An Embodied Robotic Agent Learning Affordances with Intrinsic Motivations and Solving Extrinsic Tasks with Developmental Learning

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Declaration

I, *Fawwad Hassan Jaskani* declare that this thesis titled "An Embodied Robotic Agent Learning Affordances with Intrinsic Motivations and Solving Extrinsic Tasks with Developmental Learning" and the work presented in it are my own and has been generated by me as a result of my own original research.

I confirm that:

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3. Where I have consulted the published work of others, this is always clearly attributed
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Fawwad Hassan Jaskani,

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This thesis is dedicated to *my beloved parents*

Abstract

Robot has gained an acceptable entity in modern world because it integrates sensors, actuation and intelligence phenomena's. The modern world robot not only perform in industry for difficult, dirty and dangerous task, it also assist in human robot Interaction Tasks. The modern robot adopts AI based designs to perform in unstructured world. Cognitive Developmental Robotics (CDR), which exists at the intersection of robotics and cognitive science, neuroscience and developmental psychology, is an innovative approach for design of cognitive robots. This approach has interdisciplinary characteristics and aims to tackle limitations that exist in current robot design. By following CDR principle, cognitive robotics concentrates on design of artificial architectures and computational models in which cognitive agents/robots higher order behavior is emerged from development and layered on former ability. The main methodologies of this approach are development learning and grounded cognition. The Consideration of these two methodologies in design of robot enables it for general tasks: Human Robot Interaction, Surgical robotics, Space exploration, Human subject centered studies (Neuroscience and psychology), Agriculture robotics

Keywords: *Robotics, Cognitive Science, Developmental Learning, Intrinsic Motivation, Extrinsic Motivation*

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Abbreviations

LIS	Locked-in Syndrome
QoL	Quality of Life
BCI	Brain-computer Interface
EEG	Electroencephalography, Electroencephalographic
NIRS	Near Infrared Spectroscopy

Chapter 1

Introduction

1.1 Overview

Robot has gained an acceptable entity in modern world because it integrates sensors, actuation and intelligence phenomena's. The modern world robot not only perform in industry for difficult, dirty and dangerous task, it also assist in humans (HRI human robot Interaction Tasks). The modern robot adopts AI based designs to perform in unstructured world.

Cognitive developmental robotics (CDR), which exists at the intersection of robotics and cognitive science, neuroscience and developmental psychology, is an innovative approach for design of cognitive robots [1, 2]. This approach has interdisciplinary characteristics and aims to tackle limitations that exist in current robot design. By following CDR principle, cognitive robotics concentrates on design of artificial architectures/computational models in which cognitive agents/robots higher order behavior is emerged from development and layered on former ability. The main methodologies of this approach are development learning and grounded cognition. The Consideration of these two methodologies in design of robot enables it for general tasks: HRI, Surgical robotics, Space exploration, Human subject centered studies (Neuroscience and psychology), Agriculture robotics

1.2 Neuroscience

Neuroscience is the study of nervous system with deals with biological and psychological phenomenon. It deals with the understanding of complexity of neurons, reactions of the body against any incident. It deals with the consciousness of human beings and the psychological behavioral models.

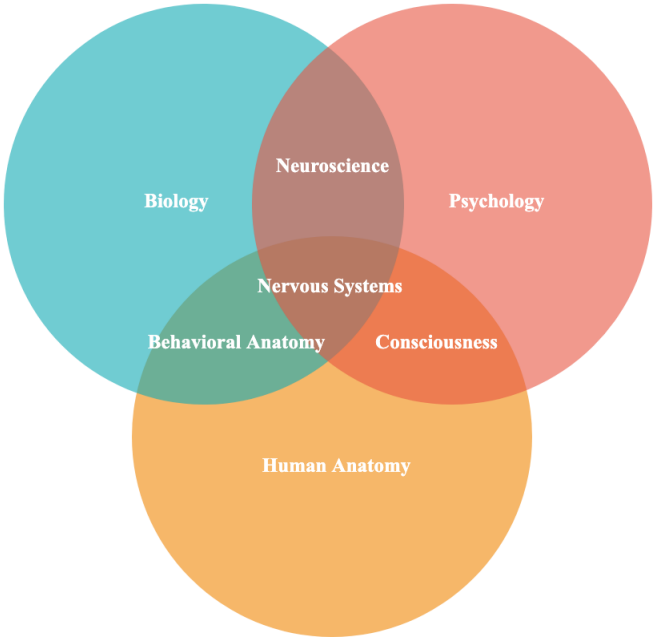

Figure 1.1: Neuroscience and its relation with other discipline of sciences

1.3 Cognitive Robotics

Cognitive Robotics deals with the study to enhance an ability in robot to think with intelligent behaviour in order to learn and find a reason to behave in the complex environment and how to deal with complex goals.

1.4 Intelligent Agents

Intelligent agents refer to the intelligent program or a machine, which can work autonomously by gather information and take decisions by having a prior knowledge or not. It works autonomously. Learns from environment by reinforcement learning with adaptive nature. It learns from past experiences and complete goals.

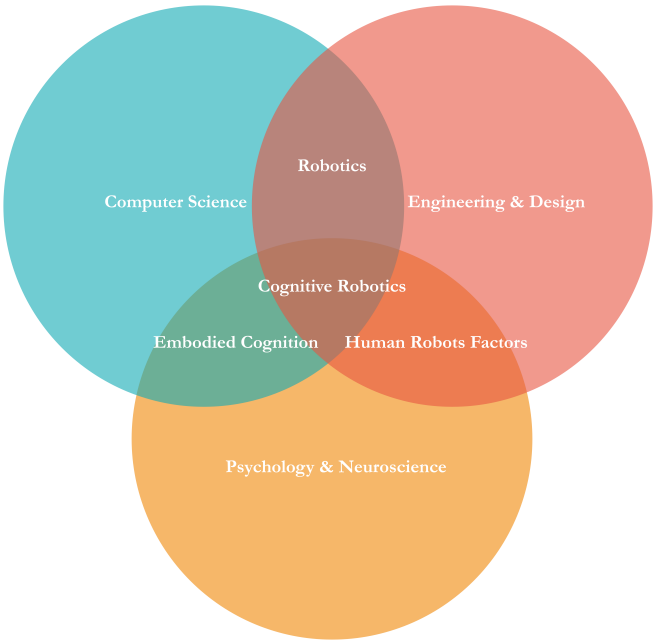

Figure 1.2: Neuroscience and its relation with other discipline of sciences

1.5 Developmental Robotics

Developmental robotics is a field involving ideas from Artificial Intelligence, Psychology, Neuroscience and dynamic systems. Main goal of developmental robotics is to develop a goal based cognitive learning in the robot, to take decision in under pressure environment as well as friendly environment.

1.6 Organization of Thesis

Structure of the following thesis is defined as follows:

Chapter 1: It includes the introduction of background, research impact and justification, aims and objectives, research contribution to knowledge by following study.

Chapter 2: It contain literature review associated to Affordances and Cognitive Robotics.

Chapter 3: It contain materials or data of research work, proposed method chosen for present study and the different methods or tools to study Cognitive Robotics in different setups.

Chapter 4: It contain results obtained by applying the method and identifying the parameters for study in the present study. It contain discussion on the results obtained.

Chapter 5: The recommendations and conclusions of research work are summary are written.

Chapter 2

Literature Review

2.1 Overview

Affordances plays an important role in developmental robotics in finding the relationship between robot and this environment. The affordance deals with the capability of a robot to deal with the object in a certain manner such as grasping of an object or pulling of an object. In this paper we will discuss the applications of affordances in developmental robotics and its types related with cognitive sciences and neurosciences

2.2 Embodied Robots

This work [1] proposes a structure for the control and learning of Embodied Robots. The designing has been made inside an open-completed the process of getting the hang of setting. A regular circumstance used in such a context1: the circumstance is used here to test the proposed building. The general structure of the circumstance incorporates two phases [1]:

(a) First characteristic motivation arrange where the operator isn't given any task and should transparently research nature to freely pick up anyway a lot of extensively helpful data as could sensibly be normal;

(b) A second external motivation organize where the specialist needs to unwind in any event one errands doled out remotely inside a comparable area (outward undertakings). Significantly, the extrinsic stage can furnish an objective extent of the idea of the figure used by the specialist to independently get the hang of during the inborn stage. In the

natural time of the specific circumstance used here, the operator can see questions and examine and gain capability with the effects of certain pre-trained exercises (e.g., "move in space" or "change object concealing"). In the outward stage, the agent is required to use the data picked up in the inherent stage to enlighten extrinsic assignments: first the operator needs to recollect the state of specific things set in a particular game plan (objective; notice how this is a helpful strategy to empower the specialist to store the goal in a setup proper for its systems); by then the articles are "modified" into a substitute state ("initial state"); last the operator needs to return the articles to the goal state.

References