Lab 2: Dobot Magician Lite: Pick & Place

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***Abstract*—This lab focuses on implementing robotic pick-and-place operations using the Dobot Magician Lite. The objectives were to gain practical experience with suction and gripper end effectors, program motion sequences through Python and the pydobot library, and evaluate coordinate accuracy through teaching and point adjustments. Both end effectors were tested to compare performance in handling objects. The lab provided hands-on insight into motion control, accuracy considerations, and the practical trade-offs between different end effector designs.**

I. Problem Statement

Robotic pick-and-place operations are widely used in industrial and research applications, but their effectiveness depends heavily on the choice of end effector and the accuracy of motion execution. The challenge arises in determining how different end effectors, such as suction cups and grippers, perform when handling objects of varying shapes, sizes, and surface properties.

Additionally, ensuring precise motion sequences requires accurate teaching of points and correction of positional errors. This lab addresses these challenges by programming the Robot Magician Lite to perform pick-and-place tasks using both suction and gripper end effectors, with the goal of analyzing their performance and evaluating the accuracy of robot motion control.

II. Procedure

A. Suction Cup End Effector

The suction cup end effector was attached to the Dobot Magician Lite. Using a sample python program, the movement of the Dobot was tested.

Then, the pallets were placed on the table and taped to prevent them from moving during the experiment. Using a python script, a safe home position was established for the Dobot. An intermediate position was also established for the Dobot to return to after it picked and dropped the block. Then, the position of the first block and its end position were coded into the python script. The same steps were followed for all the other blocks. The start and end positions of all 4 blocks are recorded in Table 1 and Table 2.

The Dobot picks a block from its position on the first pallet, and places it in the same corner on the other pallet using the suction cup end effector and returns to the intermediate point. After all 4 blocks are transferred to the second pallet, they are again picked and placed back onto the first pallet, their original start positions.

The *.suck()* function was used to enable and disable suction at the pick and drop points. The *time.sleep()* function was used to enact a delay while picking and dropping blocks. Utilizing the time package, the script also prints the cycle time on the terminal. By playing around with the order of the blocks being picked and dropped, we were able to decrease the cycle time of the entire experiment.

Using the variable *z_lift*, a safe height of 50 is defined for the intermediate point. This allows the Dobot to rise above the block after picking and dropping the block.

Using a time delay function of 2 seconds, we were able to get the suction to turn on in time to pick up the block and get it to shut off in time to drop it off correctly. We tried the suction cup on other items (pen, pencil), but when the weight of the object increased, the suction cup could not pick the object or did not place it accurately.

Table 1 (First pallet to second pallet)

	x (start)	y (start)	z (start)	x (end)	y (end)	z (end)	r
Block 1	270	-10	-45	270	-98	-45	0
Block 2	270	46	-45	270	-40	-45	0
Block 3	330	46	-45	330	-40	-45	0
Block 4	330	-10	-45	330	-98	-45	0

Table 2 (Second pallet to first pallet)

	x (start)	y (start)	z (start)	x (end)	y (end)	z (end)	r
Block 1	270	-98	-45	270	-10	-45	0
Block 2	270	-40	-45	270	46	-45	0
Block 3	330	-40	-45	330	46	-45	0
Block 4	330	-98	-45	330	-10	-45	0

B. Gripper End Effector

The gripper end effector was attached to the Dobot Magician Lite. Using a sample python program, the movement of the Dobot was tested.

Then, the pallets were placed on the table and taped to prevent

them from moving during the experiment. Using a python script, a safe home position was established for the Dobot. An intermediate position was also established for the Dobot to return to after it picked and dropped the block. Then, the position of the first block and its end position were coded into the python script. The same steps were followed for all the other blocks. The start, end positions and rotation angle for all 4 blocks are recorded in Table 3 and 4.

The Dobot picks a block from its position on the first pallet, and places it in the same corner on the other pallet using the gripper end effector and returns to the intermediate point. Since the pallets are taped and the Dobot is unmoved, the positions of all the blocks are the same from the suction cup experiment, except for the *z* variable, which changed due to the gripper end effector being significantly longer than the suction cup end effector. Also, since the gripper end effector has three prongs, it picks the block in a rotated position, and places it incorrectly. To tackle this, the *r* variable was also defined for all drop positions to place the blocks correctly onto the pallet. After all 4 blocks are transferred to the second pallet, they are again picked and placed back onto the first pallet, their original start positions.

The *.grip()* function was used to enable and disable the gripper at the pick and drop points. The *time.sleep()* function was used to enact a delay while picking and dropping blocks. Utilizing the time package, the script also prints the cycle time on the terminal. By playing around with the order of the blocks being picked and dropped, we were able to decrease the cycle time of the entire experiment.

Using the variable *z_lift*, a safe height of 50 is defined for the intermediate point. This allows the Dobot to rise above the block after picking and dropping the block.

We tried the gripper on other items (pen, pencil), and compared to the suction cup, the gripper was able to pick and place other objects with more precision.

Table 3 (First pallet to second pallet)

	x (start)	y (start)	z (start)	x (end)	y (end)	z (end)	r (end)
Block 1	270	-10	-12	270	-98	-10	5
Block 2	270	46	-12	270	-40	-10	5
Block 3	330	46	-12	330	-40	-10	5
Block 4	330	-10	-12	330	-98	-10	5

Table 4 (Second pallet to first pallet)

	x (start)	y (start)	z (start)	x (end)	y (end)	z (end)	r (end)
Block 1	270	-98	-12	270	-10	-10	10
Block 2	270	-40	-12	270	46	-10	10
Block 3	330	-40	-12	330	46	-10	10
Block 4	330	-98	-12	330	-10	-10	10

III. RESULTS

The Dobot successfully executed the pick-and-place tasks using both the suction cup and gripper end effectors. The Dobot demonstrated consistent accuracy when moving between predefined coordinates, though minor deviations were observed in repeated trials.

The experiment showed the differences in the performance of the different end effectors. The suction cup showed more accuracy in picking and placing, whilst also completing the whole cycle faster than the gripper. The gripper showed better reliability in securely holding items but required rotation alignment to place the blocks correctly, therefore increasing the total cycle time.

We were able to reduce the cycle time for both the end effectors by trying different pick-and-place patterns. Table 5 below shows the different times for each cycle.

Table 5: Times for each end effector

	Initial cycle	**Second cycle**	**Third cycle**
Suction Cup	119 seconds	115 seconds	110 seconds
Gripper	120 seconds	115 seconds	114 seconds

Overall, the Dobot was able to complete the intended operations, validating the programmed motion sequences while highlighting the importance of calibration and end effector selection for task-specific performance.

IV. REFLECTIONS

The experiment proved essential in learning how to guide the Dobot through its pick-and-place tasks. To achieve accurate motion sequences, multiple points had to be taught and adjusted, with corrections required to place the blocks correctly. This highlighted the iterative nature of robot programming, where precise calibration plays a key role in task success. The process reinforced the importance of systematically teaching points to minimize errors and ensure consistent execution.

The programming was achieved with 100 lines of code, though it became evident that efficiency could be improved, and then reduced it to just above 65 lines. Repetitive sequences have been reduced through the use of arrays and loops, which made the code efficient.

When comparing end effectors, the gripper was more reliable overall. While the suction cup was effective on smooth, flat surfaces, it failed with rough surfaces and inconsistent points

of contact. The gripper, however, provided consistent gripping across a wider variety of objects, though careful alignment was required to complete the experiment. These variations demonstrated in a clear manner how object type impacted success rates and how it was important to select the proper end effector for the task.

In general, the experiment highlighted the interplay between hardware selection, programming efficiency, and calibration accuracy in achieving dependable robotic manipulation.

V. CONCLUSION

In conclusion, the experiment successfully demonstrated the Dobot's capability to perform pick-and-place operations while highlighting the practical considerations required for reliable robotic manipulation. The process of teaching points, adjusting paths, and refining code revealed the importance of precision and efficiency in both programming and calibration. The comparative evaluation of the suction cup and gripper showed that end effector must be chosen according to object type, with the gripper proving more versatile across varied shapes.

Overall, the experiment emphasized that effective automation depends on a careful balance between hardware selection, software optimization, and iterative testing, all of which are critical skills for real-world applications in robotics and industrial automation.

VI. TECHNICAL SPECIFICATIONS

Robot Name: Dobot Magician Lite
Robot Serial Number: DT-MGL-4R002-01E
Repeatability: ±0.2mm
Maximum Payload: 0.25kg
Maximum Reach: 340mm
End Effector: Suction Cup, Gripper Hand
Software Platform: Python
Safety Features: Collision Detection

VII. CODE AND VIDEO

Video for the suction cup end effector:
https://youtube.com/shorts/bz40owsR9jM?feature=share

Video for the gripper end effector:
https://youtu.be/pUQqh0UVLkA

Repository Link:
https://github.com/VarunPro23/RAS/tree/main/Lab%202

Repository content:

- *lab2_suction.py* – code for the suction cup end effector
- *lab2_gripper*.py – code for the gripper end effector