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Robot Programming using AI – Algorithm and Program Concepts

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***Abstract* — Robot programming using AI involves integrating artificial intelligence techniques into robotic systems to enable them to perform more complex tasks autonomously using sensor inputs or by using the database. AI allows robots to learn from their environment, adapt to changes, and make decisions based on data, rather than relying solely on pre-programmed instructions. This paper gives an Insite and overview of how AI is used in robot programming**

***Keywords*—Robot Programming, Artificial Intelligence, Intelligent Robot, AI using Knowledge Base. AI using Data Base. ABB RAPID program, Lab View program**

I. Introduction

An intelligent robot is a robot that has the ability to take actions and make choices. Choices to be made by an intelligent robot are connected to the artificial intelligence built into it through

- Knowledge Base – Acquire through Digital Inputs
- Data Base – Acquire through Vision Sensors

The Algorithm and programming for both the methods are dealt in this chapter. The programming using sensor input is explained specifically using RAPID Language and the Vision Sensor acquiring and Image processing logics are explained specifically using LAB View Software (Software by National Instruments)

II. Intelligence Through Knowledge Base

The RAPID Language can acquire and process the sensor inputs. Using this feature, the Robot can be programmed based on CNC Door Condition. Ie. If the Doors of the CNC Machine is Open, then the Robot would move and Load or Un Load the components. If the Doors of the CNC Machine is closed, it would wait for the completion of the task. The Digital Input & how the DI is tested and the program for the same using IF conditions are explained in this session.

Fig 1. In the above figure the Robot acquire the sensor input. It places the component only if the slot is free.

Algorithm for Knowledge Base Programming.

The real-world feedback can be given as input to the Robot using Digital Inputs. There are reed-switches attached to the attached to the Doors, Chuck, Conveyor Belt etc. in Robot Work Cells. These Reed-Switch inputs are given as Digital Inputs to the Robot Control Unit. In ABB Robot IRB 1410, eight such Digital Inputs can be given. The below figure 2 shows the Reed Switches fitted on the CNC Door and the Digital Input Signals given to the ABB Robot Controller.

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Fig 2 Reed Switches fitted on the CNC Door and DI signal given to Robot

From various Reed Switches and sensors the inputs are given as DI to the Robot controller. The Digital Inputs (DI) assigned to the ABB Robot available in the Robotics Lab of our institution are given in the Table I below.

TABLE I
DI values set for various action performed

S.No	Action Performed	DI Set
1	Conveyor Stopped	DI10_3
2	Chuck Close	DI10_4
3	Chuck Open	DI10_5
4	Door Open	DI10_6
5	Door Close	DI10_7

Based on the Reed switch values are the Digital Inputs are set on their own. The below diagram explains how the Digital Input 6 is set during CNC Door Open and CNC Door Close conditions.

Fig 3 DI values Set for on its own for various door conditions

To check the DI conditions, we have a command as TESTDI. Based on TESTDI the program statements A or program statements B is executed. This makes the Robot to work based on real world input.

Program for Knowledge Base Programming.

The programming can be done using RAPID program. The IF statement is available under ADD INSTRUCTION. IF statement can be added. To add ELSE to IF Statement, select the IF statement and press EDIT- Change Selected – Add ELSE.

The program listing is given below.

```
Module  Main module

Proc main()
IF TestDI( DI10_6) THEN      (Test Door Open)
        MoveJ(*)             (To Left)
        MoveJ (*)            (To Right)
ELSE
        MoveJ (*)            (To Up)
        MoveJ (*)            (To Down)
ENDIF
End Proc


End module
```

So based upon the DI values, the program listed either after IF or after ELSE is executed. In the above program, if the Door is Opened, the Robot moves its arm to the Left and Right. If the Door is Closed, the Robot moves its arm Up and Down. The below figure 4 explains the above program logics.

Fig 4. If Door Open Robot moves left and right else moves up and down

III. INTELLIGENCE THROUGH DATA BASE

Image can be acquired using Vision sensors. The acquired image can be compared with the known image spectrum data and processed using Lab View Software. Inferences can be made by comparing the acquired image Colour with the Database of images Colours available as shown in the figure 5 below.

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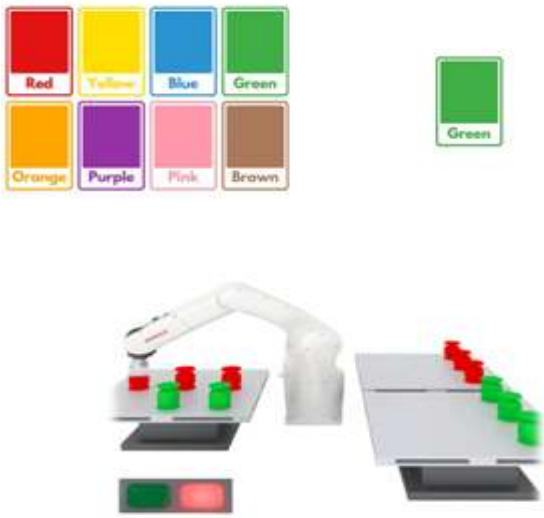

Fig 5. Robot sorting using Vision sensor and Colour Database

The Block Diagram for image processing using Lab view and the Front Panel showing Inferences arrived using Lab View are explained in this session.

A. Algorithm for Data based programming:

To detect the colour of the Object, the image of the Object has to be acquired using Vision Acquisition module of Lab View. Continues image acquisition can be done by using a USB Camera.

The Colour Learning by the Machine can be done through IMAQ Colour Learn Module. Each colour has a spectrum value. We can acquire the image of known colour and note down the spectrum value and position and store them as Data. Similarly, we can acquire images of various Colours and stores its spectrum values and positions and store them all as data.

With these data and through Lab View programming, the colour can be identified.

B. Program for Data based programming

Open Lab View – Blank VI and Press CTRL T to get Front Panel & Block Diagram Windows.

1. In Block Diagram, Right Click – Vision and Motion – Vision Express – Vision Acquisition.
2. Select USB Camera Port & Click Next – Select Continuous Acquisition with Inline Processing – Acquire Most recent image – Next – Next – Finish.
3. Extend the Vision Acquisition Icon to get the Image Out button.
4. Right Click Vision and Motion – Image Processing – Color Processing – IMAQ Color Learn.
    - Connect Left Top – Image Port with Image out
    - Connect Left Centre – Error out to Error In
    - Connect Left Bottom – Color sensitivity – Rt Click – Create Control.
    - Connect Right Top – Color Spectrum Port – Rt Click – Create Control.
5. Rt Click – Array – Index Array and Extend Down for multiple colors.
6. For each color, run the camera & check the spectrum value and position. These values have to be entered as constants as shown in the Block diagram.
7. Place our components on the conveyor and run it by change DO_14 from 0 to 1.

Check the color identified by Lab View Software.

C. NI Lab View Screen Shots

The NI Lab View Block Diagram used to create the logic is given as figure 6 below.

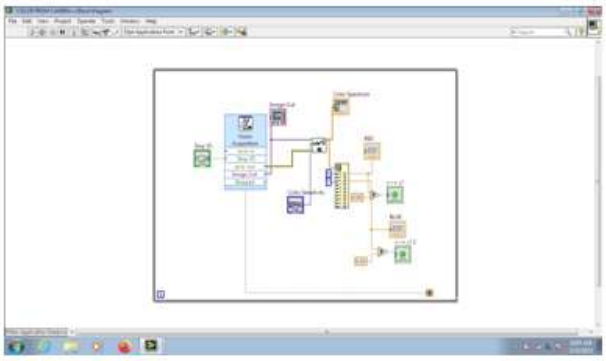

Fig 6. NI Lab View Block Diagram

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The Front panel of NI Lab View showing the output is shown as figure 7 below.

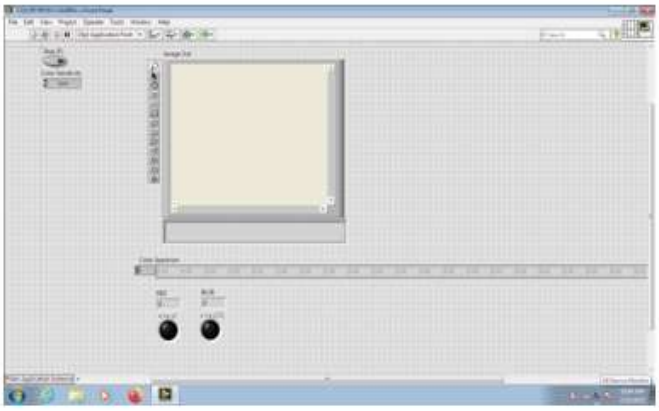

Fig 7. NI Lab View Front Panel

REFERENCES

Various research works are carried out using AI techniques to program the robot like Machine Learning, Deep Learning concepts as dealt in references [1], [2] and [3]. But in this paper the AI Robot programming is done using RAPID program and Lab View software. The references for which are given as [4] and [5] below.

[1] Deep Reinforcement Learning for Robotics: A Survey of Real-World Successes Chen Tang, Ben Abbatematteo, Jiaheng Hu, Rohan Chandra, Roberto Martín-Martín & Peter Stone — Annual Review of Control, Robotics, and Autonomous Systems, 2025..

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[3] Deep Reinforcement Learning for the Control of Robotic Manipulation: A Focused Mini-Review Rongrong Liu, Florent Nageotte, Philippe Zanne, Michel de Mathelin & Birgitta Dresp-Langley — Robotics (MDPI), 2021.

[4] Technical Reference Manual – RAPID Overview

[5] NI Vision for LabVIEW User Manual