

# **Towards The Development of Non-Verbal Multimodal Bidirectional Cognitive Architecture for Interactive Robot Assistant**

## **Research Proposal**

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## **1 Aims & Objectives**

### **1.1 Aims**

- The main aim of this research is to develop a basic model of cognitive architecture for a robot which is able to perceive and perform nonverbal multimodal natural interaction with human in real time. The design of proposed cognitive architecture is explained in subsection 4.1.
- The second aim of this research is to implement and analyse the performance of the cognitive architecture in a robotic system which is situated in a pick and handle scenario. In this scenario, the robot is expected to detect human attention, recognize pointing gesture from human, infer and pick human required object, and handle the object to human in an appropriate way. The details of the scenario can be seen in subsection 4.2.

### **1.2 Objectives**

- Develop four perception subsystems to recognise nonverbal communication modes from human and to sense environment condition, which are pointing gesture, eye gaze, head pose, and object recognition subsystem.
- Develop multimodal perception inference engine to process and combine all perception inputs.
- Develop kinematics engine for robotic arm and head in order to enable nonverbal multimodal feedbacks from the robot such as pointing, picking, handling, gazing, and head movement.
- Develop cognitive engine to integrate perception, planning, and actuation subsystems.
- Develop learning algorithm to improve cognitive engine based on past task execution memory.
- Setup and integrate robotic system for implementing the cognitive architecture.

## **2 Motivation**

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## **3 Literature Review**

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## **4 Basic Design**

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4.1 System Block Diagram

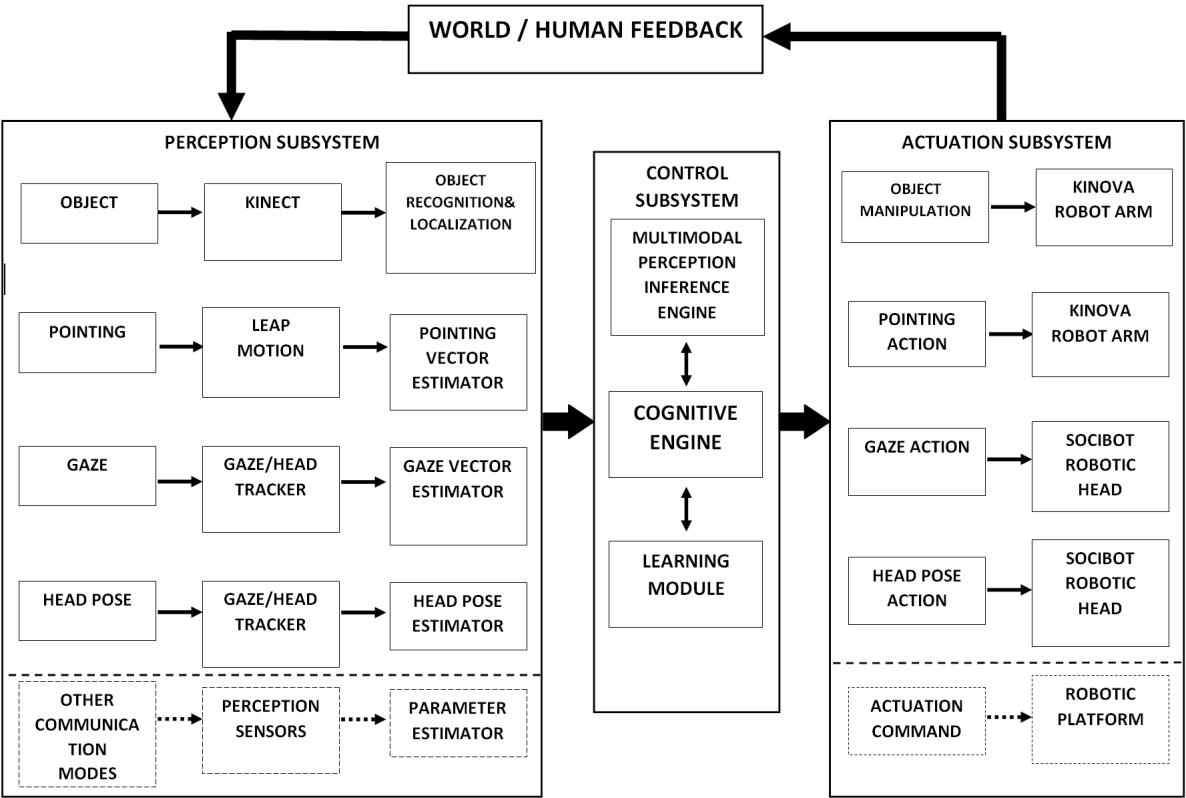


Figure 1: Cognitive Architecture Block Diagram

4.2 System Flow Diagram

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5 Risk Register

6 Time line

The table below shows proposed project timeline. The project is started from week 2 of March and will be finished on week 2 of September, so the project will take 25 weeks to finish.

7 References

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Table 1: My caption

S	Description	Perception Input				Actuation Output			
		Gaze	Head Pose	Hand Gesture	Object Recog.	Gaze	Head Pose	Hand Gesture	Object Manip.
1	Wait human attention								
2	Look into human eyes								
3	Wait pointing gesture								
4	Look at the direction of pointing gesture								
5	Infer required object								
6	Point to inferred object								
7	Look into human eyes								
8	Wait for human confirmation. If nod, continue to step 9, if shake, return to step 3, if timeout or losing attention, return to step 1.								
9	Look to the object and pick object								
10	Bring object toward the direction of human								
11	Look into human eyes								
12	Wait for open palm gesture (human hand reaching toward object). If detected, go to step 14, if timeout or losing attention go to step 13.								
13	Look to object and put object on that location								
14	Look to object and bring object closer until on top of the hand								
15	Look into human eyes								
16	Wait for human confirmation. If nod, continue to step 17, if hand is withdrawn and timeout, go to step 13								
17	Look to the object, release the object, return to step 1								

Table 2: Risk register ranking

Risk	Mitigation	Like lihood	Im pact	Score
Implementation failure of the proposed method in one or more subsystem	Build and test subsystems as early as possible, so that the methods can be changed if they fail. Plan to implement more than one method for each subsystem	3	2	6
Scenario is too complex for the robot to be achieved	Finish the development stage as soon as possible so that we can improve the system if it cannot achieve desired scenario. If this option fails, simplify the scenario, without sacrificing the purpose of experiment.	3	2	6
Failure of perception sensors that are going to be used for experiment	Order more than one set of perception sensor for each mode of nonverbal communication	2	3	6
Late arrival of ordered perception sensors	Order the sensors as soon as possible and borrow the sensors from other researchers as a backup plan (the sensors are widely used at BRL)	2	2	4
Failure of robotic platform that is going to be used for experiment	Use robotic platform that is available more than one set in BRL. If not possible, use robotic platform that have similar type and features with the primary one as a backup	1	4	4

Table 3: Project Timeline

	W E E K S																								
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Project KickOff																									
Literature Review																									
Project Planning Basic Design																									
Develop and Test Perception Subsystems, Order Sensors.																									
Develop and Test Control Subsystems																									
Develop and Test Actuator Subsystems																									
System Integration																									
Run Scenario																									
Write Up																									