The project of "Diagnostics lab automation" which is to be implemented in the Anand Diagnostics Laboratory is aimed at automating the process of archiving. After the sample is tested, the sample is stored for a fixed time period in cold storage, for re-tests and review. The test tubes are scanned in an LIS mapping each sample to a specific position in the corresponding tray whose code is also recorded, enabling one to trace back. The transfer is completed only if all tests assigned to the given sample have been completed.

The process of scanning and transferring the test tubes is currently being done manually. Our task is to automate the process reducing human intervention effectively reducing error. The task is set to be performed by a robotic arm with 5DOF. Image processing has been used to make the process efficient by reducing the number of work cycles to the number of test tubes present.

Dobot manipulation

1. Determination of co-ordinates of all slots
2. Reading matrix to locate slots in which test-tubes are present
3. Pick and place
4. Test tube manoeuvre to scan barcode.

DOBOT Magician is a multifunctional small-sized desktop robotic arm for practical training education, deploying multiple functions, such as 3D printing, laser engraving, etc. It has 4-axes of motion and 5 Degrees of Freedom. <insert images>

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| Module | Version |
| Dobot Studio | 1.9.4 |
| Dobot Firmware | 3.7.0 |

The CP210x USB to UART COM Port driver was used for device operation. In this project, we have used we have used the suction cup and air pump given in the kit for orientation, pick and place operations. The signal (SW1 and GP1) and power lines of the pump were connected to the Dobot via EIO Extended I/O) pins located at the base of the machine. The suction was interfaces with those on the forearm (slot1/GP3) articulated to Joint 4.

The controls were handled using the python script editor IDE provided in Dobot Studio. For additional python operations, the required library modules were added to the Ide path of Dobot Studio.

1. Determination of co-ordinates of all slots

Given that the Dobot was capable of linear motion in the x, y and z axes, with 1 unit movement being about 0.35mm, we provided the coordinate values of the left-top most slot anointing it as the origin(ox,oy). Additionally the slot interval of 21 units for x and y axes were also provided. With the given information, the Dobot was able to compute the co-ordinates of any slot using indeces provided.

x , y= ox+(i\*ds), oy+(j\*ds )

where x and y are co-ordinate values of the slot, ox and oy origin co-ordinates, ds the distance between slots being 21 units. For the movements of the z axes, the risen position for which the test tube is not an obstruction and lowering height at which it is securely placed for the given setup are provided and used via flagging.

2.Reading matrix to locate slots in which test-tubes are present and pick place

Reading the binary matrix which has been generated by the image processing segment, the indices of all the slots where a test-tube is present is noted. My methods mentioned in the section above, the co-ordinates of the test tube is determined and test tube is picked up using the suction module. After the scanning mentioned in section (3) is completed, the tubes are places in an adjacent tray using the same co-ordinate mapping mechanism mentioned above.

3.Test tube manoeuvre to scan barcode.

The scanner (Retsol LS500 barcode scanner) is a commercial scanner which can scan codes present virtually in front of it. In order to ensure the barcode (which is present on a single side of the tube) is captured, the joint4 directly abouve the suction cup is made to rotate in steps till the barcode is duly noted. Upon successful scan, the sample is placed in the destination rack.

Integration

The matrix generated by the image processing segment is written into a .txt file and retrieved by the Dobot Studio IDE using file handling. This is done in order to ensure persistence of data. In order to ensure compatibility, the required library modules were added to the Ide path of Dobot Studio. The three modules namely, image processing, barcode scanning and LIS access are integrated using modularity of python by importing them in cascade and then calling the required functions.