GRADUATE CERTIFICATE INTELLIGENT REASONING SYSTEMS

PROJECT REPORT

Cognitive robots to imitate human action using knowledge base system

GROUP MEMBERS

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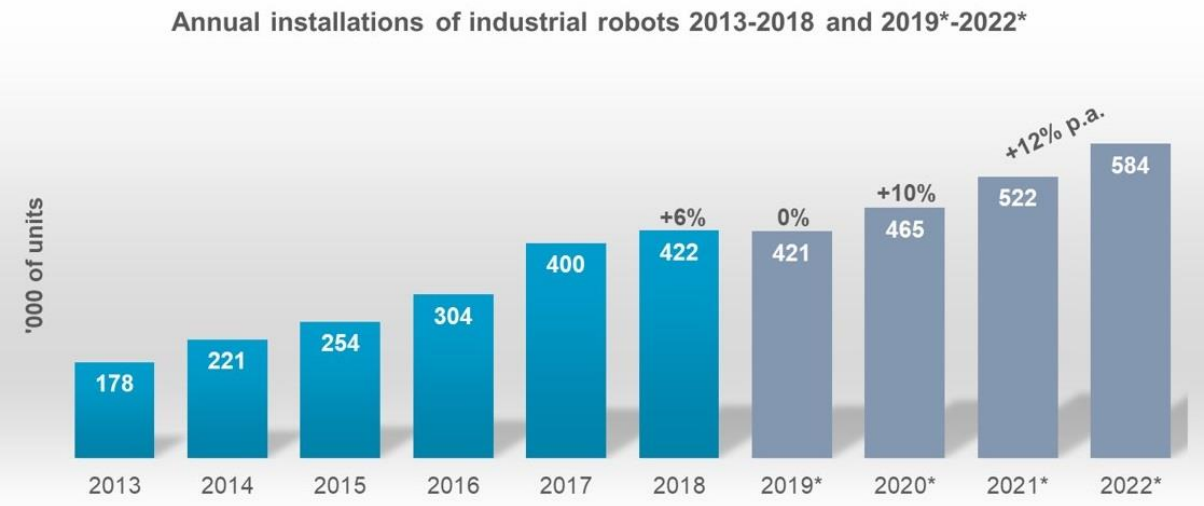
1. Introduction

In recent years with artificial intelligence (AI), it has been shown that the usability of machines is enhanced when they become capable to process data, finding patterns, and suggesting proper actions. In this project, a model for semantic memory is used that allows machines to collect information and experiences to become more proficient with time. By analysing the image data, the processed information is stored in the knowledge graph which is then used to comprehend the work instructions expressed in natural language. This imparts industrial robots' behaviour to execute the required tasks in a deterministic manner.

2. Market Research

Smart robot system needs to cover a large spectrum of applications. Industrial robots are made to do complex tasks in factories. A typical industrial robot application, robots include welding, painting, assembly, disassembly, placing for printed circuit boards, labeling, palletizing, product inspection, and testing; all accomplished with high endurance, speed, and precision. In the year 2020, an estimated 1.64 million industrial robots were in operation worldwide according to the International Federation of Robotics. Robots are a kind of technology that is used nowadays these had entered into each and every field such as Agriculture, industry, medicine, technology, and traveling.



3. Business Justification

A lot of research is based on the use of neural networks and especially deep learning methodologies. These methods allow the robot to learn tasks in a way close to human learning but only for specific purposes. In an industrial environment, robots need to process work instruction, extract information and execute requested tasks consistently. The problem considered is to give a robot the ability to process a work instruction for an operator, extract information and execute the requested tasks.

Programming these robots or replicating their tasks onto another robot requires a lot of effort. A typical robotic application requires a specialist to break down the complicated task into smaller sub-tasks and actions. The expert writes detailed instructions in the form of robot programs to make the robot accomplish the desired task. This process needs a high level of expertise and is time-consuming. With the shortages in skilled manpower and resources to train the workforce, it is important we need to capture the factory process into a knowledge base system. The future factory automation process will depend on the task-oriented knowledge graph

4. Project Objective

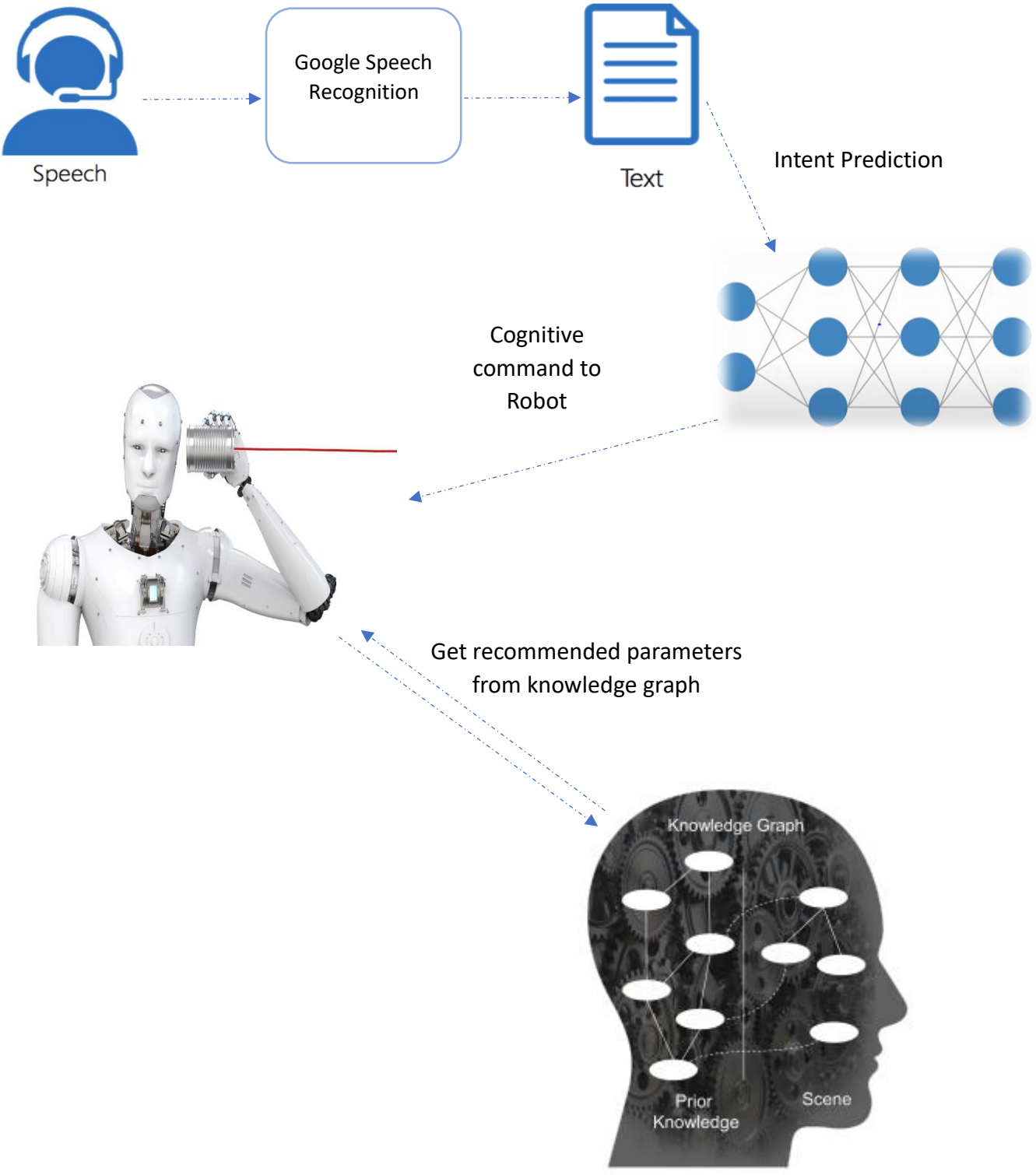
The project focuses on making use of machine reasoning and cognitive reasoning methods to create a knowledge base for articulated robots.

4.1 System Design

The system will be listening to the user input using google speech recognition. The text is sent trained neural network model to predict the intent. The predicted intent is sent to the robot to perform the requested task by the user.

Example: If the user says, “please pick red coins”. Robot will command to pick the red coloured coins available in the vision window.

To complete the action requested by user robot needs query the knowledge base for gripper width to be used for picking up the object and placement location.

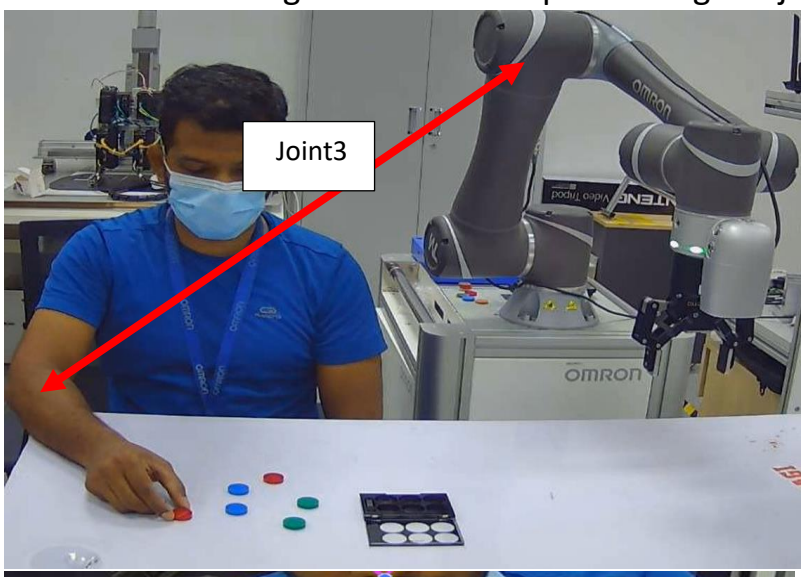

Speech
Google Speech Recognition
Text
Intent Prediction
Cognitive command to Robot
Get recommended parameters from knowledge graph
Knowledge Graph
Prior Knowledge
Scene

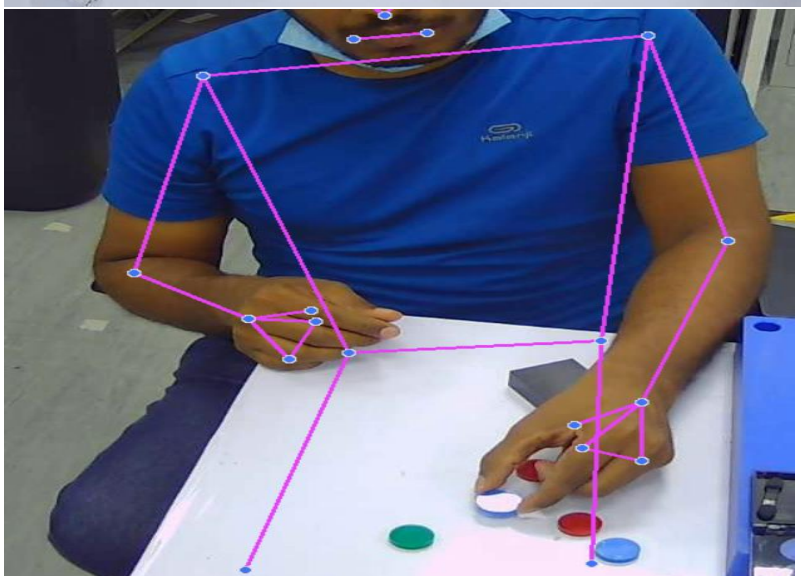
4.1 New knowledge from recorded video

Below is the list of data items which will be added to the existing knowledge graph.

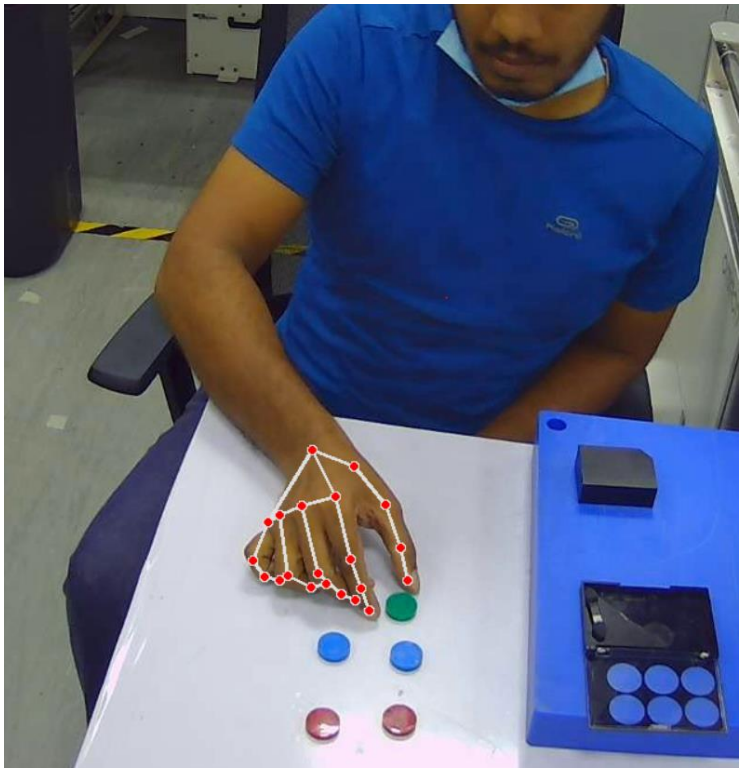
- Color of item
- Final drop-off location by human (finalX, finalY)
- Total distance the object has been moved by human (distance)
- Time taken by human to move object to its destination (cycletime)
- Speed at which object is moved by human(speed)
- Finger gap maintained when moving the object(gripper_wdith)
- Right hand elbow angle (in degrees)
- Left hand elbow angle (in degrees)

Both the elbow angles are used for positioning the joint 3 of the robot.





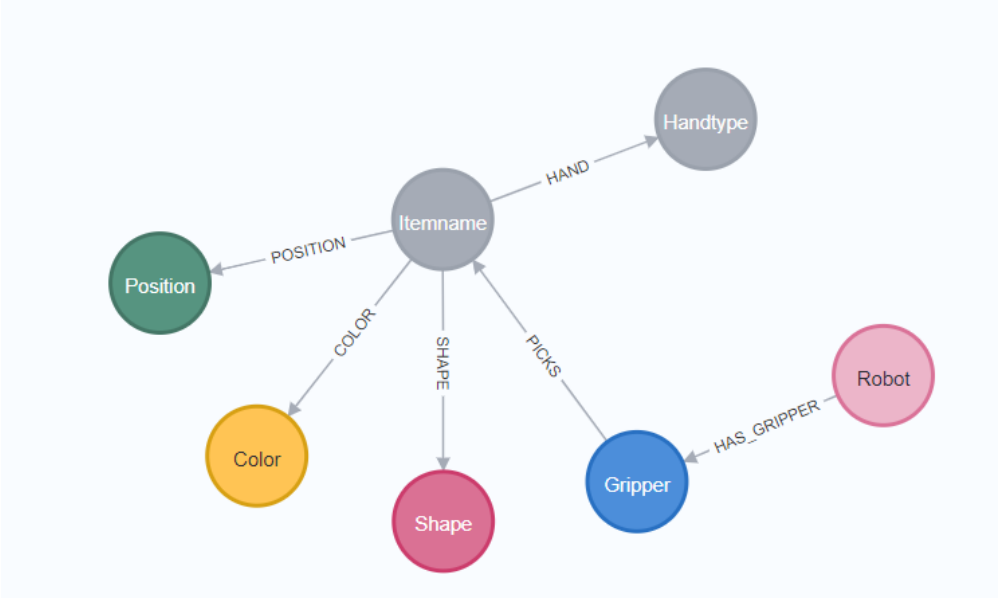
The gripper width to pick the object is determined by analyzing the distance between index fingertip and thumb tip.



Media pipe framework is being used to process the video files and get data points which will be later added to the knowledge graph system based on neo4j.

4.2 knowledge graph from expert

Below is the screenshot from neow4j data base which shows the node labels and relation types


Handtype
HAND
Itemname
POSITION
Position
COLOR
SHAPE
PICKS
Robot
HAS_GRIPPER
Color
Shape
Gripper

Appendix 1: Proposal

Date of proposal:

28 January 2022

Project Title:

ISS Project – Intelligent Cognitive robots learn by imitating human action

Sponsor/Client: *(Name, Address, Telephone No. and Contact Name)*

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Background/Aims/Objectives:

The proposed system will make use of various reasoning methods to create a knowledge base for the robotic arm to imitate human action.
The system will reduce the programming and training time required when deploying new robots in the factories.

Requirements Overview:

- Research ability
- Programming ability
- System integration ability

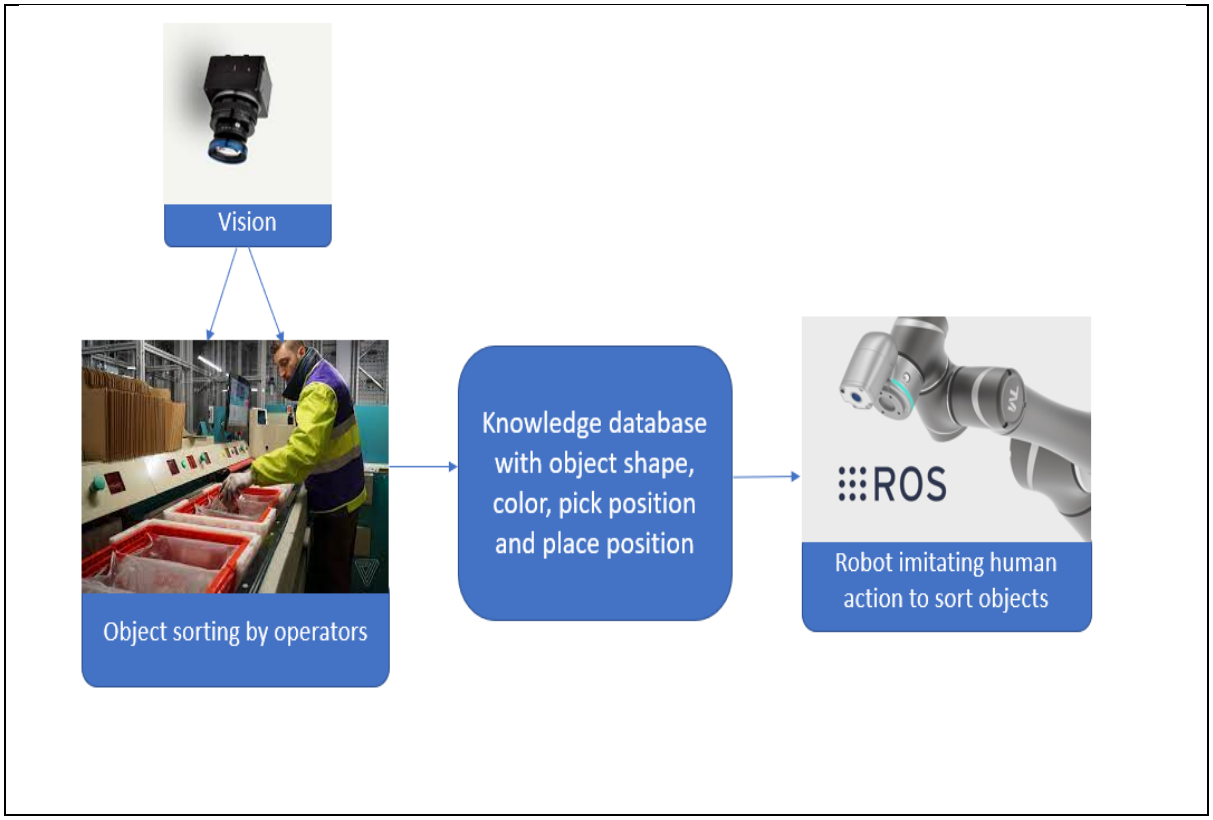
Resource Requirements (please list Hardware, Software, and any other resources)

Hardware proposed for consideration:

- GPU, Intel i7 notebook
- Omron TechMan collaborative robot
- 2D color camera

Software proposed for consideration:

- Neo4j
- Mediapipe
- Python


Vision
Object sorting by operators
Knowledge database with object shape, color, pick position and place position
ROS
Robot imitating human action to sort objects

Appendix 2:
Mapped System Functionalities

Module Courses	System Functionality / Techniques Applied
Machine Reasoning (MR)	Knowledge Representation, Rule Based System
Reasoning Systems (RS)	Analytic and Synthetic tasks
Cognitive Systems (CGS)	NLP Chatbot

Appendix 3:
Installation and User Guide

Installation:

The code can be executed from python environment. Below is the requirement file

- mediapipe
- pyttsx3
- nltk
- speechrecognition
- neo4j
- opencv-python
- tensorflow
- pyaudio

File Structure

- main.py

- bodypose_analyze.py

- handpose_analyze.py

- robotserver.py

- tp_final.py

- graphdb.py

- chatbot.py

- video.mp4

speech

- textpredict.py

- train.py

- chatbot_model.h5

- classes.pkl

- words.pkl
- intents.json

Appendix 4:
Reflection on project journey

Lessons learned:

This is an individual project. Learnt a lot from this project about First, how, and where the reasoning system will be useful in the robotics industry. Second, understood how the future of robotics knowledge will be moving towards semantics rules based.

Future:

I will be extending this project using a 3D camera in the real-world factory application in Singapore. This project gave a lot of recognition for me in my department, as the project is a mock-up of real-life events in factory environment.