
| Yaw | Origin yaw. | | | |

#### CompOriginXY():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def CompOrigin( | | ProbePointList | , | list |
|  | | ProbeRadius |  | float |
| ) | |  |  |  |
| Calculates and returns origin of 2 intersection lines based on their probed locations. | | | | |
|  | | | | |
| **Parameters** | | | | |
| ProbedLocations | List containing probed locations. | | | |
| ProbeRadius | Radius of measurement probe in mm. | | | |
|  |  | | | |
| **Returns** | | | | |
| ((OriginX, OriginY): float(2) - X and Y coordinates of the origin point) | | | | |

#### CompPlane()

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def CompPlane( | | ProbedLocations |  | list |
| ) | |  |  |  |
| Calculates and returns the Roll and Pitch of the measured plane using a least squares estimation. | | | | |
|  | | | | |
| **Parameters** | | | | |
| ProbedLocations | List containing probed locations. | | | |
|  |  | | | |
| **Returns** | | | | |
| ((Roll, Pitch): float(2) - Roll and pitch of the measure plane in degrees. | | | | |

#### CalibrateByProbing():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def CalibrateByProbing( | | PlaneProbingLocations | , | list |
|  | | YawProbingLocations | , | list |
|  | | ProbeRadius | , | float |
|  | | ProbeLength | , | float |
|  | | DisplacementX | =-200, | float |
|  | | DisplacementY | =200, | float |
|  | | DisplacemenZ | =200, | float |
|  | | ForceThreshold | =20, | float |
|  | | MoveAcceleration | =50.0, | float |
|  | | MoveVelocity | =100, | float |
|  | | ProbeAcceleration | =8.0, | float |
|  | | ProbeVelocity | =15.0 | float |
| ) | |  |  |  |
| Performs planar and yaw probing using default settings on a flat horizontal object with straight edges. Computes the origin and probes its location to acquire a set height, returns A coordinate frame ID if the operation was successful, returns -1 if the operation failed. | | | | |
|  | | | | |
| **Parameters** | | | | |
| PlaneProbingLocations | List containing coordinates for planar probing. | | | |
| YawProbingLocations | list[4] - List containing 4 coordinates coordinates for yaw probing. | | | |
| ProbeRadius | Radius of measurement probe in mm. | | | |
| ProbeLength | Length of measurement probe in mm. | | | |
| DisplacementX | The distance we offset in X direction. | | | |
| DisplacementY | The distance we offset in Y direction. | | | |
| DisplacemenZ | The distance we offset in Z direction. | | | |
| ForceThreshold | The maximum measured Force before move is considered complete. | | | |
| MoveAcceleration | The acceleration of the return movement. | | | |
| MoveVelocity | The velocity of the return movement. | | | |
| ProbeAcceleration | The acceleration of the probing movement. | | | |
| ProbeVelocity | The velocity of the probing movement. | | | |
|  |  | | | |
| **Returns** | | | | |
| SettingSucess: int - [Successful coordinate setting: Set coordinate ID (101 - 200) / Failed coordinate setting : -1] | | | | |

#### ProbeCoordinateOffset():

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Function | | Parameters | Values | Datatype |
| def ProbeCoordinateOffset( | | Pointlist | , | list |
|  | | OffsetX | =0, | float |
|  | | OffsetY | =0 | float |
| ) | |  |  |  |
| Returns the coordinate(s) offset in X and Y directions by the specified probe offset. | | | | |
|  | | | | |
| **Parameters** | | | | |
| Pointlist | list or posx: float[6] - Containing coordinates to be offset. Return type is either list or posx: float[6] | | | |
| OffsetX | The distance we offset in X direction. | | | |
| OffsetY | The distance we offset in Y direction. | | | |
| **Returns** | | | | |
| (posx: float[6] CorrectedPointlist-> CorrectedPointlist type is posx, list: CorrectedPointlist of type posx: float[6]-> CorrectedPointlist type is list of type posx: float[6]) | | | | |

### Classes

#### Probe:

|  |  |
| --- | --- |
| Class | Methods |
| Probe: | ProbeCoordinateOffset(self,Pointlist) |
|  | ProbePoint(self, ToolAxis, Displacement=200, ReturnProbetoStart=True) |
|  | ProbeYaw(self, ProbePointList, DisplacementX=-200, DisplacementY=200) |
|  | ProbePlane(self, ProbePointList, ToolAxis="z", Displacement=-200) |
|  | CalibrateByProbing(self, PlaneProbingLocations, YawProbingLocations, DisplacementX=-200, DisplacementY=200,DisplacementZ=None) |
| A class containing compiled methods for easier probing and setting of probe offsets and data. | |
| **\_\_init\_\_(): S** | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | Function | | Parameters | Values | Datatype | | def \_\_init\_\_( | | self | , | self@Probe | |  | | ProbeRadius | , | float | |  | | ProbeLength | , | float | |  | | ForceThreshold | =20, | float | |  | | MoveAcceleration | =50.0, | float | |  | | MoveVelocity | =100, | float | |  | | ProbeAcceleration | =8.0, | float | |  | | ProbeVelocity | =15.0, | float | |  | | ClearanceZ | =100.0, | float | |  | | OffsetX | =0.0, | float | |  | | OffsetY | =0.0 | float | | ) | |  |  |  | | Returns the coordinate(s) offset in X and Y directions by the specified probe offset. | | | | | |  | | | | | | **Parameters** | | | | | | self |  | | | | | ProbeRadius | Radius of probe | | | | | ProbeLength | Length of probe (Z height offset) | | | | | ForceThreshold | The maximum measured Force before move is considered complete | | | | | MoveAcceleration | The acceleration of the return movement | | | | | MoveVelocity | The velocity of the return movement | | | | | ProbeAcceleration | The acceleration of the probing movement | | | | | ProbeVelocity | The velocity of the probing movement | | | | | ClearanceZ | Height to move above material when attempting to maneuver | | | | | OffsetX | Probe X direction offset | | | | | OffsetY | Probe Y direction offset | | | | |  |  | | | | | **Returns** | | | | | | (posx: float[6] CorrectedPointlist-> CorrectedPointlist type is posx, list: CorrectedPointlist of type posx: float[6]-> CorrectedPointlist type is list of type posx: float[6]) | | | | | | |
|  | |