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Research paper

A Novel Robotic Arm Design for Small Scale Industries Using myRIO

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Abstract

In small-scale industries, under extreme working conditions, personnel are frequently involved in lifting and carrying raw materials, which is hazardous at times. Robot, a machine with intelligence can perform the same task with the help of control instructions fed by computer or remote control. Technological development in the area of robotics made it possible to design robotic arm with the same degree of precision as a replacement to the human intervention. This will introduce automation in small-scale industries, which saves time, reduces human effort and expenditure in production. Further, this will be a starting point for complete automation of entire process, which can be expensive and complicated. NI LabVIEW along with NI-myRIO can provide a better solution in designing a more precise and accurate robot in a very low cost, which is affordable by small-scale industries. NI-myRIO is used to generate and acquire signals for controlling and processing. Further it has an inbuilt processor and FPGA which has many reconfigurable analogue and digital features.

Keywords: *LabVIEW, NI-myRIO, Robotic Arm, Servomotors.*

1. Introduction

Using robotics in industrial automation and introducing flexible manufacturing system has generated a great demand present days. Robot is more than a machine, introducing robotic technology in small scale-industries has become a solution for problems faced by small-scale industries by reducing the financial burden bourn by the industries and also completing the production/manufacturing process on time to meet the customer demand. Robotic automation [6,11] is suggested in order to replace routine, repetitive, dangerous, time taking tasks performed by human and also, to eliminate human involvement in hazardous working areas. Robotic automation results in great increase in production capacity, improved production quality at low cost. It only required few people to program / monitor the computer / remote and carry out routine maintenance.

Though industrial robotics are in use from early 70s', since 2010 the demand is increased rapidly due to the awareness and trend towards automation and innovation in industrial robots [1]. The existing robotic arms are capable enough to surpass human capability of precise control and movement, which has provided scope for gradual amalgamation of robotics and health care. Further, it is possible to design robot to meet specific and exact needs using NI LabVIEW and NI myRIO with the help of more effective and accurate sensors at small-scale industry affordable cost. Industrial robots are tend to perform a specific operation or movement based on the predefined actions required. The use of generative modelling approach forecasts grasping tasks based on the tentative data fed from sensors received from data, it also identifies the objects and grip selection will be in a task-oriented manner [2, 5]. The capabilities of grasper like Self-adjustability and Self-Stability makes it to perform its tasks accurately avoiding possible mistakes [3]. Further, these advantages enable the functionality of the grasper to be fully computerised / automated.

This system is proposed to replace the requirement of human involvement in performing certain tasks. In this robot, the motion is defined based on the data acquired from the sensors. If the root confronts any difficulty during its functioning, it halts and gives an alert. Robot is used for picking an object and placing it at a predefined destination point. In order to achieve this, the robot should be designed with high endurance, speed and precision in order to ensure quality work with more production output with in the same time taken by the personnel by reducing the overall production cost.

Though the robotic technology is at midst level, in most of the small scale industries the strenuous work is carried out by workers. The proposed robotic arm is a solution due to its capability of handling all the risks including the severe consequences involved and still maintaining the productivity. Unlike existing stationary robotic arms, the proposed robotic arm has extension of capability of moving from one place to the other which will make it powerful in industries [5]. The proposed robotic arm will execute the work at tough working environments and can easily handle repetitive and tedious works which inturn increases the quality of work resulting in less production cost for the industry. Also the robotic arm uses servo motors which are available at very low cost and will require less investment in adopting them in industries. Most of the works executed human can be replaced by this kind of efficient robots in near future.

The remainder of this paper is organized as follows: Section two gives the problem statement. Section three provides the technology adopted for robotic arm. Section four provides the detailed methodology design of the platform. Section five gives flowchart of the system. Section six shows the results of the proposed method. Finally, section seven concludes this work. Some future suggestions such as a functional addition and hardware improvement the project are also mentioned.

2. Problem Statement

Most of the small scale industries are still backward in adopting technology in this technology era and mostly depending on manpower to execute most of the physical work which becomes the major part of production cost due to the increased labour wages. These industries under certain dangerous situations use manpower to carry material weighing high, dangerous materials like chemicals, molten metals and etc. Miss handling of such dangerous materials or mistake in carrying material that weigh high will become hazardous for the worker and also, cause severe accidents in the industries. Working under this kind of tensed environment, where workers need to execute the tasks carefully may result in reduction of productivity.
Robotic automation is quite expensive for the small scale industries due to the initial investment required. The proposed robotic arm addresses the above problems with a solution with a fine product. Object handling was implemented using NI myRIO model by reducing the product cost.

3. Technology Adapted

Proposed design of robotic arm is implemented using three servomotors [7,9], which are autonomously controlled through the instructions, fed from NI myRIO hardware. The NI myRIO hardware is preloaded with NI LabVIEW program, which makes enables the servomotors to function autonomously including executing functions like holding the identified / required material / object, moving it from one place to the other place and placing it at an accurate destination position.

4. Methodology

Fig.1 depicts the model of a robotic arm identified for implementing using the proposed method.

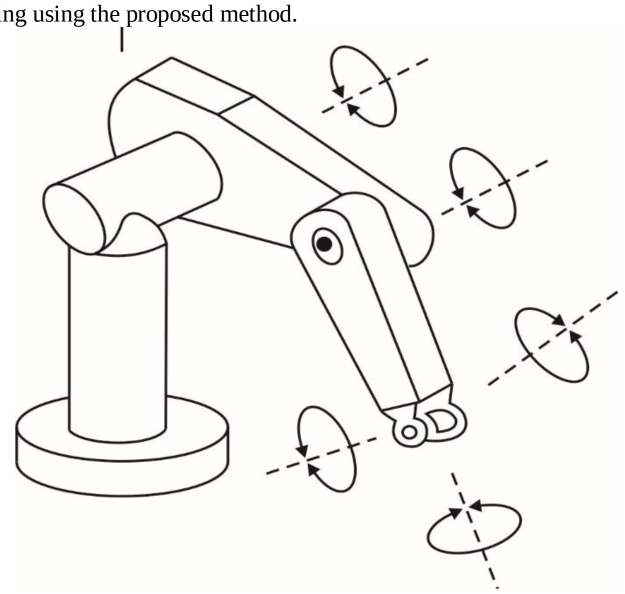

Fig. 1: Model of Robotic arm

Once the arm's end effector reaches the destination, keeping the same orientation the height will be adjusted to accomplish the task.

The proposed robotic arm perform its tasks based on three servomotors. NI myRIO Port A, Port B and Port C are connected to Servomotor 3, Servomotor 2 and Servomotor 1 respectively. The connected servo motors are controlled by the signal received from the respective ports. IC L293D along with a motor driver [10] is used to control the robot, which is equipped with the proposed robotic arm. The IC can control two dc motors or one bipolar servomotor. DC motors with low RPM will be used to execute slow movements upon receiving signals. To drive the motors and to supply higher power, externally 12V will be given to the motor driver as shown in Fig. 2.

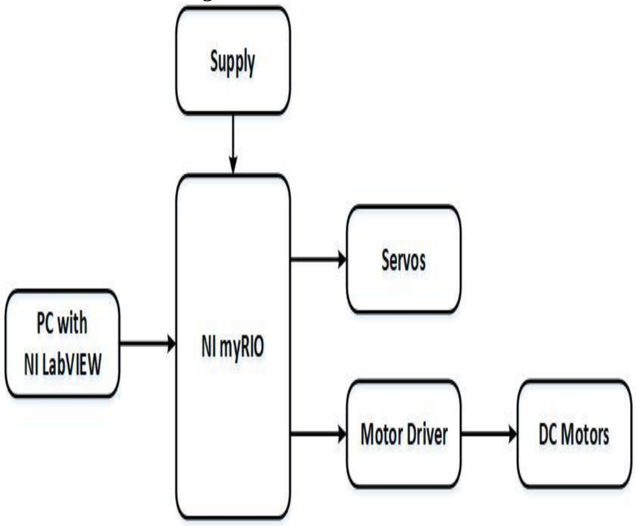

Fig. 2: System Block Diagram

NI myRIO shown in Fig. 3 is developed by National Instruments [8] equipped with a dual core ARM Cortex A9 Processor and one Xillinx FPGA with analog and digital I/P's and O/P's [4]. The core reason for adopting NI myRIO is its capability of acquiring and processing data at real time besides, reconfigurable I/O embedded controller with a real time processor, user reconfigurable FPGA as a single and compact board. In addition to the above NI myRIO has additional Input / Output Ports for Analog and Digital I/O and Pulse width modulation [4]. To maintain the communication and control the host computer to robot Wi-Fi is available on the board.

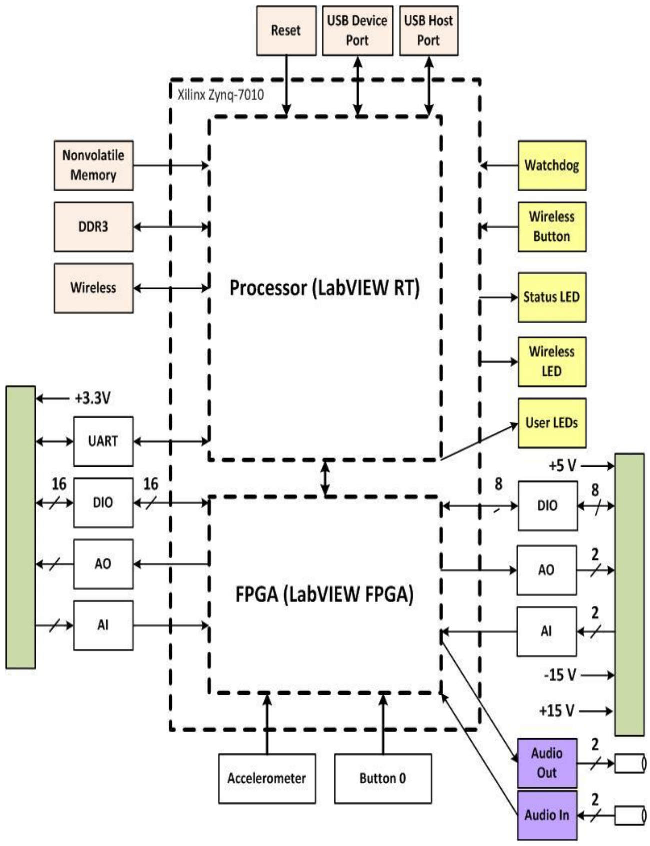

Fig. 3: Layout of NI myRIO

NI myRIO Port A and Port B has 34 pins each termed as MXP and Port C has 10 Pins. NI myRIO produces PWM signals through three pins from Port A, three pins from Port B and two pins from Port C. In Port A and Port B, the pins twenty-seven (27), twenty-nine (29) and thirty-one (31) will produce PWM through FPGA. Each Port has an independent pin to generate 5V. To control the servomotor, three pins will need to be connected in accordance to generate control signal, reference HIGH and LOW, such that it can be varied using PWM signal, which is connected to control as shown in Fig. 4. L293D IC is used to control DC motors, control signals are generated through Digital I/O pins of Port B, namely D I/O 11, 12, 13, 15 and 17.

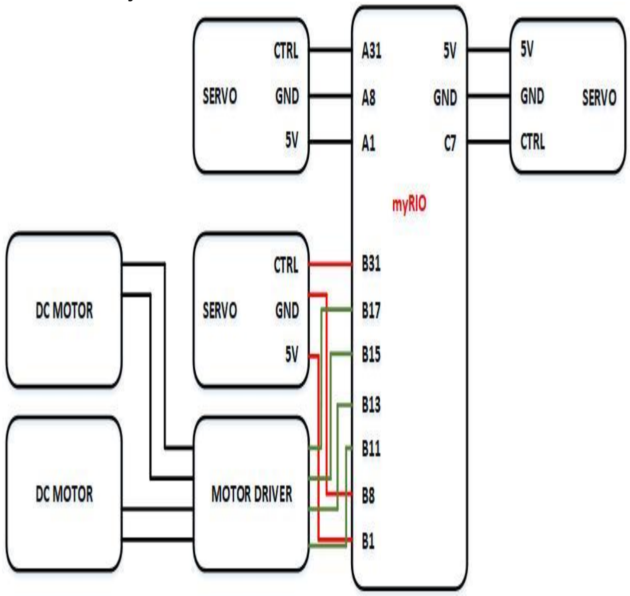

Fig. 4: Connection Diagram

5. Flowchart

Flowchart of proposed system is shown in fig. 5.

6. Results

Fig. 6 shows the prototype of the proposed robotic arm. The arm is installed on a red coloured base. The base is driven by a DC motor setup controlled by a motor driver. The arm was positioned in different angles which represents the flexibility of the arm to extend to reach all the areas unlike human arms which are flexible to certain extent. The gripping action is taken care by the servo motor and the thread connected to the motor.

All motors will move the arm to the initial position i.e., moving the arm to an angle of ninety degrees to the base and signals are sent to servomotors continuously from the NI myRIO, after processing to handle the weight of the object being carried by the arm. After setting to initial position, the arm will be operated with help of servomotor2 by making angular movement with the other branch. Servomotor 3 starts functioning and results in positioning the arm to a bending position as shown in Fig. 7 and servomotor 1 starts rating and resulting in holding and lifting the specified object.

Once the object is picked up, as shown in Fig. 8, servomotor 1 starts rotating and checks whether it can hold / carry the weight. Upon confirmation the robotic arm mounted base moves. Once the robotic arm reaches the destination / desired location the robotic arm moves with the help of the servomotors and control instruction fed from NI myRIO, places the object in a desired location. Fig. 9 shows the Block diagram of the control VI executed using LabVIEW.

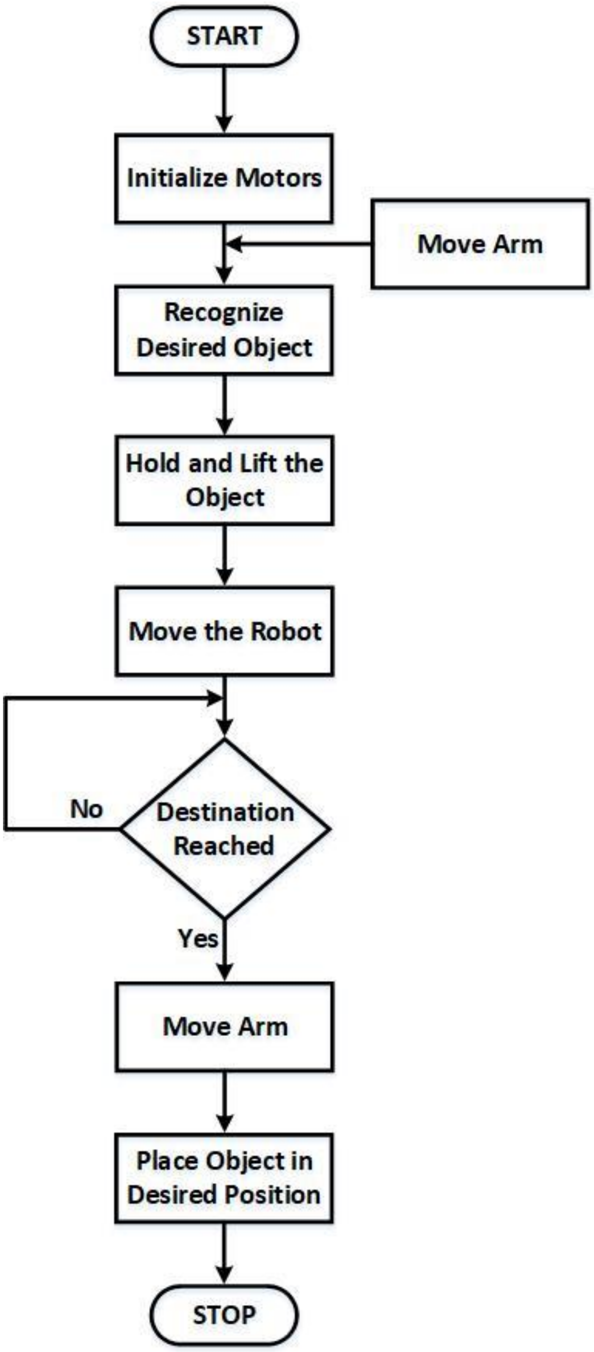

Fig 5: Flowchart

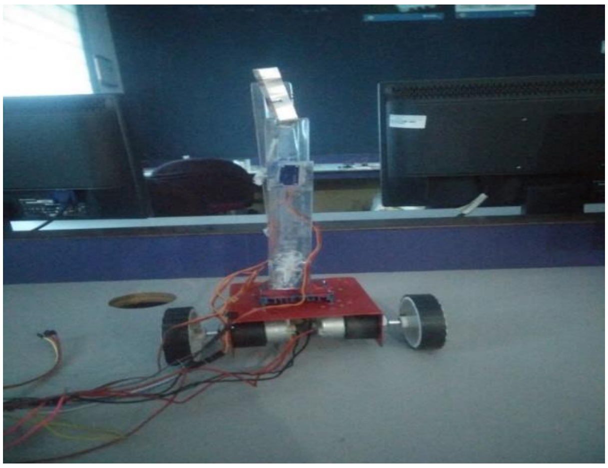

Fig. 6: Proposed Robotic Arm

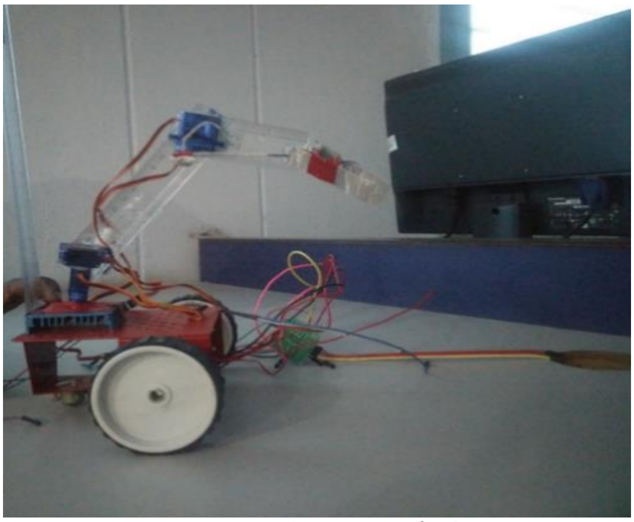

Fig. 7: Bending Position of Robotic Arm

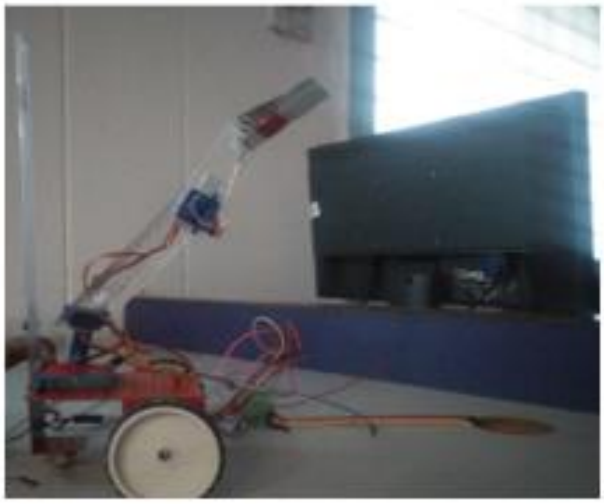

Fig. 8: Picking and Lifting the object

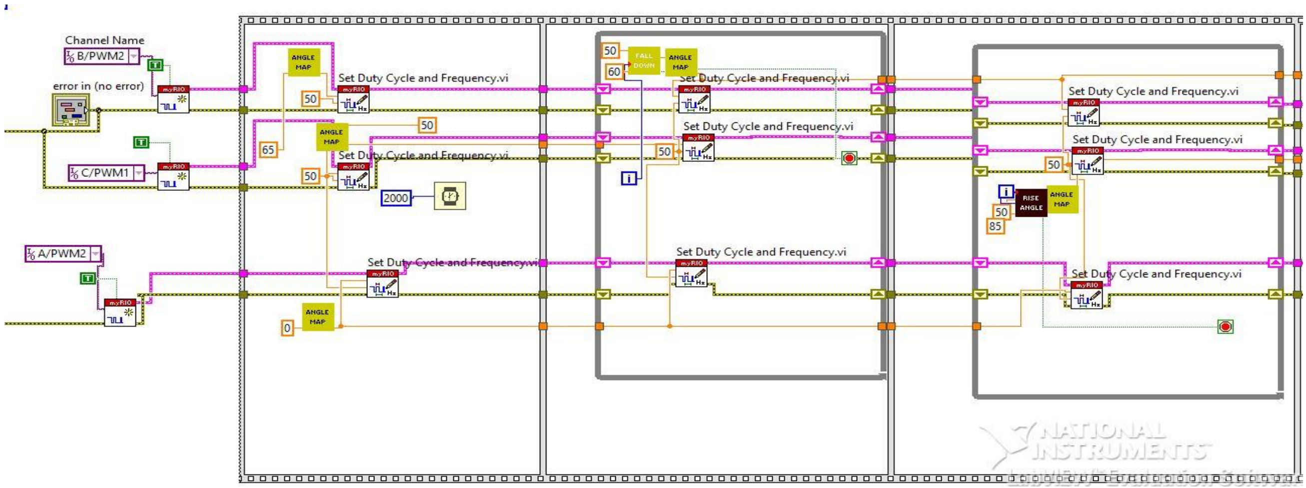

Fig. 9: Block diagram of the control Vi

7. Conclusion

A robotic arm can be manufactured economically with in the financial vicinity to benefit the small scale industry financially both in terms of low investment cost and low production cost with quality and high production output and it also eliminates the financial burden to be borne by the small scale industries in the form of wages to manpower. It also provides a solution to accidents happen in industries by replacing the manpower working under tiresome atmosphere. Robotic arms proves to be more productive in comparison to the humans. This automated setup can be used in different work places with in the industry and in different industries to perform same task and/or similar tasks as per the requirement by simply modifying the controls. Most of the manufacturing industry, mining and medical fields will migrate towards automation to perform under hazardous environment in coming days and the proposed model will be the best suited for certain applications.

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