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Control Robotic Arm Workstation Using IoT System for Education

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ABSTRACT

Robotics play an important role in the era of modern technology. Robots can be defined as mechanical devices programmed to perform manipulative tasks under automatic control. Robotic arm is usually used in conjunction with aids such as machines and fixtures. As advancement in robot technology have become an integral part of automation in the manufacturing process. This research gives an idea of how robotic arm can be controlled using internet systems. Therefore, it also a way to reduce the risk of humans being in dangerous areas. The emergence of technology has managed to witness the evolvement of a new era known as the Internet of Things (IoT). The purpose of the research is to control robotic arm workstation using IoT system for education. The research is using Arduino uno Wi-Fi microcontroller and blink application to control IoT system. By using Arduino microcontroller, the robotic arm can directly connect to the internet. Therefore, the implementation of control robotic arm using IoT based on internet connectivity of students.

1. Introduction

The Covid-19 pandemic has raised significant challenges for all community worldwide. This new strain was unknown before December 2019, when an outbreak of a pneumonia of unidentified cause emerged in Wuhan, China. The first case of COVID-19 in Malaysia was detected on 25 January 2020. The WHO Country Office in Malaysia has been working closely with the Ministry of Health to respond to this outbreak [1]. Globally, everything has stopped included higher education. These drastic changes had an impact on lecturers who teach practical subjects such as robotics. The practical subject does not succeed in achieved the objectives because online learning only served the visual. A robot can be defined as a programmable device. It is the combination of mechanical, electrical and electronic elements. Besides that, it is a machine that functions in place of a living agent. Robots are especially desirable for certain work functions because, unlike humans, they never get tired. For the examples, they can endure physical conditions that are uncomfortable or even dangerous, they can operate in airless conditions and they do not get bored by repetition [1]. There will be save the human

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energy and time. There are many definitions of robots. It seems to be of difficulty to suggest an accurate meaning for the word robot, that there are various definitions of this word, different according to the points of view. Some view a robot through the aspect of reprogram ability while others more concern on the manipulation of the robot, behavior, intelligence and so on. The British Robot Association (BRA) defines robot as a programmable device with a minimum of four degrees of freedom designed to both manipulate and transport parts, tools or specialized manufacturing implements through variable programmed motion for the performance of the specific manufacturing task. While the Robotic Institute of America, on the other hand defines the robot as a reprogrammable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motion for the performance of a variety of tasks [2].

The Internet of Things (IoT) has gained significant mindshare, let alone attention, in academia and the industry especially over the past few years. The reasons behind this interest are the potential capabilities that IoT promises to offer. On the personal level, it paints a picture of a future world where all the things in our ambient environment are connected to the Internet and seamlessly communicate with each other to operate intelligently. The ultimate goal is to enable objects around us to efficiently sense our surroundings, inexpensively communicate, and ultimately create a better environment for us, one where everyday objects act based on what we need and like without explicit instructions [3].

Many robotic arms using Internet of Things (IoT) have been proposed by past researcher [4-10]. Rayes & Salam [11] will be proposed a smart classroom using IoT. The design the smart classroom concept come into the literature as Internet based distance education system; or as intelligent environment issued with an assembly of many various types of hardware and software modules. In the process of everyday teaching, teachers or professors are usually trying to find out if the students (or more general the listeners) were satisfied with the lecture, which section of the lecture was interesting, which presentation techniques and methods were more effective and attractive than the others. This study deals with Integrating the IoT technology with the social and behavioral analysis, a standard classroom can be transformed into a smart classroom that actively listens the voices, conversations, movements, behavior. In order to come to a conclusion about the lecturers' presentation and listeners' gratification. This will help the lecturers to consistently deliver good presentations.

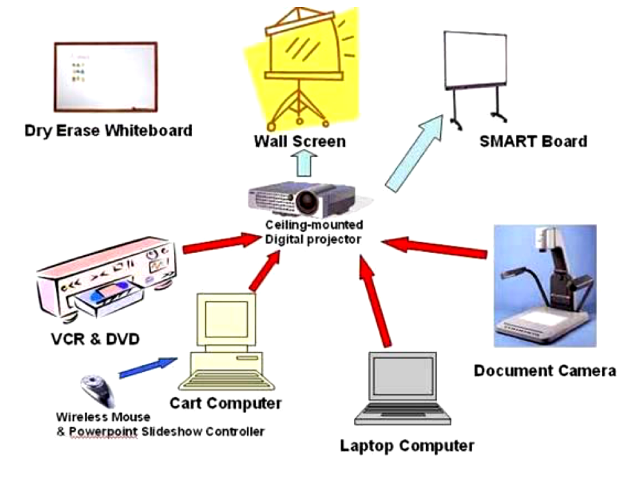

Fig. 1. How of Smart Board [11]

Many authors [12-20] represent controllable robotic arms using Internet of Things (IoT) technology consider different degrees of freedom for various applications. According to IR 4.0

development, Chia [21] also produced the robotic arm using Internet of things (IoT). The research use IOT module to receive data from the workstation, and then the AOI system detects product damage and product identity. The results of the experiment are stored in the database and shown on the web page. All workstation data situations can be monitored through the monitoring web page by the user. The purpose of the research, it can leave hazardous conditions and remotely via computer to monitor the work process.

2. Methodology

Figure 2 block diagram shows the block diagram of the research. The project is consisted of input, process and output. The inputs are switch and power supply. The process is Arduino microcontroller and the output are PC and smartphone.

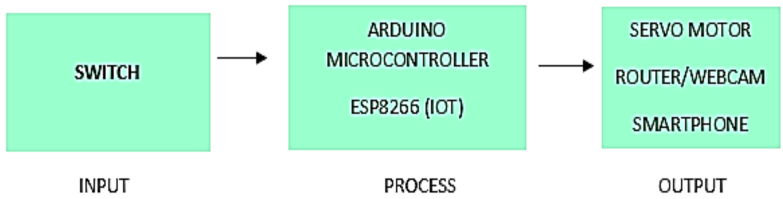

Fig. 2. Block Diagram of research

The research can be operated in either using smartphone or laptop as shown in Figure 3. To make this possible, the subscription to Blynk application is necessary for developer only while on student's part, the research only use the free version of the application. Every workstation of robotics arm will be equipped with Arduino, Raspberry Pi and webcam. Raspberry Pi work as a "slave" at each workstation while the "master" controller is a PC which connected through LAN or Wi-Fi.

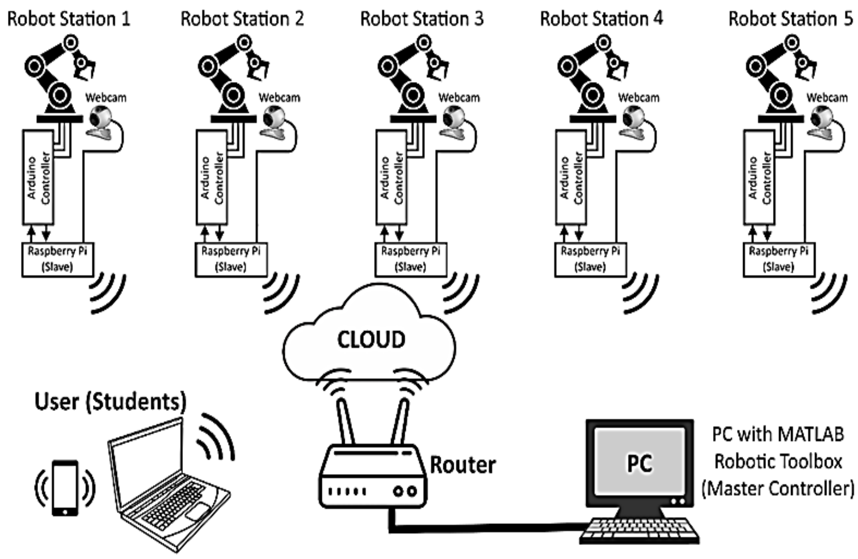

Fig. 3. Robotic Arm workstation using IOT

Figure 4 show the flowchart of the research. This flowchart described the starting process is initializing the serial communication port. Then, find the angle of each joint. If the angle is valid, the signal will be sent to Arduino controller to monitor and control the robot arm.

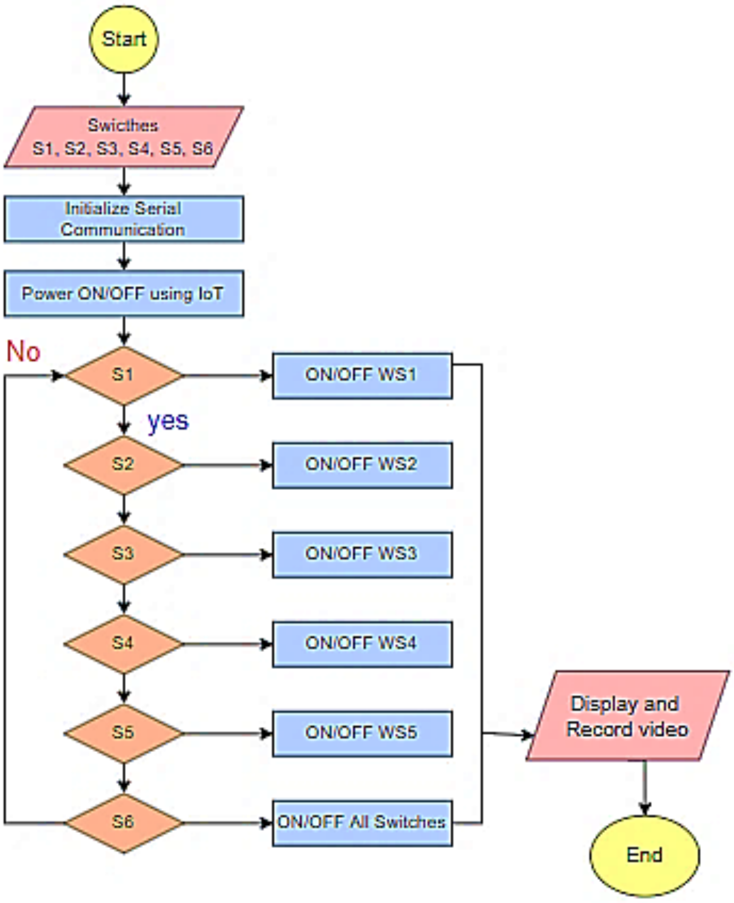

Fig. 4. Flowchart of Robotic Arm using IOT

3. Material of Project

The main components that will be used in this project are shown in the Table 1.

Table 1
List of materials

No.	List of Materials
1.	Robotic Arm
2.	Arduino Wi-Fi
3.	DC Servo Motor
4.	Tinker Kit Braccio Robot
5.	ESP32 Camera Module
6.	Smart Phone
7.	PC

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. The Arduino Uno WIFI use for the research as a controller and the robotic arm can connect direct using IOT.

Fig. 5. Arduino Uno Wi-Fi

A The DC servomotor is used as an output to control movement of the robotic arm. The connection of servo motors is directly to an Arduino to control the shaft position very precisely because servo motors use feedback to determine the position of the shaft, you can control that position very precisely. As a result, servo motors are used to control the position of objects, rotate objects, move legs, arms or hands of robots, move sensors etc. with high precision. Servo motors are small in size, and because they have built-in circuitry to control their movement, they can be connected directly to an Arduino.

Most servo motors have the following three connections:

i. Black/Brown ground wire.
ii. Red power wire (around 5V).
iii. Yellow or White PWM wire.

Fig. 6. DC Servo Motor

The tinker Kit Braccio is a fully operational robotic arm, controlled via Arduino. It can be assembled in several ways for multiple tasks such as moving objects. You can also attach a camera or solar panel. There are so many ways in which the Braccio can extend the reach of your devices. Please note: Arduino board not included. There is an on-board voltage regulator for higher voltages that protect the Braccio shield. The protection doesn't work for the Arduino Yun if you put the bridge between Vin and 5V on the Arm Robot Shield V1 (greater version of are called Braccio shield and has a power switch on the top of the shield). Braccio Shield: The maximum length and width of the Braccio Shield PCB are 2.7 and 2.1 inches respectively, with the power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100-mil spacing of the other pins.

Fig. 7. Tinker Kit Braccio Robot Arm

The ESP32-CAM is a low-cost ESP32-based development board with onboard camera, small in size. It is an ideal solution for IoT application, prototypes constructions and DIY projects. The board integrates Wi-Fi, traditional Bluetooth and low power BLE, with 2 high- performance 32-bit LX6 CPUs.

Fig. 8. ESP32 Camera Module

4. Results and Discussion

In this study, the implementation control robotic arm workstation based on IoT will be tested five samples internet connectivity of students as shown Table 2 till up Table 5 show the results control and monitor of robotic arm education using IoT.

Table 2 shows the results of sample 1, workstation A, workstation C and workstation E have a strong connectivity and allow the switch to be turned on. While workstation B and workstation D have low connectivity and cause the switch turned off.

Table 2
Results of Sample 1

Students (Group 1)	**Workstations**	**Internet Connectivity**	**Switch (ON/OFF)**
Student 1	Workstation A	Strong	ON
Student 2	Workstation B	Low	OFF
Student 3	Workstation C	Strong	ON
Student 4	Workstation D	Low	OFF
Student 5	Workstation E	Strong	ON

Table 3 shows the results of sample 2, workstation A, workstation B and workstation E have medium and strong connectivity and allow the switch to be turned on. While workstation C and workstation D have low and no connectivity and cause the switch turned off.

Table 3
Results of Sample 2

Students (Group 2)	**Workstations**	**Internet Connectivity**	**Switch (ON/OFF)**
Student 1	Workstation A	Strong	ON
Student 2	Workstation B	Medium	ON
Student 3	Workstation C	No internet	OFF
Student 4	Workstation D	Low	OFF
Student 5	Workstation E	Strong	ON

Table 4 shows the results of sample 3, workstation A, workstation B, workstation C and workstation D have medium and strong connectivity and allow the switch to be turned on. While workstation E have no connectivity and cause the switch turned off.

Table 4
Results of Sample 3

Students (Group 3)	**Workstations**	**Internet Connectivity**	**Switch (ON/OFF)**
Student 1	Workstation A	Medium	ON
Student 2	Workstation B	Medium	ON
Student 3	Workstation C	Medium	ON
Student 4	Workstation D	Strong	ON
Student 5	Workstation E	No Internet	OFF

Table 5 shows the results of sample 4, workstation A, workstation B and workstation C have medium and strong connectivity and allow the switch to be turned on. While workstation D and workstation E have low connectivity and cause the switch turned off.

Table 5
Results of Sample 4

Students (Group 4)	**Workstations**	**Internet Connectivity**	**Switch (ON/OFF)**
Student 1	Workstation A	Strong	ON
Student 2	Workstation B	Strong	ON
Student 3	Workstation C	Medium	ON
Student 4	Workstation D	Low	OFF
Student 5	Workstation E	Low	OFF

Table 6 shows the results of sample 5, workstation A, workstation D and workstation E have medium and strong connectivity and allow the switch to be turned on. While workstation B and workstation C have low and no connectivity and cause the switch turned off.

Table 6
Results of Sample 5

Students (Group 5)	Workstations	Internet Connectivity	Switch (ON/OFF)
Student 1	Workstation A	Strong	ON
Student 2	Workstation B	Low	OFF
Student 3	Workstation C	No Internet	OFF
Student 4	Workstation D	Medium	ON
Student 5	Workstation E	Medium	ON

Overall, the results are showing the robotic arm workstation can be operate based on internet connectivity as shown in Figure 9.

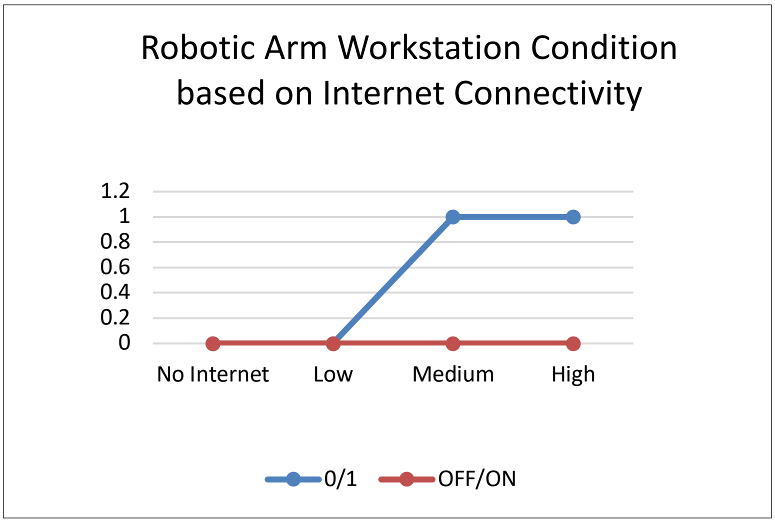

Fig. 9. Robotic Arm Condition

Regarding to the Table 2 - Table 6, the internet connections of students are strong or medium, the switch of the robotic arm will be **"ON"** and the robot will be operated. When the internet connections are low or no internet, the switch will be **"OFF"** and the robot cannot be operated.

Table 7
Overall Results

Condition of Internet Connectivity	Switch Condition (ON/OFF) 0 = OFF / 1 = ON	
No Internet	0	OFF
Low	0	OFF
Medium	1	ON
High	1	ON

4. Conclusion

For the conclusion, research has successfully to control robotic arm workstation through the Internet of Things (IoT) system. Meanwhile, the robotic arm can be smartly monitor using personal computer or smartphone connected to the same network. In this study, the robotic arm using IoT is to help the students and lecturer will be able to interact through online practical learning sessions. Students can operate the robotic arm directly through online. Lecturers can implement teaching and learning through monitoring of tasks given to students. This research also can be useful to various industrial applications where machines need to be controlled from distant places. Further work, the research will be monitored using webcam.

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