Real-Time Intelligent NI myRIO-Based Library Management Robotic System Using LabVIEW

Anita Gade and Yogesh Angal

Abstract Library administration is a subcontrol of institutional administration that focal point of consideration on particular issues confronted by library administration. Human being has always tried to give life qualities to its artifacts in an effort to find choice for human to complete tasks by intimidating situation. The prominent thought of robot is work and appearance similar to person. Today's exceptionally forming human advancement, time and labors are impediment for culmination of assignment in expansive scales. The robotics is assuming vital part to spare human endeavors in an expansive bit of the standard and much of the time conveyed works. Frequently, we need labor to pick the book and give up it to the issuing counter. People take additional time and exertion for issuing and returning the book. To conquer this bother, we have developed automation in library for quick conveyance of books utilizing robot with a few degrees of freedom. The usage of robots portrays some of cutting-edge patterns in robotization of the present day process. This work presents automation in library using robot. To accomplish this work, task planning algorithm is used. RFID technology is used to identify the book. This system is NI myRIO-based mechatronic framework recognizes the book, picks a book from source area, and places at desired location using LabVIEW software.

Keywords Book · IR sensor · LabVIEW · myRIO · National instruments RFID · Robotic arm

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1 Introduction

The procreative displaying method allows evaluating the understanding endeavors given faulty questionable data, and furthermore dissents and handles assurance in task-organized way. Robot mechanism have transformed into the game plan, lacking limits as cost work wage and customer's demand. The utilization of robot has expanded seriously; mechanical arms are exceptionally adaptable with the more exact and productive sensors, and we can incite the robot for particular and exact needs. This framework is utilized keeping in mind the end goal to replace human to perform the tasks. Robotic arm is a kinematic chain of open or closed robust links interrelated by movable joints. Robotics autonomy is related with mechanics, gadgets, and programming. These days Robotics Research is focusing on creating frameworks that exhibits adaptability, adaptation to internal failure, measured quality, coordinated idea, programming condition, and perfect availability to different components. In this outline, connections are considered to compare with humanoid structure [1]. Final element of arm is a wrist joint which interfaces a gripper. All troubles required in library administration process have been strongly assessed. In this expect, we are working up a structure using sensors, as demonstrated by the sensor records, the advancement of the robot is controlled. Using mechanical arm, this system picks the book from source zone and spots at fancied range [2]. LabVIEW program empowers the robot to move from source point to destination point keeping away from undefined obstacle present in the path. Robot is working on principle of Sense, Think, and Action, avoiding the obstructions for achieving the goal.

2 Related Work

2.1 System Block Diagram

Figure 1 shows implementation of system consisting of ultrasonic sensor which is used for obstacle detection. This sensor transmits and receives the ultrasonic waves reflected from an object. Once an electrical pulse is applied to the sensor, it vibrates over particular range of frequencies and generates sound waves. As obstacle comes in front of the ultrasonic sensor, the sound waves will revert in the form of echo along with generation of electric pulse. It estimates the time taken between transmitting sound waves and receiving echo. The echo patterns and sound waves patterns will be compared to decide detected signal's condition. The myRIO (my reconfigurable input-/output-embedded controller) is a real-time processor. Benefit of this device is its capability to gain and processing information in actual world. The robot's integral sensors and motors are controlled through the FPGA. The robot

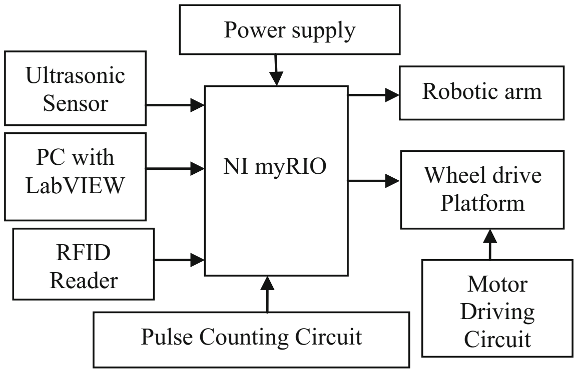


Fig. 1 System block diagram

uses four wheels in drive [3]. Rotation of wheel is measured with optical quadrature encoders with pulse width modulation. The driving framework consists of a main frame, a dc motor, a pair of spur gears, and a flange. The spur gears convert rotary motion into linear motion by operating the dc motor. An end effector is the last part of the robotic arm, which is designed to interrelate with the situation. End effector consists of gripping tool which is utilized for holding the book. The robotic movement is a collaborative action of forward, reverse, left, and right direction to perform the desired task of book griping. We have systemized Wi-fi communication in between robotic system and PC (Fig. 2).

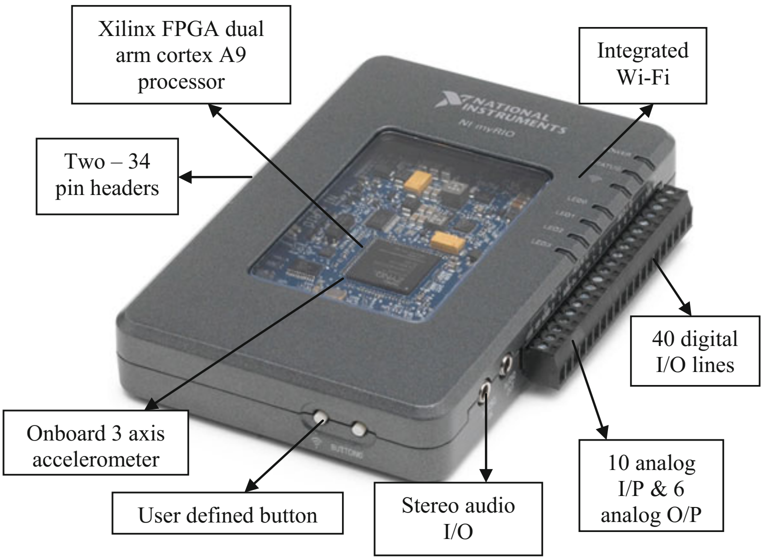


Fig. 2 NI myRIO device

- myRIO
- Power source

We are utilizing battery for power source.

- Actuation

Actuators are strengths of a robot, the elements which transform power into development. Actuators are electrically driven motors that turn a steering wheel and conventional motors control robot in variables.

- RFID

Radio-frequency recognizable proof makes use of electromagnetic radiation to interchange data which consequently distinguish and track labels appended to books. Our framework executes book induction and book-based handle arranging reasonable for a manufactured operator with a particular epitome, by utilizing RFID innovation. The labels hold electronically put away book information. The label data is put away in memory. The RFID tag fuses programmable justification for setting up the transmission and sensor data, independently. It can likewise go about as a security gadget. Truth be told, library spending plans are being lessened for staff, making it essential for libraries to add robotization to adjust for the diminished representatives size. If RFID sensor data matches with entered book then robot performs the action.

- Manipulation

Robots which have to work in the real world need systemized modular concept to control the objects. Robotic hands are as often as possible indicated as gripping tool, whereas the robot arm is referred to controller. Robot arms have flexibility of replaceable effectors, permitting them to execute little scope of assignments. The length of every connection has been planned according to application prerequisite. Gripper is the gadget toward the end of automated arm, intended to collaborate with nature comprising of holding device, utilized for grasping the book. This robot advances in reverse, left, and right, so we can travel wherever to pick book.

- Ultrasonic Sensor

The ultrasonic sensor empowers the robot to practically see and identify and avoid obstacles and compute distance. The working slope of ultrasonic sensor is 10 to 30 cm (Fig. 3).

- Axes of Robotic Arm
- Shoulder raises and brings down the upper arm [4].
- Elbow raises and brings down the forearm.
- Wrist pitch raises and brings down the gripper.
- Wrist roll rotates the end-effector gripper.
- Kinematic Chain.

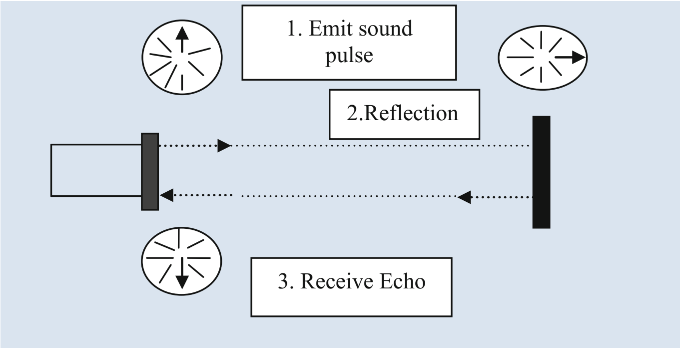


Fig. 3 Ultrasonic sensor

Robot kinematics controls the activity of the controller.

Figure 4 shows the axes of robotic arm. Basics of trigonometry give the joint coordinates of the robot arm for location and direction of the end effector as follows:

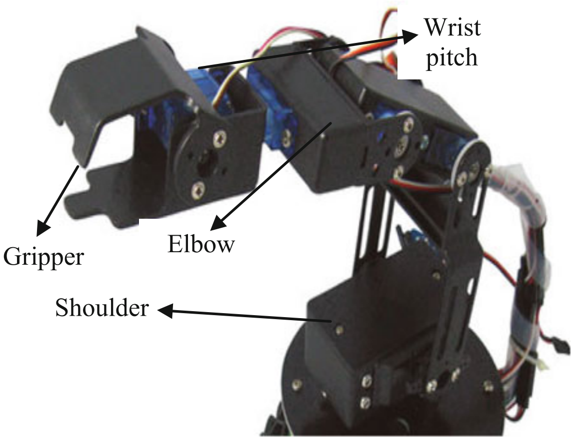
$$x = L_1 \cos \theta_1 + L_2 \cos(\theta_1 + \theta_2) + \theta_1 + L_3 \cos(\theta_1 + \theta_2 + \theta_3) \quad (1)$$

$$y = L_1 \sin \theta_1 + L_2 \sin(\theta_1 + \theta_2) + L_3 \sin(\theta_1 + \theta_2 + \theta_3) \quad (2)$$

$$\varnothing = \theta_1 + \theta_2 + \theta_3 \quad (3)$$

Equations (1), (2), and (3) gives the correlation between the effector coordinates and combined coordinates. To find the joint coordinates to the position of end-effector coordinates (x, y, ¢), we needs to evaluate the nonlinear equations for θ_1, θ_2, and θ_3.

Fig. 4 Axes of robotic arm



Substituting (3) into (1) and (2), θ_3 is eliminated so that we have two equations in θ_1 and θ_2:

$$x - L_3 \cos \emptyset = L_1 \cos\, \theta_1 + L_2 \cos(\theta_1 +\, \theta_2) \tag{4}$$

$$y - L_3 \sin \emptyset = L_1 \cos \theta_1 + L_2 \cos(\theta_1 + \theta_2) \tag{5}$$

Rename Eqs. (4) and (5) as $x_p = x - L_3 \cos \emptyset, \quad y_p = y - L_3 \sin \emptyset$ for ease. From Fig. 5 and the law of cosines, we get Eq. (6).

$$\cos\, \alpha = \frac{P^2 + Q^2 - L_1^2 - L_2^2}{2L_1L_2}$$

$$\propto = A\, \cos\left(\frac{P^2 + Q^2 - L_1^2 - L_2^2}{2L_1L_2}\right)$$

$$\theta_2 = 180 - \alpha \tag{6}$$

$$\theta_2 = A\, \tan 2\left(y_p, x_p\right) + A\, \sin\sqrt{\frac{L_2 \sin \theta_2}{x_p^2 + y_p^2}} \tag{7}$$

From Eq. (3)

$$\theta_3 = ø - \theta_1 - \theta_2 \tag{8}$$

By executing the Eqs. (6), (7), and (8) using LabVIEW, we acquired the robot arm end-effector position. By executing Eqs. (7), (9), and (10), we got the correct joint angles [5].

$$\theta_2 = \theta_2 - 270 \tag{9}$$

$$\theta_2 = 180 - (\theta_3 + 270). \tag{10}$$

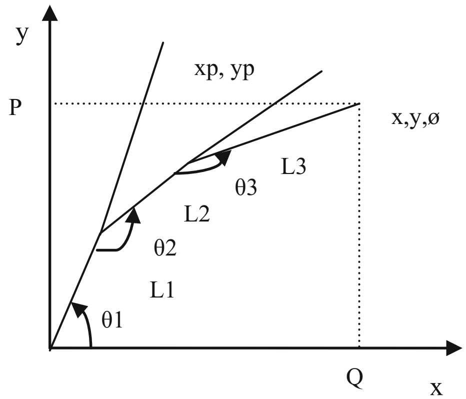


Fig. 5 Kinematic chain

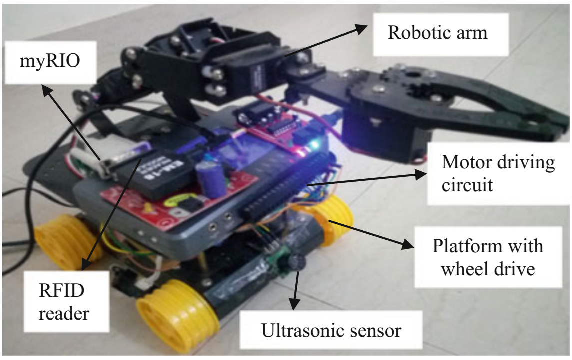


Fig. 6 System development

2.2 *System Development*

Figure 6 shows developed library management robotic system. This system contains NI myRIO device which is processing element. LabVIEW software is used to control and monitor the framework [6]. The arms are directed in *X* and *Y* directions to place the book. For multidirectional robotic movement, DC motors are fitted under the base of robotic chassis platform. Each book placed in rack is tagged by RFID encoder. The robot performs a brute force method search, and when the RFID tag information is matched with desired book, the robotic arm will close jaws to get a hold of the book. The arm is designed so that the book which it grips should not fall down. Suppose user wants to select particular book, then user has to give specific number which is tagged to the book. At that same time, controller starts the RFID module and starts book detection. RFID reader sends particular book tag information to myRIO and then robot starts to travel. If book is detected, then it will proceed for the verification. Arm will pick that book. After picking the book from the rack, robot will return to the book-issuing counter and place the book.

3 Flowcharts for Execution of System

3.1 *Flowchart for Issuing Book*

After entering the user login details, enter the required book to be searched. At that point, framework will show availability of book. Then, user needs to check out book. If searched book is accessible at that time, myRIO provides the flag to robot for fetching the book from specific rack to issuing kiosk (Fig. 7)

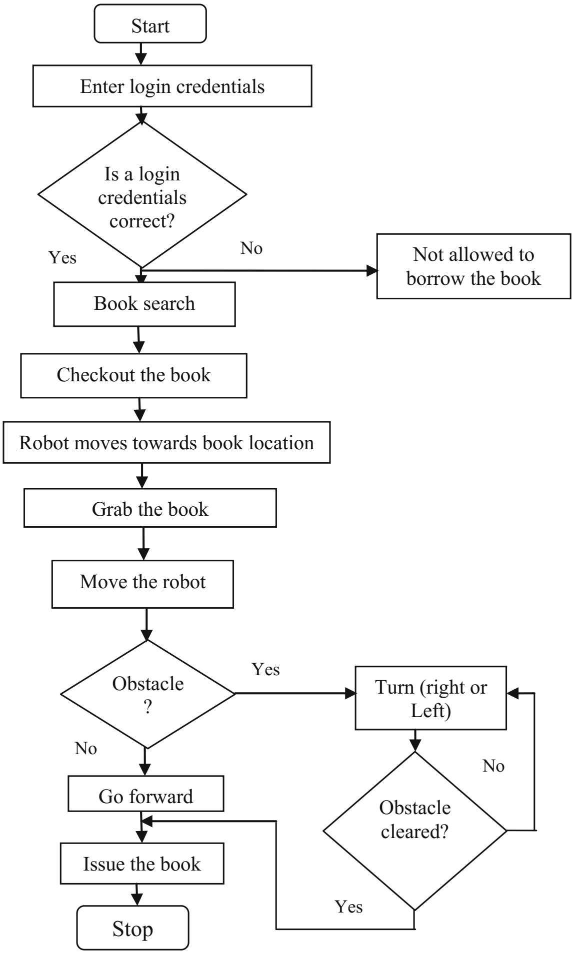


Fig. 7 Flowchart for issuing book

3.2 Flowchart for Returning Book

While returning the book, robot grips the book and detects location of book and moves toward this book location to place book (Fig. 8).

4 Experimental Results

While accessing library records, enter the login details for getting the record data. If login credentials are correct, then user can access the library. Following results show user interface VI, issuing book VI, returning book VI, searching book VI, admin access VI, etc.

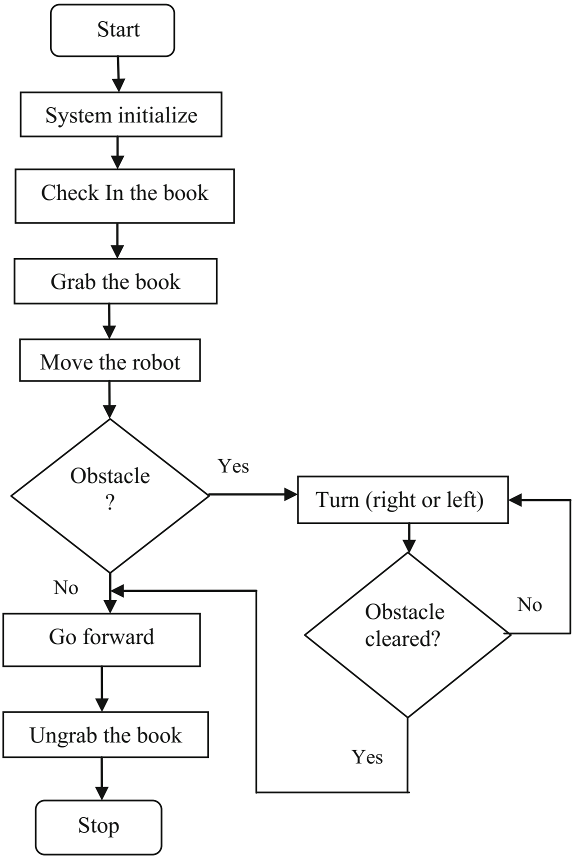


Fig. 8 Flowchart for returning book

4.1 *User Interface Display*

See Fig. 9.

4.2 *Issuing Book Display*

See Fig. 10.

4.3 *Returning Book Display*

See Fig. 11.

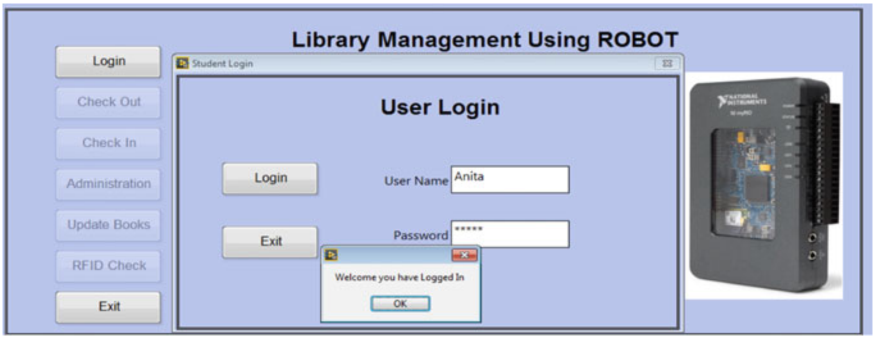


Fig. 9 User interface display

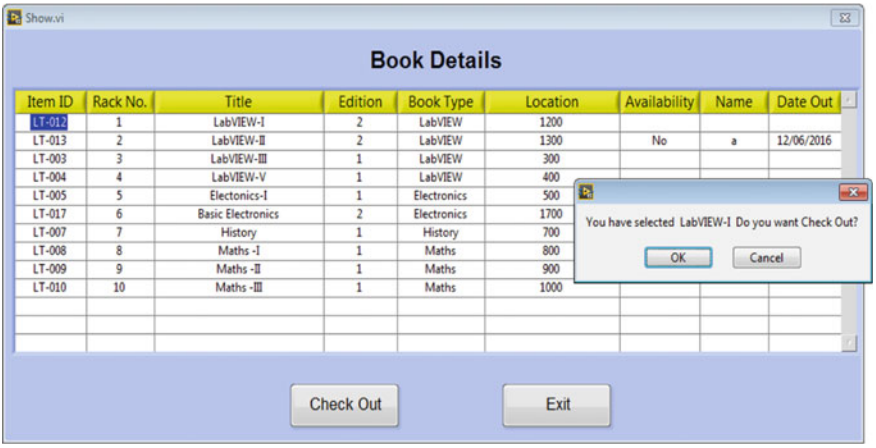


Fig. 10 Issuing book display

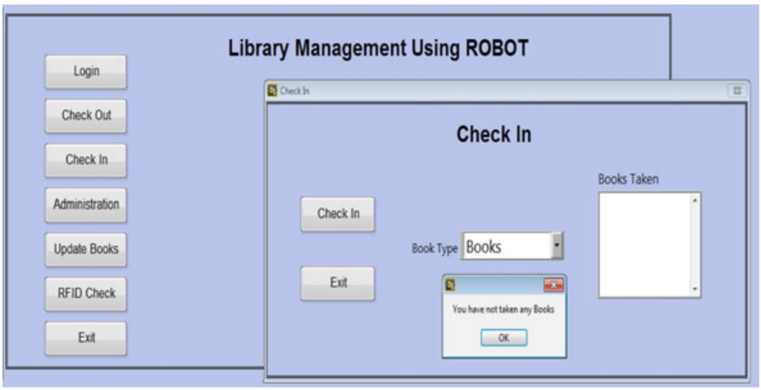


Fig. 11 Returning book display

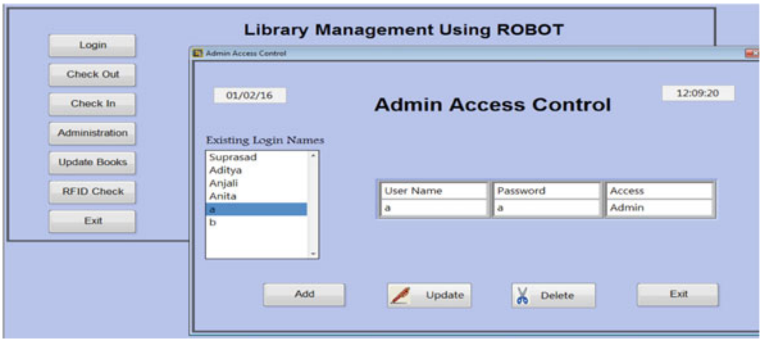


Fig. 12 Admin access display

4.4 Admin Access Display

See Fig. 12.

4.5 Book Update Display

See Fig. 13.

4.6 RFID Test Display

See Fig. 14.

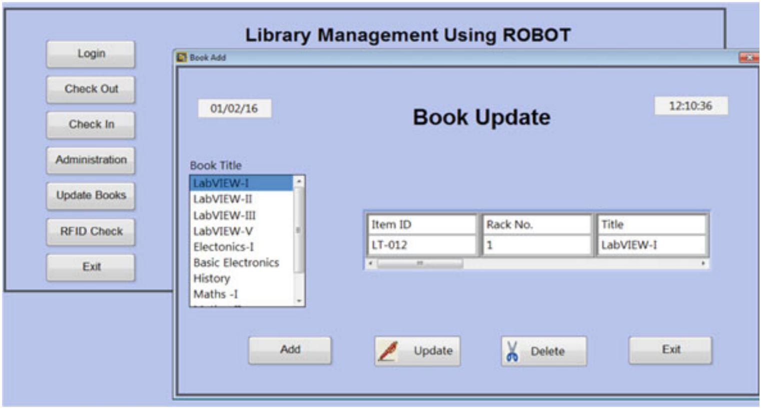


Fig. 13 Book update display

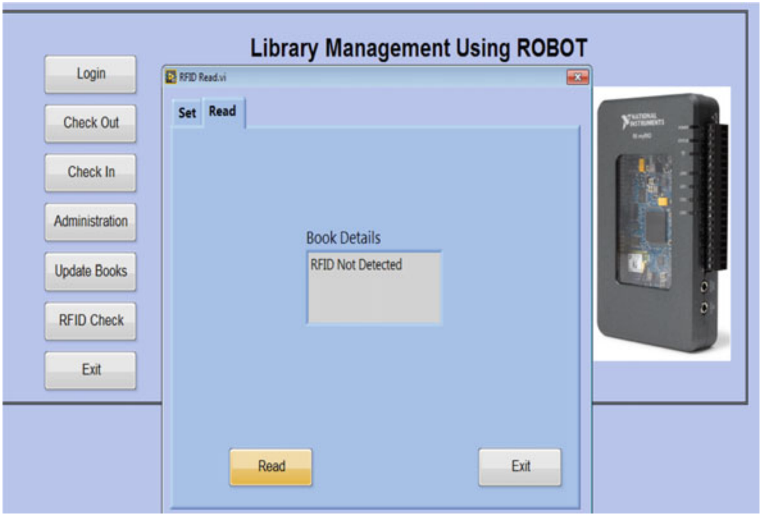


Fig. 14 RFID test display

Fig. 15 Robot output

4.7 Robot Output

See Fig. 15.

5 Conclusion

This work presents automated framework that is able of issuing and returning of book. This system works with high precision, consistency and speed by avoiding obstacle. This scheme eliminates the use of paper work by managing the book database electronically. Admin can update database of new books in library and their accessibility. This system has well systematized and analytically organized the books in various categories in scheme; thus, client can simply access the library.

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