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Automated Learner Robot through Image Processing

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Abstract :- While we currently have a good understanding of the behavioral and neurobiological mechanisms underlying associative learning processes, we understand much less about the mechanisms underlying more complex forms of cognition in robots. In this study, we present a proposal for a new way of thinking about machine cognition experiments. We describe a process in which a physical cognition task domain can be decomposed into its component parts, and models constructed to represent both the causal events of the domain and the information available to the agent. We then implement a simple set of models, using the planning language within the OPENCV simulation/real time environment, and applying it to a puzzle tube task previously presented to orangutans. We discuss the results of the models and compare them with the results from the experiments with orangutans, describing the advantages of this approach, and the ways in which it could be extended. This prototype will be essential in developing intelligent cognitive systems like robots with human like intelligence in perception, motor control and high level cognition. This project involves design and implementation of a self-learning bot. Our system proposes a design prototype where a machine can learn to act in an unpredictable environment. This type of innovation is essential for master slave learning behavior analysis.

Keywords: - Image Processing, Encoding, Decoding, ZigBee, Robotics, Artificial Cognitive Systems (ACS)

I. INTRODUCTION

This project mainly deals with the learning strategies for the humanoid robot and the intelligent machines. It concerns with creating autonomous robots that can learn to act in an unpredictable environment. This prototype will be essential in developing intelligent cognitive systems like robots with human like intelligence in perception, motor control and high level cognition. This project involves design and implementation of a self-learning bot. A manually controlled bot performs a specific task in an arena that has a camera mounted on top of it. The camera will capture the task performed by the manually controlled bot using a web-cam. The task once captured will be encoded and sent to the learner bot. Once the learning is complete, the learner bot can perform the same task as the manual bot.

System mainly divides into three parts i.e. master robot, learner robot and controller. The master robot will be controlled via four switches. This robot will move in the arena where we have overhead Camera connected with PC. This Camera will capture the movement of master robot and give it to PC via serial communication for further processing.

Overhead Camera will be connected to a computer through USB. We will have runtime capture of task performed by master bot through this camera. Robot detection and its movement will be processed by JAVA programming running in the PC. Image processing toolbox will be used to process the frames coming from the camera. The task will be encoded after processing and will be send to the microcontroller via serial communication. The microcontroller will get the encoded task from PC and sends wirelessly via ZigBee Communication Protocol to learner bot.

The learner Robot will replicate the task performed by its master. It will receive the encoded task with ZigBee wireless protocol and decodes it in the microcontroller. It will understand the task after decoding and perform the same in the live arena.

ATmega 328 microcontroller is used on both master robot and learner robot. The ATmega328 is a single chip microcontroller created by Atmel and belongs to the mega AVR series. The ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Ardunio development platform, namely the Ardunio Uno and Ardunio Nano models.

ZigBee is a specification for a suite of high-level communication protocols used to create personal area network built from small, low-power digital radios. Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of

250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that require short-range low-rate wireless data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi.

II. RELATED WORK

After analyzing the requirements of the task to be performed, the next step is to analyze the problem and understanding its context. The first activity in the phase is studying the existing system and other is to understand the requirements and domain of the new system. Both the activities are equally important, but the first activity serves as a basis of giving the functional specifications and then successful design of the proposed system. Understanding the properties and requirements of a new system is more difficult and requires creative thinking and understanding of existing running system is also difficult, improper understanding of present system can lead diversion from solution. The proposed design involved the following research paper analysis:

- "A Survey of Artificial Cognitive Systems" by Vernon, D. in IEEE conference in April, 2007:
  This survey presents an overview of the autonomous development of mental capabilities in computational agents. It does so based on a characterization of cognitive systems as systems which exhibit adaptive, anticipatory, and purposive goal-directed behavior. We present a broad survey of the various paradigms of cognition, addressing cognitive (physical symbol systems) approaches, emergent systems approaches, encompassing connectionist, dynamical, and enactive systems, and also efforts to combine the two in hybrid systems.

- "Robotics and Intelligent Systems in Support of Society" by Raj Reddy, Carnegie Mellon University in June, 2006:

Michigan, 2 has been demonstrated in several assistive-care situations (see figure 1a). Pearl provides a research platform to test a range of ideas for assisting the elderly. Two Intel Pentium 4 processor-based PCs run software to endow her with wit and the ability to navigate, and a differential drive system propels her. A Wi-Fi network connection helps her communicate as she rolls along, while laser range finders, stereo camera systems, and sonar sensors guide her around obstructions. Microphones help her recognize words, and speakers enable theirs to hear her synthesized speech. An actuated head unit swivels in lifelike animation.

- "Quantitative Assessment of Single-Image Super-Resolution in Myocardial Scar Imaging" by DANIEL A. HERZKA3 (Member, IEEE) in Sep, 2013:

Recent evidence suggests that the complex geometry of the scar determines the propensity to ventricular arrhythmia, and predicts death. Our previous work using high-resolution ex vivo MRI demonstrated a critical link between the complex scar geometry and electrical circuits of ventricular arrhythmia. However, the spatial resolution of clinical cardiac MRI is not sufficiently high to allow reconstruction of the complex scar geometry. Improved resolution of clinical cardiac MRI would allow qualitative assessment of the scar and more appropriate utilization of clinical image data to predict lethal arrhythmia, guide therapy and prevent death. To improve the spatial resolution of an imaging system, one straightforward approach is to directly acquire a high resolution image. This solution, however, may not be feasible due to higher noise levels associated with high-resolution image acquisition, longer acquisition time and higher hardware cost such as in high and ultra-high field system.

- "A new breed of robot - [control robotics]" by Felsberg , M. in Feb, 2009 :

Designers of artificial cognitive systems (ACS) have, until recently, tended to adopt one of two approaches to thinking robots: classical rule-based artificial intelligence or artificial neural networks. However, a new breed of cognitive, learning robot developed through the European Union-funded project COSPAL (cognitive systems using perception-action learning) combines the best of both worlds. In this paper, the author describes the challenges faced by artificial cognitive system design and defines the progress made through the COSPAL project initiative.

III. PROBLEM STATEMENT

This project involves design and implementation of a self-learning bot. A manually controlled robot performs a specific task in an arena that has a camera mounted on top of it. The camera will capture the task performed by the manually controlled robot using a web-cam. The task once captured will be encoded and sent to the learner bot. Once the learning is complete, the learner robot can perform the same task as the manual robot. Design of robots involved selection of actuators, low power controller board, input sensor design and output sensor design. There are some design challenges like working with adverse light conditions, Zigbee wireless interference with nearby radio waves, real time tracking, simulation with expected output are also involved.

IV. ARCHITECTURE

3.1 System Design:

The following state-chart presents various states that the system can be in and the transitions among them.

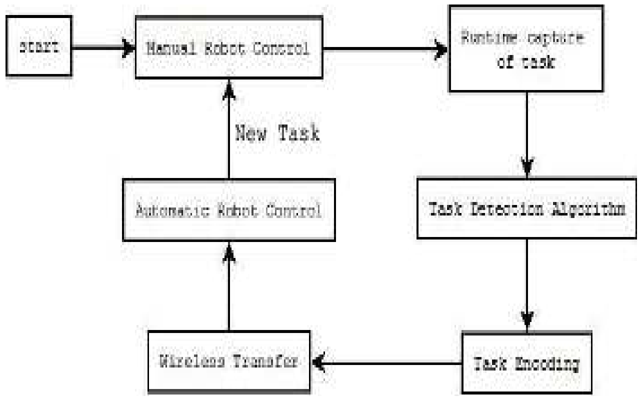

Fig. 3.1(a) System Design

The use case for the system is as follows:

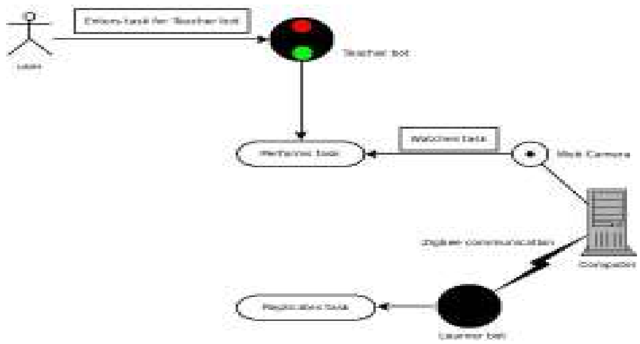

Fig. 3.1(b) Use case Diagram

3.2 Master Side Block Diagram:

This is master robot and will be controlled via four switches. This robot will move in the arena where we have overhead Camera connected with PC. This Camera will capture the movement of master robot and give it to PC via serial communication for further processing.

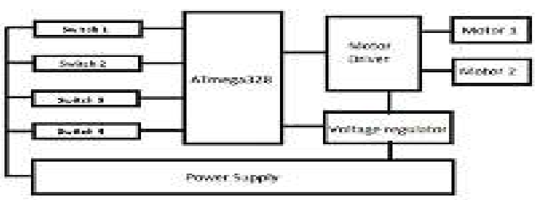

Fig. 3.2 Master side Block Diagram

3.3 PC Side Block Diagram:

Overhead Camera will be connected to a computer through USB. We will have runtime capture of task performed by master bot through this camera. Robot detection and its movement will be processed by MATLAB software running in the PC. Image processing toolbox will be used to process the frames coming from the camera. The task will be encoded after processing and will be sending to the microcontroller via serial communication. The microcontroller will get the encoded task from PC and sends wirelessly via ZigBee Communication Protocol to learner bot.

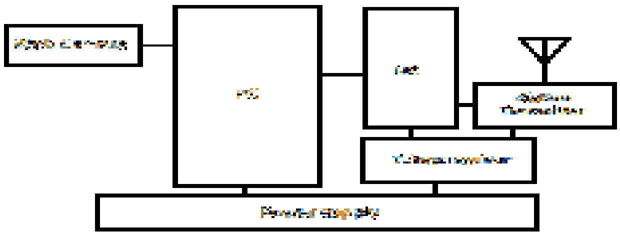

Fig. 3.3 PC side Block Diagram

3.4 Learner Side Block Diagram:

This is a learner Robot and will replicate the task performed by its master. It will receive the encoded task with ZigBee wireless protocol and decodes it in the microcontroller. It will understand the task after decoding and perform the same in the live arena.

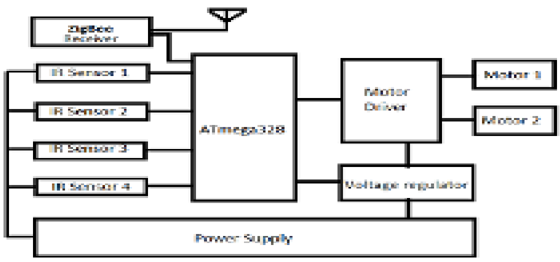

Fig. 3.4 Learner side Block Diagram

(1) Remote patient robotics surgery:
This application will help the surgeon to do surgery form long distance remotely in this application doctor will act as master and robot which is actually performing the surgery will be learner.

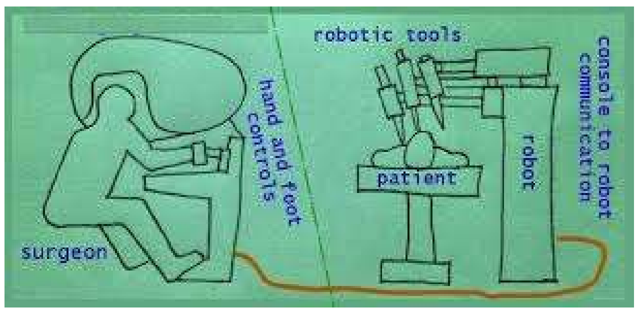

Fig 4.1 Remote Patient Surgery

(2) For bomb defusing:

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This will help to defuse the bomb without losing anyone's life. The person who has knowledge of bomb defusing will act master and the robot which will actually defuse the bomb will act as learner.

(3) Suspected vehicle tracking system:

Suspected vehicle can be tracked with help of this application. The vehicle which is suspected will be master and robot which is tracking it is learner robot.

(4) One to Multiple Workers:

This application will be useful in industries. One worker will act as master and number of robot will replicate as learner robot.

V. CONCLUSION

Result of our proposed technique is based on image processing system and robotics and it's compared on some other image processing enhancement techniques. In this paper we have propose artificial cognition based on image processing technique by implementing the two robots called master robots and learner robots and data transmition can be done via ZigBee wireless communication .

ZigBee is low cost and low power consumptive wireless network which provide large distance area. It also has low latency. Due to all these advantages our system uses ZigBee wireless communication for data transmition.

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