

Neuro-Robotics

Sandeep Kumar Singh¹, Manik Chandra Pandey², Amit Asthana³

SITE, Swami Vivekananda Subharti University, Meerut

Abstract-Neuro-Robotics has become an important abstraction in many areas of science and technology. Robotics is the part of electrical engineering, mechanical engineering, and computer science assign with the design, construction, operation, and application of robots. Neuro-Robotics are branch of Robotics, Cognitive Science study of the mind and its processes (Philosophy, Psychology, Artificial Intelligence, Neuro Science, Anthropology and Linguistics), and Behavior (Attention and Visual Search). Neuro-Science is combine with other fields such as computer science, cognitive science, chemistry, engineering, medicine (including neurology), linguistics, mathematics, genetics, and allied direction including philosophy, physics, and psychology. This paper identifies and difference five different views of Neuro-Robotics system which can roughly specify as (1) Robotics, (2) Neuro-Robotics And Major Class of Neuro-Robotics Model, (3) Cognitive Science and fields, (4) Behavior and Attention (5) Visual Search (6) Learning, development knowledge and processing of language

Keywords-Neuro-Robotics, Robotics, Cognitive Science, Behavior, Neuro-Science

I. INTRODUCTION

Neuro-Robotics has become important area of Science and Technology. That combine study of Cognitive Science and Robotics. Robotics is denote the area of Science and Technology that are mechanical engineering, electrical engineering and computer science this are making design, construction, operation, and application of robots, and computer science that control their system as well as sensory feedback, and information processing. Robots are have some kind of mechanical construction operation, as well as they have some electrical components which are source of power and control the machinery, that are a shape or frame to perform a particular task. Robotics contain some level of basic knowledge that is make from computer program code is robot decides when or how to do some particular or targeted task.

These technologies relate with automated machines that can replace of humans in dangerous environments. That can make possible from use of cognitive science and behavior. Cognitive Science make knowledge in robots that are inspired by human brain. And the Cognitive Science denote six major areas of representing the knowledge are Cognitive

Philosophy, Cognitive Psychology, Artificial Intelligence, Cognitive Neuroscience, Cognitive Anthropology, and Cognitive Linguistics.

II. Neuro-Robotics

Neurorobotics [1] is combined of robotics, electrical engineering, mechanical engineering, computer science, and cognitive science such as psychology, philosophy, artificial intelligence, neuroscience, linguistics, and anthropology. Artificial intelligence used to create neural systems, that behavior like human or animals brain. Neural systems are brain inspired algorithm's, computational models based biological neural networks, connectionist networks, artificial spiking neural networks, large scale simulations of neural microcircuits, biological systems, in vivo and in vitro neural nets. Neural system and computational model that combined with machine or robot.

Major Classes of Neuro-Robotics

Neurorobots are divided into various classes based on the purpose.

- **Locomotion and Motor Control**

Locomotion and motor control models used to study motor feedback, control system, developing controls, error correction on robots. Locomotion is model that is inspired from computational model, machanical engineers, and cognitive science. The main purpose of this process to make knowledge and communicate for capable to performing a particular, or targeted action.

Another purpose to study motor control, error correction, motor action, sensory input, error feedback.

- **Learning and Memory System**

In learning and memory system study of process brain design, memory system, and learning. Learning process is model of memory that analyze environment, culture, behavior, thinking, planning, navigation, etc. and store information into brain with categories and organized.

- **Action Selection And Value System**

In action selection and value systems studies with positive or negative and value on an action. Behavior thought that provide some changes of information into brain positive or negative thought that direction of action information based on value system.

- **Sensory Perception**

In sensory perception is ability to take information via sense or any other action. Senses that allow to use environment process to performing a task. Perception is such as sound, speech, touch, taste is combined with sensory system that studies in sensory perception.

III. Cognitive Science

In 11 September, 1956 a large scale meeting on cognitive science in Massachusetts Institute of Technology (MIT). Cognitive is process of brain action or process that acquiring knowledge and understanding through thought, experience, and the sense. The process such as knowledge, attention, memory and working that use to judgment and reasoning, evaluation, problem solving, decision making and analysis the environment. Cognitive process use knowledge to generate new knowledge.

The process are analyzed from different – different areas linguistics, neuroscience, and anesthesia, anthropology, psychiatry, education, psychology, philosophy, biology, systemic, logic and computer science. In Neuro-robotics analysis different type of field's electrical engineering, mechanical engineering, computer science and cognitive science is related with branch are Cognitive Philosophy, Cognitive Psychology, Artificial Intelligence, Cognitive Neuroscience, Cognitive Anthropology, and Cognitive Linguistics.

Cognitive Architecture is refers to the theory of cognitive science and branches Cognitive Psychology, Artificial Intelligence, Cognitive Neuroscience, Cognitive Anthropology, and Cognitive Linguistics that are structure of knowledge of human mind.

Cognitive Science [2] has been three levels of analysis are:

- The Computational Theory
- Representation and Algorithms
- The Hardware Implementation
- **Philosophy**

Philosophy [3] is the process of study general and fundamental nature of reality, value, knowledge, reason, language and mind. Philosophy of language is related with problems four areas are language use, nature of meaning, language cognitive and the relationship with language and reality environment. Philosophy of mind is process to study of nature of mind, brain events, brain action ,brain function, brain properties and relation with physical body that perform particular or targeted task.

Philosophy study process is divided into sub-fields are:

- Chronological
- Topical
- Divisions of style
- **Psychology**

Psychology [4] term used and first time introduced in 1950s and 1960s is process of study of behavior and mind. And theoretical process cognitive psychology is use to study brain processes like attention, memory, language use, problem solving, perception, thinking and creativity.

Cognitive psychology[5] is integrated with various fields of psychological study are social psychology, personality psychology, educational psychology, personality psychology, developmental psychology, abnormal psychology, and economics.

The main focus of study cognitive psychology process is study brain process that affect behavior. Those process are related with following:

- Attention
- Memory
- Perception
- Language
- Metacognitive

Cognitive psychology applications are:

- Social psychology
- Personality psychology
- Educational psychology
- Personality psychology
- Developmental psychology
- Abnormal psychology

Cognitive Neurophilosophy is branch that relate with cognitive philosophy that aims to understand structure and function of brain and specify psychological processes. Cognitive psychology is the science capable for brain processes are responsible for cognitive abilities to store and produce new memories, recognize people, produce language, and objects as ability to reasoning and problem solving.

- **Artificial Intelligence**

Artificial Intelligence (AI) [6] is purpose to making intelligence for machines or software. In this field study to make robots, computer, embedded machine, smart device, software and etc. that are capable of intelligent behavior. The main goal of artificial Intelligence (AI) research is knowledge, reasoning, planning, natural language processing, learning, communication, perception that is make ability in a machine to move and manipulate or other type of changes in object. Artificial Intelligence touch many kind of field's mathematics, mathematical optimization, logic, probability based method, economics, and mathematics based searching technique and many others.

The main purpose and capability of artificial intelligence are following:

- Deduction, reasoning, problem solving
- Knowledge representation
- Breadth of commonsense knowledge
- Default reasoning and the qualification problem
- Sub symbolic from of some commonsense knowledge
- Planning
- Learning
- Natural Language Processing
- Communication
- Perception
- Motion and manipulation
- Social intelligence
- Creativity
- General intelligence
- **Neuroscience**

Neuroscience [7] is science purpose to study of nervous or neural system and branch of biology. That science collaborates with other fields such as computer science, cognitive science, engineering, linguistics, medicine and neurology, genetics, mathematics, psychology, philosophy, neuroeducation, neurolaw, neuroethics, neurobiology.

Cognitive Neuroscience [8] is process to study to theoretical biological process and psychological, cognitive function are produced from neural circuits in brain. As well as cognitive science is branch as study of process physiology psychology, psychology, cognitive, neuroscience, neuropsychology, overlapping. Cognitive neuroscience release theories in cognitive science with the help of neurology, neuropsychology, psychiatry, neurobiology, bioengineering, physics, philosophy, linguistics, mathematics, computer science, engineering and computational modeling.

Cognitive neuroscience is focus on the neural sub-branch of brain process are:

- Neurolinguistics
- Neuroimaging
- Positron emission tomography
- Functional magnetic resonance imaging

Theories of cognitive neuroscience and sub-fields branches make methods and experimental theories from psychophysics, functional neuroimaging, cognitive psychology, electrophysiology, behavior genetics, cognitive genomics, and computational neuroscience.

Computational neuroscience or Theoretical neuroscience is process to study of brain function aims to focus on information processing properties of structure that make nervous or neural system. That links from science fields as well as cognitive science, neuroscience, psychology, electrical engineering, computer science, physics, and mathematics. And also connected with learning theories of

machine learning, computational theory, and neural networks.

Major points and goals of Computational Neuroscience are:

- Single-neuron modeling
- Development, axonal patterning, and guidance
- Behaviors of networks
- Memory and synaptic plasticity
- Sensory processing
- Cognition, discrimination, and learning
- Computational clinical neuroscience
- Consciousness

● **Anthropology**

Anthropology[9] is the process to study humanity, culture, sociocultural, biological, archaeological, linguistics, social activities, art, music, media, visual, economic, political economy, political, legal, public, applied, development, medical nutritional, psychological, cognitive, transpersonal, nature, science, technology, digital, cyborg, ecological, environmental.

Cognitive anthropology [10] is approach to study cultural anthropology which explain pattern of cultural innovation, shared knowledge, and transmission of time and space using the field's theories and methods of cognitive science collaborates with evolutionary biology, experimental psychology, historian, linguists, archaeologists, ethnographers, musicologists, cultural forms. It also able to concern with peoples from different groups, language, interaction of language and thought, culture, culture model, knowledge, sense, series of changes and etc.

Cognitive anthropology divided into three sub-fields are:

- Semantics
- Syntactic
- Pragmatics

● **Linguistics**

Linguistics [11] is the scientific process to study of language. There are three basic points of study: language meaning, language form, and language in context. Description of language is introduced in 4th century BCE from Indian grammarian Panini, was a student of linguistics.

Language [12] is ability to acquire and use complex systems of communication. The study of language “ability to make knowledge that able to create a new language that used to communicate” is called linguistics. Linguistics analyzes human language that communicate with system relating with sound, signs, signed languages, meaning. Linguistics also includes to representates human language as social, historical, culture, political factors, social activities, art, music, media, visual, economic, political economy, political, legal, public, applied, development, medical nutritional, psychological, nature, science, technology, ecological, environmental.

Cognitive Linguistics [13] is branch of linguistics that analyzed to study language, concept, language tongue, storage, speech, writing, production, understanding speech and writing.

Cognitive Linguistics focus to study on functions are:

- Cognitive semantics
- Cognitive phonology
- Cognitive grammar
- Construction grammar
- Conceptual blending and conceptual metaphor
- Force dynamics and image schemas
- Conceptual organization: Categorization, Frame semantics, Metonymy, and Iconicity
- Cultural linguistics
- Linguistics relativity
- Sign language and gesture

IV. Behavior

The behavior [14] is mainly focus on learning and memory that can perform or action a particular task. The behavior action is part of neuroscience that science analyze nervous or neural system that able to action.

The behavior is science that study in behavioral neuroscience also known as biology psychology, psychobiology, or biopsychology to purpose to study psychological, genetics, development of behavior in human and animals.

Behavior neuroscience analyze brain processes and behaviors are:

- Perception to action and sensation
- Control of movement, action, task
- Motivated behavior (hunger, thirst, sex)
- Learning and memory
- Language
- Emotion
- Consciousness
- Decision making and Reasoning

- **Attention**

Attention [15] is part of behavior science and cognitive science that process and allocation of information, area of active, source of sensory, signals that generate attention and allocate in working memory. The sensory make signals for sensory neurons that relation with attention, behavior and cognitive process that allocates the information in brain.

Attention focus on major area of education, neuroscience, psychology, cognitive science, and neuropsychology. Attention clinical model objects are following:

- Focus attention
- Selective attention
- Divided attention
- Sustained attention
- Alternative attention

- **Visual Search**

Visual search [16] is a type task requiring attention for an active scan of the visual environment to particular object or target. Visual search can perform action from eye movements.

Visual Search major functions are:

- Feature search
- Image matching
- Conjunction search

- **Learning, development knowledge and processing of language**

Learning, development knowledge are the process of knowledge and information. Processing of language is part of study linguistics that perform knowledge of language and able to communicates with environment and objects

V. Conclusion

In this research paper studies on neurorobotics that can make nature, behavior, learning process, emotion, decision making, reasoning, thinking, planning, control movement, action or task like human and animal. The neurorobotics purpose to make is depends on classes are: locomotion and motor control, learning and memory system, action selection and value system, and sensory perception. The classes of neurorobotics is to define the purpose or motive of making the neurorobotics.

The learning, development, knowledge and processing of language, memory, attention, perception, action ability to take information via the senses and processing, vision, hearing from cognitive science. In neurorobotics take to ability information process through the cognitive science that combine studies of philosophy, psychology, artificial intelligence, linguistics, neuroscience, and anthropology through mathematics, logic, computer science, computational model, mathematical optimization, probability based method, economics, and mathematics based searching technique, mechanical engineering, electrical engineering that make design, construction, operation, and application.

VI. Reference

- [1]Neurorobotics <https://en.wikipedia.org/wiki/Neurorobotics>
- [2]CognitiveSciencehttps://en.wikipedia.org/wiki/Cognitive_science
- [3]Philosophy <https://en.wikipedia.org/wiki/Philosophy>
- [4]Psychology <https://en.wikipedia.org/wiki/Psychology>

[5]CognitivePsychologyhttps://en.wikipedia.org/wiki/Cognitive_psychology

[6]ArtificialIntelligencehttps://en.wikipedia.org/wiki/Artificial_intelligence

[7]Neuroscience<https://en.wikipedia.org/wiki/Neuroscience>

[8]ComputationalNeurosciencehttps://en.wikipedia.org/wiki/Computational_neuroscienc

[9]Anthropology<https://en.wikipedia.org/wiki/Anthropology>

[10]CognitiveAnthropologyhttps://en.wikipedia.org/wiki/Cognitive_anthropology

[11]Linguistics<https://en.wikipedia.org/wiki/Linguistics>

[12]Language<https://en.wikipedia.org/wiki/Language>

[13]CognitiveLinguisticshttps://en.wikipedia.org/wiki/Cognitive_linguistics

[14]BehavioralNeurosciencehttps://en.wikipedia.org/wiki/Behavioral_neuroscience

[15]Attention <https://en.wikipedia.org/wiki/Attention>

[16]VisualSearchhttps://en.wikipedia.org/wiki/Visual_search