

# FRAMEWORK MODEL FOR INTELLIGENT ROBOT AS KNOWLEDGE-BASED SYSTEM

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## ABSTRACT

This paper presents a philosophical view for designing and Implementation of an Intelligent Robot as knowledge based system. The philosophy based on the theoretical aspects of the relationships between cognitive science and computation theories together with the view of functional model of human system as knowledge based system. The framework model consists of ten modules; these modules are complimentary in their processes, which mean each module has a task that complements the other module's task and so on. These modules will constitute the three part of the knowledge-based system. The user interface as Robot Interface consists of three modules, which are Robot Communication Facilities, Updating Knowledge Bases, and Inserting Task Specification. The Inference Engine as processing machine consists of three modules, which are Reasoning Agent, Problem Solving Methods, and Search Techniques. The knowledge base as Robot Brain, which also consists of three modules these are Knowledge Base for Specific Domain, Knowledge Base for Robot Task, and Knowledge Base for Robot Communication. The tenth module is the Working Memory. The proposed framework model for Intelligent Robot has many capabilities such as: The Intelligent Robot can do more than one job, behave like human, work either online or off line and may be remotely, communicates in many ways, smart in term of the psychological meaning of smart, use many methods for problem solving, and use many searching techniques. The application of the framework model will be in any specific domain the robot can work in. The framework model for Intelligent Robot is concentrating in the knowledge and software engineering only independent from the hardware in term of mechanical aspects. This paper suggests that, the design and implementation of Intelligent Robot as a knowledge based system in future and as a mimic of functional model of human system.

*Keywords: A.I., Knowledge-based System, Human Behavior and Cognitive Science.*

## 1 INTRODUCTION

Many natural systems of the most creatures in the world are very rich topics for the scientific researchers. Since that a simple individual behavior can cooperate to create a system able to solve a real complex problem and perform very sophisticated tasks. The Artificial Neural Network had been developed through the study and research of human neurology system [1], and the same for Ant Colony Optimization (ACO) [2], which introduced by Marco Dorigo in his PhD thesis, is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs, they are inspired by the behavior of ants in finding paths

from the colony to food. Therefore, this paper presents the studies and researches of the human system which is the most valuable creature, Intelligent, and rich topics for the scientific researchers in the world. In this study of human system is in term of functions, since the framework model is for a Robot doing a job as human in a specified and specific domain. There are many researchers working in the Humanoid Robotics such as Professor Manuela Veloso, in the Computer Science Department, at Carnegie Mellon University working to build robots that can do the same things as humans and animals, but not necessarily via the same processes. Which is not to say Veloso's work is not inspired by human intelligence? [3]. Also, researchers are

working in Robots modeling using natural language processing for developing a robot to learn compositional meanings for new words that are grounded in its sensory capabilities. The system use logical semantics to infer which entities in the environment are the referents (extensions) of unfamiliar words; its ability to learn the meanings of deictic (“I,” “this”) pronouns in a real sensory environment; its use of decision trees to implicitly contrast new word definitions with existing ones, thereby creating more complex definitions than if each word were treated as a separate learning problem; and its ability to use words learned in an unsupervised manner in complete grammatical sentences for production, comprehension, or referent inference[4]. But unfortunately this direction of artificial intelligence researches and methodologies are still in laboratory and not widely secreted over the world and most of the AI books always started with few chapters concentrated on games theories and searching techniques. Even though, AI books, state that there are many definitions of AI and this is caused due to the fact that authors came from different schools of thoughts and backgrounds therefore accordingly, they gave their own definitions. Furthermore, most of the definitions of Artificial intelligence are concerning the human intelligence, but in reality all the creature has in some way an inelegant behavior, such as human, animals, and insects and so on. So the acceptable definition will be "Artificial Intelligence is a concept of study and research for finding a relationships between cognitive science and computation theories in order to represent these relationships as either data structures, search techniques, problem solving methods, or representation forms for knowledge and the final goal of AI is to build an intelligent machine" [5]. .Since the final goal of Artificial Intelligence is building an Intelligence Machine; therefore, the next section will discuss the characteristics and capabilities of the Intelligent Machine.

## **2 CHARACTERISTICS AND CAPABILITIES OF INTELLIGENT MACHINE**

The intelligent machine (Intelligent Robot) should have the capabilities such as, behaves like a

human being, smart, problem solver of unstructured and complex problems as human does, understands languages, learner, and able to reason and analyze data and information, and so on. We view them as follows: First behaves as human beings; this means that the machine must do all the activities that human does during his life, such as expert system where a trial is made to embody experts knowledge in certain domain in a computer program for carrying out some task, vision for dealing with three dimensions world represented together with the intend and the expectation in the scene. Unfortunately the both capabilities, intend and expectation, are very hard to embedded in the capture scene because the intention and expectation are dynamically change according to the job required by the intelligent robot. Second is smart; this term usually has many meanings in the English language; so, the meaning is concerned with Intelligent Machine to be smart, psychologically, smart means every thing gives pleasure and happiness to humans. Therefore we must design a machine that give pleasure and happiness to the users through the facilities available in all sort of multimedia equipments; Third is problem solver of unstructured and complex problems; in this context human usually solve algorithmic and no algorithmic problems and most problems are non algorithmic, therefore we have to consider methodologies for representing then on algorithmic problems in a form that enable us to develop a problem solving methods. This capability is the most important and most of the pioneers of AI, are concentrating on it, consequently most of the Artificial Intelligence books are concentrating on problem solving methodologies and searching techniques, as in [6]. Fourth is understands languages, computerized Natural Language Processing System, replace the keyboards for dealing with speech , perception, recognition, and also the Intelligent Machine capable to learning. Fifth is able to reason and analyze data and information this means the abilities of analysis, deduction, induction, and so on. All the above capabilities are non touchable things which can't be manufactured in factories but can be artificially represented as sophisticated software. Farther more researchers at robotics labs

around the world should study how the people and robots interact. This software may be embedded in the Knowledge -based System, but according to the philosophy of both functional model of human system and Knowledge-based System. Since, human interact with the environment via the five senses, then, one or more of these five senses will be included in the Intelligent Machine. Since the proposed framework model for the Intelligent Machine is based on the philosophy of regarded it as knowledge based system and the knowledge base system is a mimic of functional model of human system, therefore the next section will be brief description of the functional model of human system as knowledge based system.

### 3 FUNCTIONAL MODEL OF HUMAN SYSTEM AS KNOWLEDGE -BASED SYSTEM

Fig-3.1 presents the construction of human functional system and Fig-3-2 presents the implementation of the knowledge -based system as a simulation of functional model of human system [5]. The left side arrow presents the direction of the construction of human functional system (human career). The communication with the environment unit , human inference engine, and long term memory in functional model of human system have be simulated, in the knowledge based system, as user interface, inference engine and knowledge base respectively.

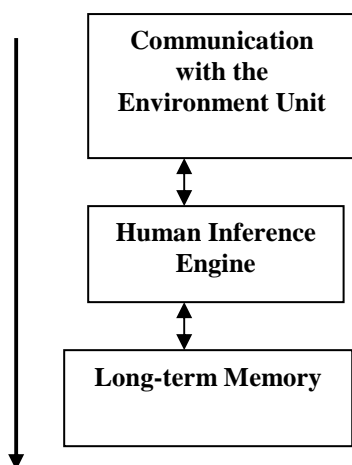


Fig-1 Functional model of Human system

But in Fig.3.2, The left side arrow presents the direction of implementation of knowledge-based system as computer-based software and the most important part is the knowledge base and the inference engine and user interface will be implemented according to the knowledge base scheme used. Therefore the most important part in the knowledge-based systems and expert systems is the knowledge base scheme.

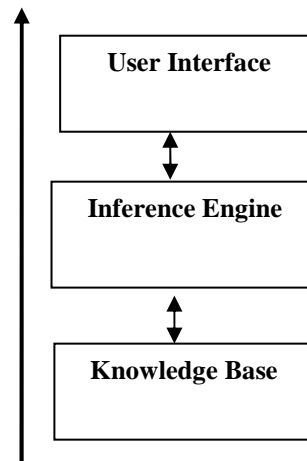


Fig-2 Knowledge-based System

### 4 THE PROPOSED FRAMEWORK MODEL

Therefore the proposed framework model for the Intelligent Robot is based on the philosophy of regarding it as knowledge -based system consists of Robot Interface and may be as a control panel, Inference Engine and can be called processing machine and the Knowledge Bases as robot brain. These three parts are present the ten modules of the proposed framework model for the Intelligent Robot. These modules are complimentary in their processes, which mean each module has a task that complement the other module's task and, as seen in the figure3.2. In the following subsections will be present the descriptions of all modules.

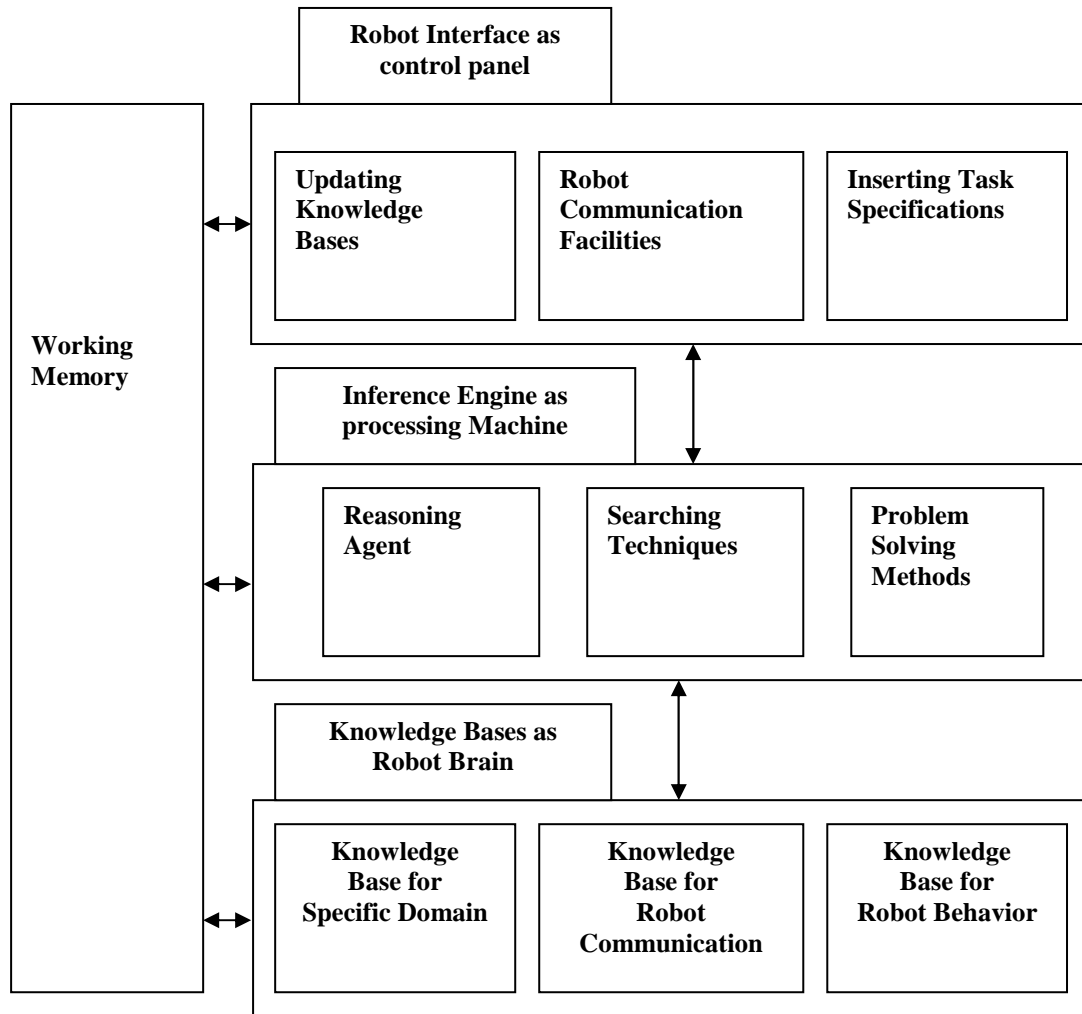


Figure-3.2 the architecture of Intelligent Robot as knowledge-based system

#### 4.1 Robot Interface as Control Panel

This is the substitute of the user interface in the knowledge-based system and consists of three modules, which are Inserting Task Specifications, Robot Communication Facilities, and Updating Knowledge Bases. Therefore, the implementation of this part can be as design and implementation of control panel dedicated for Intelligent Robot. In the next subsections will be described.

##### 4.1.1 Inserting Task Specifications

The task specifications can be inserted through this part of the proposed model and can be in the form of commands to the robot, which depend on the ways of communication with robot. The inserting task specification can be either online or off line or both and also can be remotely.

##### 4.1.2 Robot Communication Facilities

The robot communication facilities have many forms which are depend on the types of communication used for Interaction with the environment. According to the functional model of human system, this is the unit of human communication with the environment which are the five senses (vision, hearing, touching, testing, and speech), and all these are information processing systems. Therefore the researchers, in the fields of artificial intelligence, computer vision, natural language processing, and may be in other fields, should considering projects in their fields related to the Intelligent Robot design, for instance in natural language processing, the robot needs to understand human commands expressed in natural language either spoken or written. Also in computer vision the robot should capabilities of interprets the captured

scene from the video camera. So the robots will have to operate in environments designed for humans.

#### 4.1.3 Updating Knowledge Bases

This part of the proposed system is a special program, its main task to deal with the updating of the knowledge bases through the interaction with the robot interface and end user. Usually the updating facilities are the insertion of new knowledge in the specific knowledge base, changing the stored knowledge, and deleting stored knowledge. All these updating facilities are applied according to the given request by the end user. This special program should be cooperating between the user request format and the knowledge bases representation schemes, which are discussed in sections 4.4.1, 4.4.2, and 4.4.3. The design and implementation of this special program is a sophisticated system that should be based on the knowledge bases representation schemes used in the all types of knowledge bases and in cooperative with the problem solving methodologies and searching techniques used in the inference engine.

### 4.2 Inference Engine as Processing Machine

This is the substitute of the inference engine in the knowledge-based system as processing machine which consists of three modules, problem solving methods, search techniques, and reasoning agent. Therefore, the implementation of this part can be as design and implementation of all the three modules dedicated for Intelligent Robot. In the next subsections will be described.

#### 4.2.1 Reasoning Agent

In reality, human experts have common sense, deduction and analogical reasoning facilities. These three facilities are not included in one knowledge representation scheme, since the logical deduction in the rule base, analogical reasoning in the case base, and the common sense can be applied using blackboard. Since the reasoning agent heavily depend on the problem solving method and searching technique used. Unfortunately, it is difficult to implement general problem solving method for any field, or a general search technique for any field also. The reasoning agent is responsible to accept sophisticated queries concerning some specific command and to execute appropriate automated tasks. This service is provided by a special application programming interface mechanism provided in the robot interface which introduces a set of fundamental data types that can be coherently used for various complex queries and assertions. Its goal is to enable the packaging of any supported data definitions by a simple representation. The power of

the solver reasoning agent can be increased by implementing a larger number of solvers and by enhancing the capabilities to solve complex tasks [7].

#### 4.2.2 Problem Solving Methods

In reality all human being have one problem which is how to continue living, to solve such big problem, human uses a certain method to solve the problem. So there are many methods have been used to solve a problem and these methods are varying from one to another. The differences between these methods are based on the kind of problem, the domain, and the problem space. Therefore, to discuss these methods we need to concentrate on problem space representation and the problem characteristics. For problem characteristics there are a common aspects which can be regarded as the main characteristics of any problem, these are:

- 1-initial state(s)
- 2-goal state(s)
- 3-processes(s)

The initial state present the start state(s) for any problem, while the goal state(s) present the aim of solving the problem, and finally the processes present the procedures which are present the transformation from one state to another. In this context it is required a formal representation for problem space and finally the problem solving methods. The way of represent the problem space is very important for choosing a method to solve a problem and usually any method to be used highly depending on the problem space representation. In reality, most of human problem solving takes place in problem spaces that are either well known or vary only slightly from familiar situations. It is rare for a person to encounter a problem that bears no relation to similar problem solved or observed in past experience. The major aspect consists of memory of past problems and their corresponding solutions that bear strong similarity to the new problem, such knowledge once acquired can be exploited in the problem solving process. There is no other way to account for the fact that humans solve problems in familiar situations much faster and with more self assurance than in unfamiliar abstract situations. A computer model should exhibit the same skill acquisition process that is it should learn to adapt its problem solving behavior by relying on past experience when available falling back on the application of standard weak methods when more direct recall and modification of existing solutions fail to provide an answer.

### 4.2.3 Search Techniques

The searching techniques are used by the problem solver to search the knowledge bases (for Specific Domain, for Robot Communication, or for Robot Task) for the required knowledge according to the assertions (as a commands) given through the robot interface. These searching techniques are depending on the representation schemes adapted by the knowledge bases. Therefore, may be there is more than one technique can be used. There are many reasons for that, since the searching techniques have relations with the knowledge bases, problem solving methods, and reasoning agent and also the knowledge bases for the (Specific Domain, Robot Communication, and Robot Task) are varying in their formulizations and are independent in each others in their role in the model. Further more, there are many methodologies for problem solving and are varying in their formulizations too [8].

### 4.3 Working Memory

The working memory is the place where all the activities of the inference engine and robot interface have to be done, these activities are:

- The application of the problem solving methods used
- The application of reasoning agent used
- The application of searching techniques used
- The processes of editing facilities for the knowledge bases
- The processes of inserting task specification
- The processes of robot communication with the environment
- The processes of application of specific domain knowledge in order to accomplish certain job by the Intelligent Robot.

### 4.4 Knowledge Bases

This is the substitute of the knowledge base in the knowledge-based system as the robot brain, which consists of three modules, knowledge base for specific domain, knowledge base for robot communication, and knowledge base for robot behavior. Therefore, the implementation of this part can be as design and implementation of all the three modules dedicated for Intelligent Robot. Even though, the robot could be design for just dedicated to one job still the intelligent Robot needs all these three types of knowledge bases. In the next subsections will be described. The reason for that human being also in his life may he/she doing just one job , but always have all the processing information systems for the communication with the environment and the knowledge how to do the job together with the knowledge for his/her specialization.

### 4.4.1 Knowledge for Specific Domain

The knowledge base of specific domain represents the repository for one or many chunks of knowledge for a specific and narrow domain for the robot jobs. The implementation of knowledge base depends on the representation forms of the knowledge and usually there are many forms used by human which are may be applied, but the used for this purpose are limited such as: rule base, semantic nets, frame, and logic forms. Since, nobody can do any job without the knowledge of doing that job which exists in his long term memory, which is the knowledge of specific domain, accumulated during the construction of his career. Therefore this part of the proposed model is very important and vary from one particular robot to another depend on the jobs required to be done by that robot. Robotics researchers, should working to build robots that will be capable of doing not only tasks they have been programmed for, but new and more complicated ones as well. Foe example, the robot can do inspection in biological lab and vacuuming the lab also. Therefore, the knowledge engineering will be, in future, the most important and richest topic for the researchers in many fields, such as, information technology, knowledge management, and robot design. Since that robot can move and work like humans instead, most robots remain human-dependent machines that can perform only specialized tasks, like welding parts in a factory, searching through the rubble of a collapsed building or vacuuming a living room. Therefore, in order to make the robot for general purpose this knowledge base consists of many chunks of knowledge each chunk related to certain job so in this case the robot can do more than one job according to this knowledge base like human.

### 4.4.2 Knowledge Base for Robot Behavior

For autonomous movement, the robot needs to localize and simultaneously create a map or have algorithms enabling navigation of its environment. It also needs to adapt in response to changes in its environment and in its perceptual inputs, that is, a robot needs to process information dynamically in real-time [9]. This part of the model is very important and more sophisticated schemes can be used for representing such knowledge base. Since the behavior of robot for doing certain job certainly defer from another. Further more, since in section 4.4.1 suggesting, in the knowledge base for certain domain consists of many chunks of knowledge each chunk related to certain job so in this case the knowledge base for robot behavior must consists also many chunks of knowledge each chunk related to certain job.

#### 4.4.3 Knowledge Base for Robot communications

All human are communicating with the environment through the following five systems, these are: vision system, speech system, hearing system, touching system, and tasting system. Therefore the Robot Communication Knowledge base should contain the knowledge for one of the above systems or more depend in the intended way, used by robot, of communication with the environment. All the above systems are information processing systems and there are many researchers in the world concentrating in developing such systems. For instance, at the Royal Institute of Technology in Sweden, researchers have tried to tackle the issue of distance, both physical and emotional. Led by Kerstin S. Eklundh, the researchers have built a prototype of a robot that can accomplish office tasks. Users can communicate with it by speaking to it or by clicking on a graphical interface on a computer. The researchers believed that having both modes of interaction would be important in an office, where workers might be too deeply immersed in other tasks to speak to a robot [10]. Also, Trisk is a humanoid robot that integrates speech input, visual perception, and active touch in order to interact with humans and its environment. It can understand and obey natural language commands, and will soon be able to answer questions. The robot is a platform for designing new algorithms and multimodal knowledge representations for sensory-motor grounded language use. This research takes steps towards social robots that can coordinate activities with human partners using natural language and gesture [3].

#### 5 CONCLUSION

In this paper, is the proposed framework model for intelligent robot that has many capabilities these are:

- The intelligent robot can do more than one job.
- The intelligent robot can behave like human.
- The intelligent robot can work either online or off line and can be remotely.
- The intelligent robot can communicate with the environment in many ways.
- The intelligent robot can be smart in term of the psychological meaning of smart.
- The intelligent robot can use many methods for problem solving.
- The intelligent robot can use many searching techniques.

The philosophy of the proposed model introduce many research areas, which are knowledge engineering, natural language processing, computer vision, problem solving methodologies, searching techniques, robot design, and robot behavior. All the above areas should be considered in term of intelligent robot. The knowledge base for robot behavior in the proposed model is very important

and more sophisticated schemes can be used for representing such knowledge base. Since the behavior of robot for doing certain job certainly defer from another. Further more, in the knowledge base for certain domain consists of many chunks of knowledge each chunk related to certain job so in this case the knowledge base for robot behavior must consists also many chunks of knowledge each chunk related to certain job. The proposed model for Intelligent Robot should have many chunks of knowledge each one related to the method of communication with the environment, such as, spoken natural language, vision, and understanding natural language. Finally in this paper present the architecture of proposed framework model for intelligent robot concentrating in the software only independent from the hardware in term of mechanical aspects which may be another research area also.

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