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Modeling a Robotic Perception Episode

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ABSTRACT

The need to understand the human mind so as to make a robotic mind work is well recognized. In cognitive and neurosciences many questions are left still unanswered in understanding this phenomena. Since a robot faces numerous difficulties in programming itself to the degrees of freedom that it embraces with the characteristics that match with humans. The need to develop a pragmatic model that maps a human like brain must be addressed. In this paper, such a model is discussed. This is done by taking a closer look in modeling a robotic mind framework by incorporating various modeling agents into the perception base of an intelligent robotic system. This work covers the theoretical survey of the relevant literature including the theories of mind by Leslie, Baron Cohen and Mckaart on the developmental work on mapping the human mind for the understanding of intelligent robotic systems and the paper concludes with a proposition of a novel design of a robotic mind.

Key Words: Robot; Perception; Tables; Agents; Classification of agents

JEL Classification: O14; O31

INTRODUCTION

A robot faces numerous difficulties in programming itself to the degrees of freedom that it embraces characteristics that match with humans. In literature there seems to be scant if any work specifically in human mapping area with electro mechanical systems. This is what we have attempted in this work. In this paper, a model for a robot to have a human like brain is

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presented, imitating expressions, adopting human like learning and have creative ability to construct productive outputs while staying within the restrained environment of a non-human electro mechanical analogue and digital systems. The usefulness of mind mapping includes decision making, empirical understanding, stimulating creative constructs and intelligence. Raising the most fundamental questions and understanding the complexity of this highly advance system. Scientists all around the world are putting in great endeavors by taking a closer look in modeling a human mind framework with respect to the model comprising of various intelligent agents into the perception base of smart robotic system.

The comparative anatomy of human brains with other vertebrates show five major regions. In contrast, in human brain the cerebrum overlies a number of the other parts. The cerebrum is the source of all conscious sensations, actions, memory and intelligence. Mind collectively refers to the aspects of intellect and consciousness manifested as combinations of thought, perception, memory, emotion, intention and imagination - a sort of superset whose members are many including consciousness as a subset (IEEE-Spectrum, The Rapture Of The Geeks, 2006).

A human mind facilitates like an information processor that processes information from the environment and provides the logic of what is happening. Psychoanalysts explain that human beings too are information processors the human brain decodes information that's been put in it, while computers are designed in the similar pattern. A human mind is thought dependant as it transmits, the mind may wish to instruct the brain to take a certain action. This transmission back to the brain might use the Fourier transform to decompose the complex form of thought into its component waves so the individual fibers of the brain can vibrate and transmit to the muscles of the body a directive to take action or to other fibers connecting brain cells which may in turn develop the thought to the next step or stage (Witherspoon, 2004). One aspect of human mind mapping for a robot dictates an in depth look of tasks can be made under study. For instance multiple threads may be drawn from a priori state. By following each of those threads more streams are drawn that relate to each other and to all those triggers that lead upstream all the way to the priori. Additionally if a robot has to perform, continually generated new ideas synthesized with previously build ideas and experiences it must be able to use inspiration- a notion that it captures from its surroundings.

While lots of work has been done in attempting to understand this mapping process, not much success has been made in development of a comprehensive Human-Robot mapping model. Some of the critical unresolved elements include the following:

1. Perception - Evidence of perception from sensory systems.
2. Quantification - Measurement, mechanical, actional and attitudinal agents.
3. Relational understanding of stimuli with self motile motion.

The remaining of this paper comprises of a high level design of a robotic mind (Robo-Mind) and with detailed emphasis on the perception system of the robotic mind. The paper concludes with recommendations as to the theoretical significance of a Human-Robot mind.

Perception

It is the process gaining awareness from the sensory information. Usually learning begins with the sensory systems through which people receive information about their bodies the physical and social world around them. The way people perceive or experience this information depends not only on the stimulus itself but also on the physical context in which the stimulus occurs and on numerous physical, psychological, and social factors.

Perception gives rise to two types of consciousness: phenomenal and psychological. For example phenomenal consciousness is full of rich sensations that are hardly present when eyes are closed. Psychological consciousness occurs half a second after a stimulus starts. Depending on measurement methods use the capacity of perception ranges between seven and forty symbols or percepts at one time.

Leslie's Model of Theory of Mind

This theory is a manifestation of fundamental events as a central system to aim mechanics and theories of other mind, keeping in view that the concept of number may be vital to the object illustration. Though the world is naturally formed into three groups of stimuli based upon their fundamental structure; namely mechanical, actional and attitudinal agencies. The natural developmental procedure has given independent field specific modules in lieu of the argument that deals with each of these classes of occurrences (Scassellati, 1996).

Baron-Cohen's Model of Theory of Mind

This model deals with two sequences of input availability. The first principle explains stimuli in visual, auditory and physical mediums that have self-motile motion. The second principle explains all visual mechanics work eye-like. Mind reading systems such as that the set or originator to the theory of mind can be formed into four distinctive modules Intentionality detector, eye direction detector, shared attention mechanism and the theory of mind (Scassellati, 2002).

Design

A high level design comprising of many elements are derived from an earlier work on networks by the author (Shaikh, 2005 and 2001). The schematics are shown in the Figure 1.

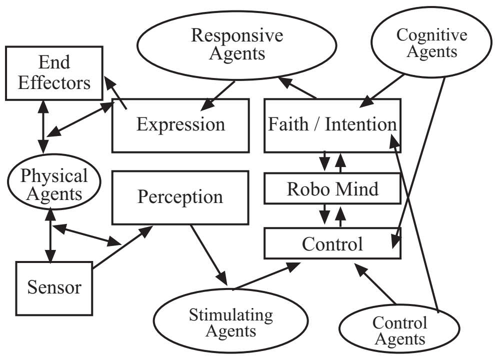

Figure 1 - High Level Design - Robo Mind Network (Shaikh, 2005)

Assumptions

The basic assumptions made to develop a high level design comprise the following: 1. Perception is a finite set of world states so that there are p (a,b) paired subsets of P, $P = [\ p\ (a,b)\ \lambda 1 \ldots\ldots\ldots p\ (x,y)\ \lambda n] \ldots\ldots\ldots\ldots (1)$

Where p (a,b) is the subset of P constituting sets of agents (a) and basic truth tables (b), so that progressive world states from ($\lambda 1 \ldots\ldots\ldots \lambda n$) bring about transformations to perceptions sequentially as in ;

$P = \lambda *\ _{x=1}\sum^{x=n}\ p\ (a,b)\ \lambda \ldots\ldots\ldots\ldots\ldots\ldots (2)$

As well as cumulatively so that,

$P\ (x,y) = {}_0\!\int^{b} p\ (a,b) + {}_0\!\int^{a} p\ (x,y) \ldots\ldots\ldots\ldots\ldots (3)$

$\text{Now, } P = P\ \lambda *\ P\ (x,y) \ldots\ldots\ldots\ldots\ldots\ldots (4)$

2. The Robo-Mind as shown in Figure: 1 is proposed only as a high level prototype. Other than perception, this paper does not dwell further into protocols and specifications of any other component of the Robo-Mind. The model comprises of Agents & Tables. Agents are Intelligent Agents whose job is to communicate intuitively between tables. Tables are sets of heuristic, predicate analysis and recursive algorithmic truth axioms organized as semantic data dictionary of decision making perceptions. It is possible to apply neural nets or some sort of tree walking approaches to connect these tables, although it is not the primary purpose of this paper, in a separate work by the authors these approaches are discussed at length. Tables are categorized as under:

1. Sensor Network - (SN)
2. Perception System - (PS)
3. Control Tables - (CT)
4. Robo-Mind Kernel - (RK)
5. Faith / Intention Rules - (FR)
6. Expression System - (ES)
7. End effectors - (EE)

Agents are categorized as under:

1. Control Agents - (ca)
2. Cognitive Agents - (ga)
3. Responsive Agents - (ra)
4. Stimulating Agents - (sa)
5. Physical Agents - (pa)

A Brief Explanation of the Design

Stimulating agents (sa) connect perception system and control tables. Stimulating agents (sa) carries filtered perception information to Control tables (CT). Control agents (ca) and Cognitive agents (ga) are responsible for maintaining Control tables (CT), learn new knowledge and provide support to unbiased operation of Robo - Mind kernel (RK). Control agents and Cognitive agents are responsible for updating and maintaining Control tables (CT), Robo-Mind kernel (RK) and Faith / Intention rules (FR). Responsive agents (ra) deal with Expression system (ES). Physical agents (pa) provide connectivity and real time communication with Sensor network (SN) and End effectors (EE). We deal with the first tedious task of designing Perception system (PS) by identifying and describing functions responsible for a comprehensive perception module in the following manner.

Perception Episode Model

Perception episode model is proposed and explained in terms of Agents and Truth tables as shown in Figure: 2

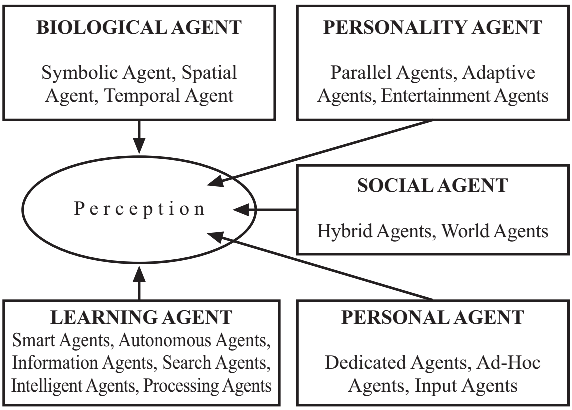

Figure 2: Proposed Perception Episode Model

Table-1 and Table-2 are attached as Appendix-A and Appendix-B, these show the details of Agents and Truth tables.

Analytical Approach

Each high level perception agent operates in a hierarchical formulation with autonomously defined procedures and processes. In Table: 3 Learning is gained by experience in intelligent systems. Here learning is a procedure and gaining experience is an acquired characteristic through a specific process. Similarly intelligent system provides creative intelligence and co-ordination by the process of unconscious incitement that is a process of automating behavior, sequential analysis, systematic performance, logical interpretation of information, symbolic information, language, mathematics, abstraction and reasoning. Procedure for perception is comprised of analyzing, performing, learning and reasoning the sensory data. Thinking procedure forms thoughts, analyze data and perform memory functions.

Agent Types	Perception (p)	Learning (l)	Creative Intelligence-coordination (cic)	Association (as)	Thinking (th)
(Ba) Biological Agents	Sensory stimuli	Gain experience	Unconscious incitement	Linking relationships	Reasoning
(La) Learning Agent	Predicate analysis	Examine	Automatic impulse	Making connections	Rational
(Sa) Social Agents		Study-Implementation	Reflexive	Involving patterns	Adapt
(Pa) Personal Agents		Implementation	Deliberative	-	-

Table: 3 (Proposed Design Elements - Agents)

Symbolic Notations

	Perception	Learning	Creative Intelligence Coordination	Association	Thinking
M(r) =	p (Ba)	l (Ba)	cic (Ba)	as (Ba)	th (Ba)
	p (La)	l (La)	cic (La)	as (La)	th (La)
	p (Sa)	l (Sa)	cic (Sa)	as (Sa)	th (Sa)
	p (Pa)	l (Pa)	cic (Pa)	as (Pa)	th (Pa)

Table: 4 (Proposed Symbolic Notations)

A mathematical expression on it is critical in understanding the mapping process with human brain.

Mathematical formulations

M = High Level Perception of the Robo-Mind.
p = Procedures that depend upon specific processes.
y = A process at instance t
t = A measurable instant in time.
R = A resulting process which has indicated a maximum limit of Perception as a finite integer indicating the level of intensity of the result of all such Processes whose sensory cumulative values have been registered at instant t.
x = Number of high level perception on which intelligent systems operate. In our model we have proposed high level perception as shown in figure depending upon the progress technology we envision more complex implementation of this model with more or less number of high level perception.
a = Cumulative result of individually integrated procedures, processes and results for each high level perception.
d = Delta determines the function showing relationship between procedures and processes.
L = High level perception results as a spread function of individual layers of our model.

If M is high level representation of the Robo-Mind,

$M = {}_{x=1}\sum^{x=n} a \log 10 (L) / n$

It can also be written that, $P(y_1) = {}_{n=1}\int^{n=x} Ba(p)\, t * R_1$ represents the relationship with Biological agent with Perception.

Similarly, $P(y_2) = {}_{n=1}\int^{n=x} La(p)\, t * R_2$ represents the relationship with Learning agent with Perception.

Also, $P(y_3) = {}_{n=1}\int^{n=x} Sa(p)\, t * R_3$ denotes social agent and Perception relationship and,

$P(y_4) = {}_{n=1}\int^{n=x} Pa(p)\, t * R4$ describes Personal agent and Perception relationship.

Additional equations for Perception, Learning, Creative intelligence coordination, Association and Thinking without any problem can also be derived.

CONCLUSION

In this paper a model of Human-Robot mind is developed. While the theoretical and empirical efforts have led to a very sound theory about Human-Robot mind mapping, it has opened up many areas of future research. The way forward includes development of intelligent agents and fact tables to test the theory proposed in this paper. The understanding of the human mind brings forth a distinct look into the deeper understanding of how human mind can be imitated in an artificial humanoid, carefully choosing the innate and relative attributes that boost intelligence factors, learning functions, its associations and imitations, visual and auditory stimuli's, thinking patterns, learning skills and their practice that are present in human mind, most optimum mirror of a robotic mind can be simply a human mind imitation, involving the findings based on the researches being carried out, the proposal of modeling a robotic mind consists of sensory and creative input mechanisms acquired by the social dynamics and environment.

The analysis and interpretation summarizes the understanding of a human mind in distinction of perception into endless categories to assimilate into the area of robotics. The model sketch gives perceptive abilities of a robot input by the human like imitation results a very prime indicator a robot must embrace. Observational behavior of the classifications of robots was limited and thus remains in its natural of settings due to which technical summary of the results are not briefed.

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APPENDIX - A
PERCEPTION EXPERIENCE - AGENTS

Agent Type	
Biological Agent	Biology, Physiology, Anatomy, Memory, Circulatory system, Circadian rhythms.
Symbolic Agents	Holistic functioning, Visual information, Language processing, Abstraction, Spatial learning.
Temporal Agents	Time based decisions, objective tasks, Routines in the brink of time.
Spatial Agents	Observing the physical real world and analyzing sensory data.
Personality Agents	Emotional reservoir, Stress management, Time constraints, Disposition, Character, Temperament, Individuality, Psyche, Traits, Charisma.
Parallel Agents	Fault tolerance, Alternate plans, Multitasking.
Adaptive Agents	Adjusting environment, Customization improvisation, Converting into new forms, Flexible, Efficient, Scalable and Extensible.
Entertainment Agents	Music, Arts, Films, Cinema, News.
Learning Agents	Current world status, Experience, Study, Examine, Edification.
Smart Agents	Analyze data, Learn new information, Form thoughts and Make decisions.
Autonomous Agents	Gain experience, Unconscious incitement, Recognition of sounds and objects (visual), Linking relationships, Form actions on sensory stimuli, Reasoning, Individual actions, Independence awareness.
Information Agents	Collect facts and data, Form knowledge, Communicate data streams, Bring news and updates, E-Commerce.
Search Agents	Seeking meaningful data, Probing, Carrying out a thorough exploration, Semantic handling of data, Pragmatic searching into the data streams.
Intelligent Agents	Learning, Creative intelligence coordination, Skilled, Association, Percepts, Thinking, Gain experience, Unconscious incitement, Sound recognition, Image conception, Linking relationships, Sensory stimuli, Reasoning, Analyze sensory data, Perform memory functions, Learn new information, Form thoughts & make decisions, Sequential analysis, systematic, logical interpretation of information, Interpretation & production of symbolic information, language, mathematics, abstraction and reasoning, memory stored in a language format.
Processing Agents	Speech recognition, problem solving.
Social Agents	Relationships, Credibility, Identity, Value system, Communal, Interactive.
Hybrid Agents	Autonomous tasks, Reactive stimuli, Proactive functioning, Socially able, User centered, Mobile, Adaptive, Robust, Transparent.
World Agents	Autonomous processing agent of all agent types.
Personal Agents	Individual, Special task, Exclusive jobs, Distinctive tasks, Confidential work routines.
Dedicated Agents	Specialized tasks, Assigned processes, Committed routine tasks.
Ad-Hoc Agents	Specific tasks, Particular performing routine.
Input Agents	Process and make sense of sensory inputs.

Table-1

APPENDIX - B
PERCEPTION EXPERIENCE - PERCEPTS, GOALS & FUNCTIONAL SCOPE

Agent Type	Percepts	Goals		Functional Scope
Personality Agents	Edification	Charming	Charisma	Social
Learning Agents	Study / Observe	Gain insight	Knowledge attainment	Open
Social Agents	Interaction	Communication	Credibility	Social
Personal Agents	Cognition	Catharsis	Improve	Specific / Inner self
Smart Agents	Analysis	Learn new information	Make decisions	Open
Autonomous Agents	Gain experience	Recognition	Awareness	Open
Adaptive Agents	Acquire skills	Acquisition & Adept	Implementation	Specific
Entertainment Agents	Sensory stimuli	Motor / Movements	Relaxation	Open
Dedicated Agents	Object oriented	Assign routines	Result oriented	Specific / Dedicated environments
Information Agents	Collect data	Form knowledge	Communicate verbal / visual / readable	TV, Internet, Cable, Satellite.
Search Agents	Meaningful data	Associate meaningful information	Inquire	Open
Ad-Hoc Agents	Random tasks	Correction of procedures	Task deployment	Specific / Personal, Office.
Hybrid Agents	Observe	Gain insight	Knowledge attainment	Open
Parallel Agents	Correspondence	Alternate functions	Multitasking	Specific
Symbolic Agents	Image conception	Figurative representation	Character definition	Specific / Media, Science, Arts
Input Agents	Sensing inputs	Making sense	Procession of inputs	Specific / Disposition / Psyche
World Agents	Sensory stimuli	Analyze	Knowledge acquisition	Open
Processing Agents	Identifying errors / discrepancies	Problem solving	Speech recognition	Open
Temporal Agents	Time slack solving	Error correction	Time specific	Specific
Spatial Agents	Analyze sensory data	Observations of the real world	Awareness	Open
Intelligent Agents	Autonomous processing	Get experience	New form of knowledge	Open

Table-2