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Real Time Trainable Industrial Robotic Arm Based on Experience Replay Learning Technique

P. P. Deshmukh[1], Prof. P. R. Indurkar[2], Prof. D. M. Khatri[3]

Department of EXTC, B. D. College of Engineering, Sevagram, India[1,2,3]

ABSTRACT: In this paper we aim at developing a system where in one can train robots to perform a task by performing the task once, manually. Such a system would reflect on the human methods of teaching wherein a person teaches a child how to perform a particular task by showing them how it is done by actually performing it once himself. As a child observes the teacher's methods and actions and tries to replicate the same when he tries it himself, our system will instill this characteristic into our robot as well. For the purpose of demonstration of such a system, we proposed to develop an algorithm via which the robot will record the actions when performed by the user during the 'learning phase' which is nothing but when the user is performing the action for the robot for the first time. We will devise a mechanism via which these actions can be stored, modified and replayed. Also, acceleration, and slow motion replays will also be included. We will create the prototype of a vehicular robot to demonstrate the system. The user will train the robot to run on certain paths by manually driving it once, after which the robot will learn and perform the tasks itself.

KEYWORDS: Robotic ARM, Hand-held Controller, Code vision AVR for embedded – c programming, Keil uvision-4.

I. INTRODUCTION

In this project we aim at developing a system where in one can train robots to perform a task by performing the task once, manually. Such a system would reflect on the human methods of teaching where in a person teaches a child how to perform a particular task by showing them how it is done by actually performing it once himself. As a child observes the teacher's methods and actions and tries to replicate the same when he tries it himself, our system will install this characteristic into our robot as well.

In traditional approach the system is designed for dedicated task which has no other use, another disadvantage is user need to have knowledge of programming for reprogram of specific task, so it can be overcome by installing wired modules to enable wired control of the robotic arm via developed handheld controller. Algorithm can be developed based on experience learning approach to record action & convert them into devised motion codes and vice-versa. This type of arm has wide variety of application in industrial automations like open and close bottle neck, cleaning of specific surface or pick and place particular object.

To achieve such intelligent robotic arm, algorithm can be developed via which the robot will record the actions when performed by the user during the 'learning phase' which is nothing but when the user is performing the action for the robot for the first time. The prototype of a vehicular arm can be used to demonstrate & developed a system to run robot according to the sequence of recorded motion codes. An additional filter can installed for adding effects.

For the purpose of demonstration of such a system, we will develop an algorithm via which the robot will record the actions when performed by the user during the 'learning phase' which is nothing but when the user is performing the action for the robot for the first time. We will devise a mechanism via which these actions can be stored, modified and replayed. Also, acceleration, and slow motion replays will also be included. We will create the prototype of a vehicular robot to demonstrate the system. The user will train the robot to run on certain paths by manually driving it once, after which the robot will learn and perform the tasks itself.

We develop an algorithm based on experience learning approach to record action & convert them into devised motion codes. The algorithm can be install in any kind of robotic system. It will help us to learn robot on real time basis. In future we can share the experience with another robotic system. We can also train the robot by visual observation technique in which robot will learn its task only by observation

II. RELATED WORK

Sander Adam, et. al, presents an paper which focuses on a promising approach for Reinforcement-learning control is experience replay (ER), which learns quickly from a limited amount of data, by repeatedly presenting these data to an underlying RL algorithm. A promising approach for RL control is experience replay (ER), which learns quickly from a limited amount of data, by repeatedly presenting these data to an underlying RL algorithm. In this paper, they evaluate ER RL on real-time control experiments that involve a pendulum swing-up problem and the vision-based control of a goalkeeper robot. These real-time experiments are complemented by simulation studies and comparisons with traditional RL. The successful real-time learning results that are presented here are highly encouraging for the applicability of ER RL in practice. ER-*Q*-learning and ER-SARSA performed well in an extensive evaluation on a range of real and simulated applications, which involve an inverted pendulum, a robot arm, and a goalkeeper robot. Among other results, ER outperformed classical *Q*-learning and SARSA, as well as the batch LSPI algorithm. A first opportunity for further research is to further speed up learning by replaying samples in backward temporal order, instead of temporal or random order; alternatively, the most promising samples could be replayed first using the so-called prioritized sweeping. The successful real-time learning control results presented in this paper are in our view an important step in this direction. [1]

Shih Huan Tseng, et. al proposed an Human Action Replication based Robot Performance Learning in a Social Environment. This paper focuses on developing intelligent robot which infer the human intentions through recognition the action & perform appropriate action from user feedback. To accomplish more natural and intelligent human robot interaction (HRI), a robot should not only be able to infer the user's intention through recognizing the actions, but also to perform appropriate decisions and to learn from the user's feedback. The experimental results show the effectiveness of the proposed approach that enables autonomous adaptation of robot's decision to the user desires. Also, they demonstrate a satisfactory performance in terms of successful inference of human intentions, as well as adequacy of the decisions made by the robot tor meeting user expectation. They presented a human awareness Decision Network model that combines human intention inference and decision making with a learning mechanism, and the experimental results showed the model's effectiveness of adaptation to the user feedback for the robot's performance. [2]

D. Katagami, et. al, presents an Active Teaching for an Interactive Learning Robot. In this paper introduces 'Interactive Classifier System' a fast learning method that enables a mobile robot to acquire autonomous behaviours from interaction between human and robot. A mobile robot is able to quickly learn rules by directly teaching from an operator. They have proposed a fast learning method that enables a mobile robot to acquires autonomous behaviors from interaction between human and robot. In this research they develop a behavior learning method ICs (Interactive Classifier System) using interactive evolutionary computation. As a result, a mobile robot is able to quickly learn rules by directly teaching from an operator. ICs is a novel evolutionary robotics approach using classifier system. In this paper, they investigate teacher's physical and mental load and proposed a teaching method based on timing of instruction using ICs. They proposed an Active Teaching method regarding for teacher's cognitive load when a teacher instruct a mobile robot to perform a simulation task.

Jamil Abou Saleh, et. al, proposed an Qualitative Evaluation Criterion for Human-Robot Interaction System in Achieving Collective Tasks. In this research intends to identify common performance metrics for task-oriented human-robot interaction. Here present a methodology to assess the system performance of a human-robot team in achievement of collective tasks. We propose a systematic approach that addresses the performance of both the human user and the robotic agent as a team. We define the robot attention demand (RAD) as a function of both direct interaction time (DIT) and indirect interaction time (IIT), where the IIT is a direct consequence of the human trust in automation. We propose a two-level fuzzy temporal model to evaluate the human trust in automation while interacting with robots. Another fuzzy temporal model is presented to evaluate the human reliability during interaction time. The model is then generalized to accommodate multi-robot scenarios. Sequential and parallel robot cooperation schemes with varying levels of task dependency are considered. The fuzzy knowledge bases are further updated by implementing an

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application robotic platform where robots and users interact naturally to complete tasks with varying levels of complexity. [4]

G. Sen Gupta,et.al proposed Master-Slave Control of a Teleoperated Anthropomorphic Robotic Arm with Gripping Force Sensing. This paper details methods of solving problems that are encountered when human beings teleoperate robots. Special emphasis has been given to the ease of operation and some form of force sensation. Through the use of a rigid control rig, fitted to the user's arm, it is possible to easily control an anthropomorphic robot arm using a master-slave control methodology. The force being exerted by the arm is measured and fed back to the user who is operating the master unit. In this paper they explained why teleoperation is needed, the advantages and disadvantages of the master-slave control system that has been implemented and the possible methods of incorporating force feedback into the system. The system was successfully designed and implemented meeting the initial specifications. The master unit was easy to use to control the slave unit and it took very little time for a user to learn to use it. It is shown that the concept of teleportation for controlling robots is a valid one when the robot is in an unstructured and unpredictable environment since the human beings operating them are far more adaptable than behavioural programming could be at this time. The system that has been implemented is cheap and effective, and with a few extra blocks added, such as a wireless link and a vision system, it can be very useful for unstructured operations where it is dangerous for human beings to go. [5]

Overall work based on developing intelligent robot which infer the human intentions through recognition the action and perform appropriate action from user feedback. . A mobile robot is able to quickly learn rules by directly teaching from an operator. In all papers work, common performance metrics for task-oriented human-robot interaction, which learns quickly from a limited amount of data.

- At present, industrial automation requires wide number of product for repeatedly done.
- The main disadvantage to design industrial machines is complex programming.
- In traditional approach, the user need to follow same procedure and give instruction every time for similar kind of work done.

III. PROPOSED ALGORITHM

- Mimic human action according to the instructions stored by the programmer during the learning phase.
- The objective of the system is to perform one task autonomously and can be reprogramming for different task.
- Another feature of the system is multiple experiences storage capability like cleaning particular surface and pick and place any object.
- Filters used to edit and add additional effects during the replay; here effect can be used for editing the speed of robotic arm.
- Reprogramming can be done for various tasks.

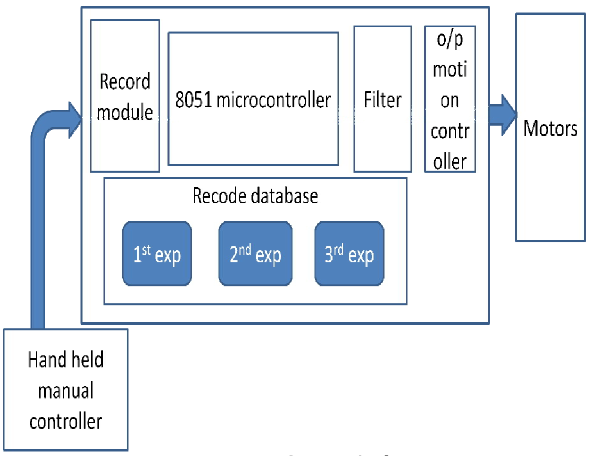

Figure 1: Basic System Architecture

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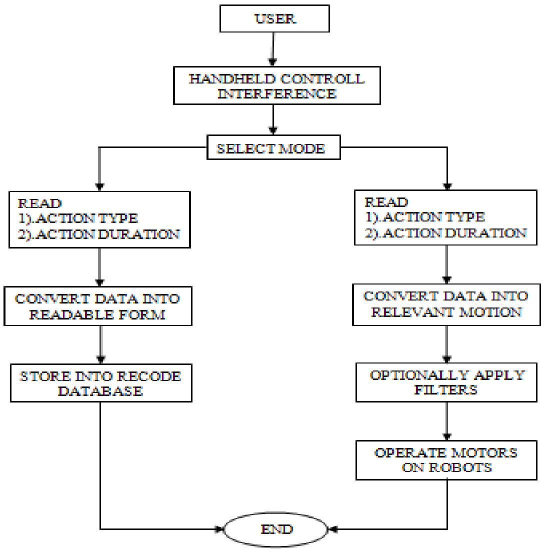

Figure 2: Process Flowchart

- A learning system can be developed which is trainable industrial robotic arm based on experience replay learning technique.
- With the development of this project, a experience learning based algorithm can developed that can be used in various modular robots to achieve real time scalability, and functionality reconfiguration.
- This project will provide a wired module to enable wired control of the robotic arm via developed handheld controller to record action & convert them into devised motion codes and vice-versa.
- Additional filter section is there to edit or add effects during the replay action.

IV. IMPLEMANTATION OF PROPOSED WORK

The system consists of set of fingerprint sensor, microcontroller and RS232 serial communication. The circuit diagram is constructed as per the block diagram. Figure shows the following circuit diagram of the system. . The port D pins i.e. pin D0 & D1 is connected to RS232 pins 10 & 9.

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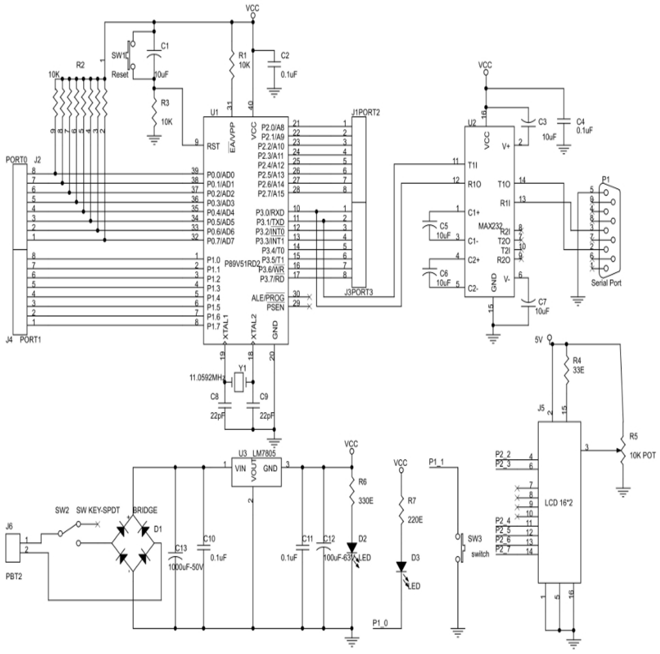

Figure 3: Circuit Diagram

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the indus-try-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory pro-grammer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC). The l293d can drive small and quiet big motors as well, check the Voltage Specification at the end of this page for more information.

For serial communication between DTE(Data Terminal Equipment) and DCE(Data Communication Equipment) RS232 is used which act as a asynchronous serial communication between MAX232 IC and computer. Serial Communication does not directly communicate with computer rather first it sends signals via MAX232. For sending the signals for reading fingerprint image from computer to microcontroller, RS232 is used. It is for reading and writing data. As ATMEGA 162 consist of only two UART, in proposed system three UART are required i.e. for interfacing fingerprint sensor 1 & 2 and RS232 for serial communication. A relay is used which works as a additional UART in system.

The LCD module consists of 16 pins, most of which are hard wire shorted or grounded or given a constant 5v input. Only 6 pins are actively used to control the LCD, i.e. print data on the LCD. Of these 4 pins are data pins. 1 pin is a edge level triggered enable pin. Another pin is the command/data select pin. These 6 pins are connected to port 2 by default.

V. CONCLUSION AND FUTURE WORK

We propose to developing an algorithm based on experience learning approach to record action & convert them into devised motion codes using the Interactive Evolutionary Robotics can be install in any kind of robotic system. It will help us to learn robot on real time basis.

In future we can share the experience with another robotic system. We can also train the robot by visual observation technique in which robot will learn its task only by observation.

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