Innovative Systems Design and Engineering
ISSN 2222-1727 (Paper) ISSN 2222-2871 (Online)
Vol.9, No.1, 2018

Design and Implementation an Industrial Application System by using Internet of Things (IOT)

Balsam qasim
Automated Manufacturing Eng. Dept., Al-Khawarizmi Eng. College
Baghdad University
*E-mail:balsamq66@gmail.com

Assistant Prof. Dr. Suha M. Hadi
Information & Comm.Eng. Dept., Al-Khawarizmi Eng. College
Baghdad University
E-mail: dr.suhahadi@gmail.com

Assistant Prof. Dr. Faiz F. Mustafa
Automated Manufacturing Eng. Dept., Al-Khawarizmi Eng. College
Baghdad University
E-mail: faizalrawy@yahoo.com

Abstract

The objective of this thesis is to design and build a real-time system for an automated production line prototype that will consist of CNC machine and robotic arm including many other components like raspberry pi as a controller kit and LDR sensor. It has been programmed in a new approach based on the technology of the Internet Of Things concept, a cloud services from amazon web services (AWS) with the python as a common programming language in the smart system industry to implement this project.

Keywords: 4 Industrial Technology, Industrial Internet of things (IIOT), Raspberry Pi.

1. Introduction

Fourth industrial revaluation will change the classic concept of machines and computer software .Using such an advanced technology will lead the world to the first steps of the new age of intelligent technology, it will make everything easier and smarter by connecting the things with each other starting with marketing department and ends with shipping the products to customers in order to make enterprise works harmonically producing the product in less time, coast and more batter in quality. Applying the Industrial Internet Of Things (IIOT) in the real life factories makes the enterprise more flexible and more efficient. In spite the manufacturing companies have been implementing sensors, Programmable Logic Controllers (PLC) and PC-based controllers for decades but they are far below IT and operational system [2].

The IoT is a network of intelligent computers, devices, and objects that collect and share huge amounts of data. The collected data is sent to a central Cloud-based service where it is aggregated with other data and then shared with end users in a helpful way [6]. IoT have been widely studied and applied in many fields, but applying it in the industry world creates something called the Industrial Internet of Things (IIoT), that allowing a tight and seamless integration between all the functional units and layers that compose industrial processes, from the lowest levels (e.g. field-level devices such as sensors and actuators) to the higher layers, including management, logistics and maintenance. This kind of architecture promises, among other advantages, improving efficiency and flexibility, reduce installation and maintenance costs and reduce unplanned downtime [7].

2. The proposed system aims and specifications

The aims of the proposed system came to execute an ordinary industrial operation at the shop floor by using IT approach as the Industrial Internet of Things (IIoT). So, we will create a production line prototype where the robotic arm picks the objects and place it on the CNC table that will treat the objects according to its G-Code, the communications between those devices will be through the MQTT protocol as an Internet of Things (IoT) protocol, by using a broker besides some other cloud computing services from Amazon Web Services (AWS) in

order to create a database and other services that will be used in the system monitoring website.

Our IIoT system will be consist of two parts, the hardware part that consist of (CNC machine, robotic arm, LDR sensor, raspberry pi kit, PC laptop) while the software part will be concern by the (MQTT Paho, python programming language, Raspbian operating system, cloud computing services).

2.1 The hardware specifications:

Computer Numerical Control (CNC)

It is a machine that automated milling devices which make industrial components without direct human assistance. [9] Open source CNC machine is GRBL CNC milling machine, 0.9j controller model with 3 stepper motors. this will be the main piece in our system which is mini CNC with 160*100*30 mm working area, Notable that GRBL CNC is a no-compromise, high performance, low cost alternative to parallel-port-based motion control for CNC milling.[5]

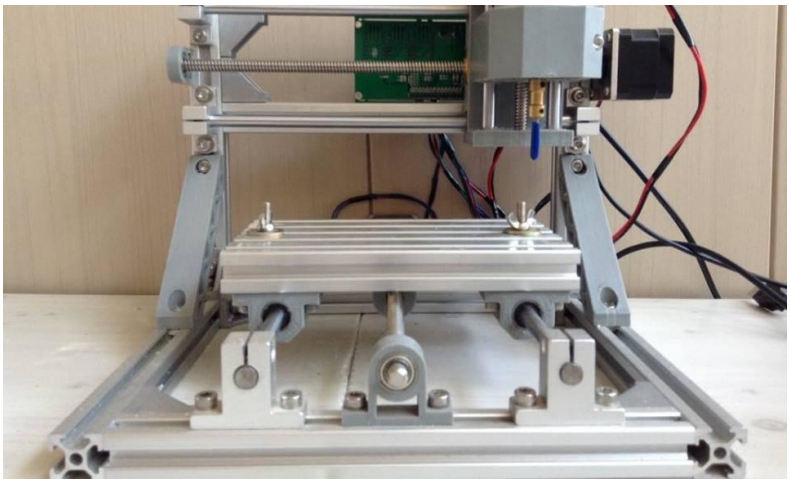

Figure 1. The GRBL CNC

B. Industrial Robotic Arm

Consist of 6 servomotors, 3 links and Gripper. It will be used in the proposed system to pick and place the products.

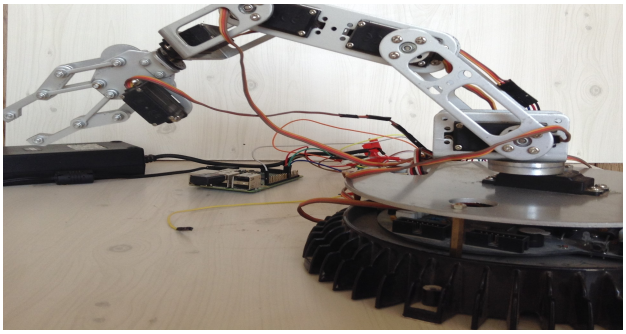

Figure 2. The robotic arm

Fig. 3: Robotic arm circuit

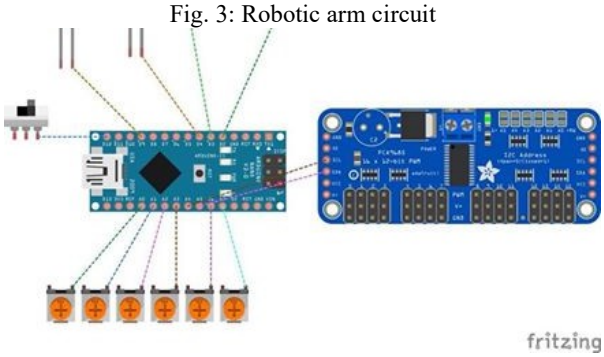

Figure 4. Robotic arm circuit design

The robotic arm circuit consist of Nano Arduino, voltage divider, 6 potentiometers for 6 motors, 2 push buttons, 2 led, switch. This circuit will be connected to raspberry pi with two GPIO pins to control the robotic arm.

C. light dependent resistors (LDR)

sensor and laser pointer also known as Photo resistor, is light sensitive device most often used to indicate the presence or absence of light, [11] Nowadays a readymade LDR circuit is Commonly used, These circuits have the ability to amplify the digital output signal.

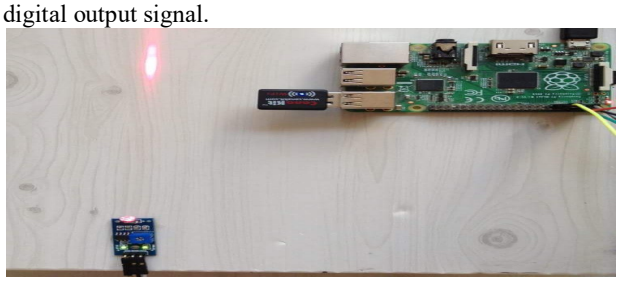

Figure 5. Sensing system (LDR sensor, laser)

D. Raspberry pi B+

Raspberry pi is a low cost, small and portable size of computer board. It can be used to plug-in to computer monitor or television, keyboard, mouse, pen-drive etc. Raspberry pi kit has built in software such as Scratch which enables users to program and design animation, game or interesting video. In addition, programmers can also develop script or program using Python language. [3]

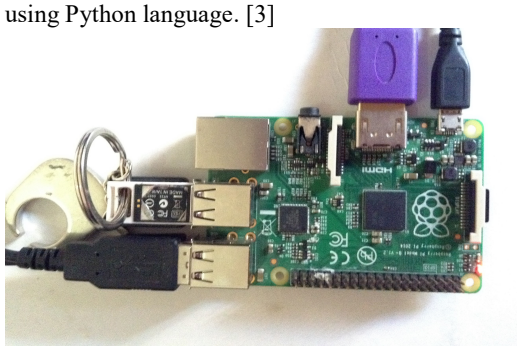

Figure 6. Raspberry pi

2.2 The Software specifications

- Amazon Web Services (AWS) It is a secure cloud services platform, offering compute power, database

storage, content delivery and other functionality to help businesses scale and grow [1], in the proposed system there are many services software have been used just like, Internet of Things (IoT), Lambda function service, Dynamo DB database service, and the last one is simple notification service (SNS) where it's an application Integration service.

- Realtime frame work

Real-time Messaging is a cloud based message broker. Enabling developers to build cross-platform apps that require real-time communication between devices. [4]

- Raspbian

It is a raspberry pi kit operating system; that can be downloaded from official web site of raspberry pi kit.

- Python programming language

will be used in this project, where python is a widely used high-level programming language for general-purpose programming, It has wide range of applications from Web development, scientific and mathematical computing to desktop graphical user Interfaces and with Raspberry Pi both makes possible to connect the project to the real world. [10]

3. The system design

As in figure (7), raspberry pi kit and PC laptop will used as controllers, raspberry pi kit will control the robotic arm and LDR sensor, while the laptop will control the CNC machine. From other side, those controllers will connect to IoT Amazon Web Services (AWS) to achieve the communication between physical layer devices.

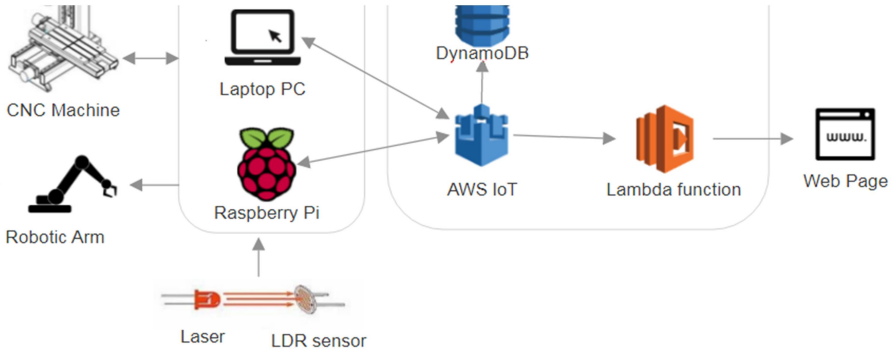

Figure 7. Hardware and software system design

4.The System Implementation

To implement our IIoT system, several of hardware and software parts had to be constructed. First of all, an Amazon Web Services(AWS) account has been created to be able to navigate through all the services that AWS provides , Separately the Raspbian operating system has been downloaded to raspberry pi kit and after setting the kit we get a ready raspberry pi controller with two versions of python that already installed, then we added the Paho MQTT python library, this library makes the controller able to communicate with the broker which means the things that connected to the raspberry pi.

Notable that the robotic arm and the sensing system (LDR sensor, laser pointer) have been connected to the raspberry pi controller through GPIO pins also by python programming language. In other side GRBIL CNC has been connected to PC laptop, and by using python programming code we can run the CNC.

In order to connect raspberry pi kit, CNC machine and LDR sensor to the Amazon Web Services (AWS) we have navigate to IoT service from the main page of the account that we created earlier, so, we will be moved to the IoT console where we can take control, create things, create certificate, make rules, and even test the things. All we have to do now is the creation of three Virtual things named Robotic arm, CNC and LDR and create their certificates and policies, the certificates and policies of robotic arm and LDR sensor should downloaded to their controller (raspberry pi) and certificate of CNC machine and it policy should downloaded to PC laptop. In this way the physical devices will be able to communicate safely with each other using the same broker (AWS

broker).

In order to create the monitoring system to monitor the data that moves between the devices in a real-time, a Realtime cloud service has been used, by service account that has been created with a secure channel that will be used to transfer the data between the IoT devices and the web page over web socket. Also a programming code is wrote to runs in Lambda function service and by using an AWS IoT rule that give a permission to Lambda function to catch the messages that will be published and send it to our web page.

Every product that have been produced in this system will be Documented in cloud database by using Dynamo DB service. Cloud watch service is used to monitor the connections state between devices with each other and the monitoring web application, by sending notifications include the reason of error if anything goes wrong, through using SNS service (Simple Notification System).

5.Test and Results

The system that had been created is working smoothly depending on many tests that have been done, where the sensing system sense product whenever it comes to the container, after, the industrial robotic arm handles it to the CNC machine where CNC treats the product and calls robotic arm to handles it to another place, moreover there is a web monitoring system where all data under monitoring.

6. Conclusion

This paper emphasizes on the Industrial Internet of Things (IIoT) application, it has been created a system presented an industrial application from production line of physical layer in a factory by using the Amazon Web services some of the concluded points are summarized below:

- Users can submit production requests in terms of Cloud Service queries remotely, via the network.
- The system is completely secure, the devices can communicate with each other by using MQTT protocol through using the internet of things technology that makes the system smarter and more flexible,
- Online monitoring and controlling that will minimized the interaction between users and service providers.
- Applying an industrial internet of things(IIOT) is saving the cost of producing the product

References

https://aws.amazon.com/what-is-aws/

Developing Manufacturing Execution Software as a Service for Small and Medium Size Enterprise ,Adedotun Olanrewaju Adetunla , August 2015

Exploring IOT Application Using Raspberry Pi, Cheah Wai Zhao, Jayanand Jegatheesan, Son Chee Loon, January - February (2015)

https://framework.realtime.co/messaging/

https://github.com/grbl/grbl

https://inductiveautomation.com/what-is-iiot

http://ieeexplore.ieee.org/abstract/document/7301497/

https://www.morganmckinley.ie/article/what-are-cnc-machines

https://www.programiz.com/python-programming

http://www.resistorguide.com/photoresistor/