Industrial IoT Solution for Powering Smart Manufacturing Production Lines

Ayman M. Mansour[1(✉)], Mohammad A. Obeidat[2], and Yazan A. Yousef[3]

[1] Department of Communication, Electronics, and Computer Engineering, College of Engineering, Tafila Technical University, Tafila 66110, Jordan
mansour@ttu.edu.jo
[2] Department of Electrical Engineering, Faculty Engineering, Al-Ahliyya Amman University, Amman 19328, Jordan
m.obeidat@ammanu.edu.jo
[3] Ejada Industrial Company, Sahib Industrial City, Sahab, Jordan

Abstract. Iot has great benefits in all areas of life, such as factories, transportation, and airports. In this paper, a solution for monitoring the machines in a wet wipes papers factory is proposed. This factory face a problem in controlling the machines outside the working hours. One of the problems is dissolving the glue using to seal the wet wipes paper container by the heater machine about one hour before the workers come to the factory in the morning. To solve this problem, A system can be used to monitor the heater machine and this machine can be controlled online using IOT technology. The IOT can be used for both monitoring and controlling the whole process for all machines in the factory.

Keywords: Internet of Things · Factory automation · Glue heater

1 Introduction

The Internet of Things (IoT) is a system that allows devices to be connected and remotely monitored across the Internet. In the last years, the IoT concept has had a strong evolution, being currently used in various domains such as smart homes, telemedicine, industrial environments, etc. [1–5].

The production line for the manufacture of wet wipes (Fig. 1) consists of three stages. The first stage is the basic stage so that the function of the machine at this stage is to draw Tissue rolls, which are called (Nonofen), and sometimes consist of 6 or 12 rolls. So that its main function is to bend and cut the napkins according to the required size and dimensions.

Within this stage, the wipes are moistened with perfume or a moisturizing substance to obtain the required moisture percentage. After this process, through a number of transmissions, the tissues that were cut and moistened are transferred to the star, which places the tissues on top of each other in order to reach the required number and the number of tissues varies. It is called a start because of its shape and movement which is

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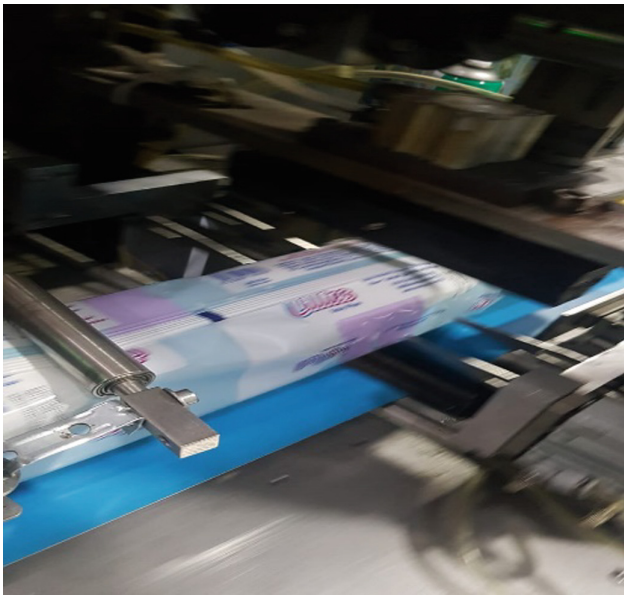

Fig. 1. Wet wipe production line.

similar to a star. Inside the product, according to demand, it comes with 120, 72 or 52 napkins.

There are some main parts of this machine. The main motor pulls the rolls into the machine. The folds (which bend the napkin to the required width and control the width is manual, and as for the length of the napkin, it is controlled by entering the required dimension scale into the control screen only. Humidification pump, which pumps a percentage of the perfume or water during the withdrawal process, and the humidification percentage is controlled through the main control screen of the machine (machine).

The blades, which play an important role in the quality of the product, which cut the required length so that its principle is a rotational principle, that is, through an electric motor at a very high speed, which cuts the napkins, and the number of blades is 2 according to the rotational speed. The star, which are cut to certain dimensions, are emptied through transmissions and transmissions are belts with circular sections, and the material from which they are made is rubber. The star rotates at a certain speed, transferring the tissues to the elevator. The elevator principle of its work is based on the time delay, and the tissues are connected to a machine, and the napkins are arranged in it on top of each other vertically to obtain the required number of napkins either 120, 72 or 52.

The second stage, which is called the stage of packaging and welding. This machine consists of the nylon material with which the product is wrapped. The nylon is welded longitudinally and transversely, and then each piece is separated from the other (each product from the other). This machine consists of longitudinal welding discs that pull the nylon in conjunction with the entry of wet wipes inside it. And then, a knife that cuts

each product from the other. At this stage, the production and expiry date is set and the batch number is called the batch number and batch number.

Temperature plays an important role in this stage, so that for each nylon, which encases the product, a certain temperature is heated through the screen for this machine, and through electric heaters, the heat called the heater is generated. The temperature is known from the thermo cable. The synchronization of the entry of wet wipes into the nylon is controlled by sensors that work on taking a reading through the wipes and thus giving an automatic order to electric motor so that it weaves the transmissions to enter the wet wipes into the nylon to complete the welding process and cut each product from the other. Note between each machine (stage) there are transmissions that move the product from one stage to another. After the second stage, the product is transferred to the third machine so that the product remains only to add the plastic cover.

The third stage is the focus of this paper. At this stage, the machine is No. 3, which gives the product the final requirements in order for the product to be usable. The plastic cover is added and the product brand is added through the so-called stickers (stamps) as shown in Fig. 2.

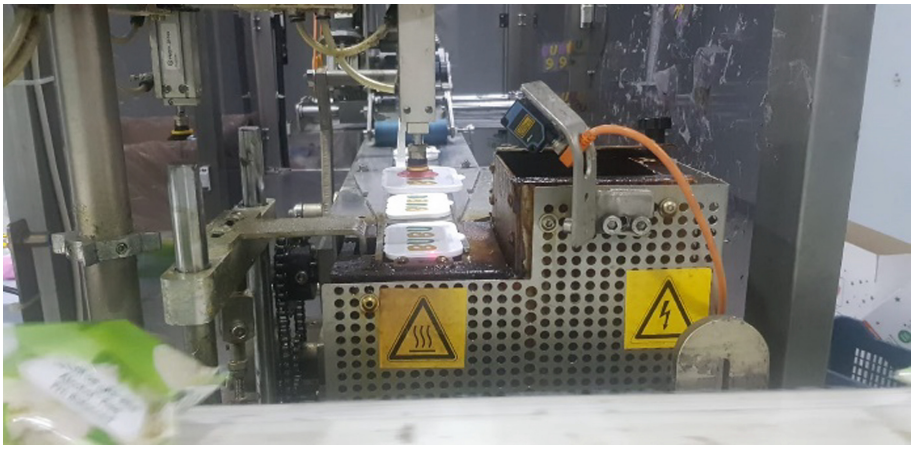

Fig. 2. Wet wipe cover packet fixing device.

The plastic cover is fixed with reusable glue to keep wet wipes from drying out, which is the main focus. The glue needs a temperature of 165 °C to turn from a solid state to a liquid state. So that heating is done by a heater (electrical heaters) (Fig. 3) and it takes 50 min to turn into a liquid state, in addition to the large amount in the space designated for the glue.

What is required is to make a specific program in order for the glue machine to work through an online application, so that the time required for the machine to be ready to work before starting the factory's work in the early morning is reduced.

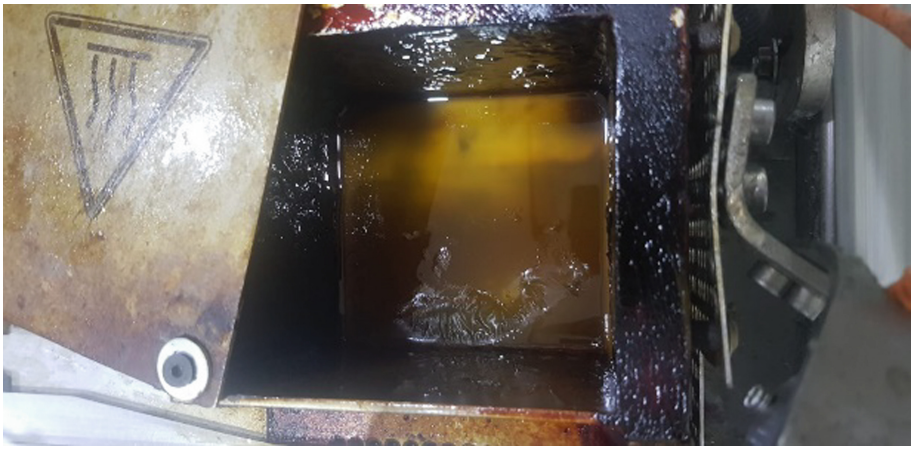

Fig. 3. Glue heater.

2 System Architecture and Design

This section illustrates system architecture and design as well as the software configuration, The components of the real smart network are: Tow computers with network interface card (NIC), Ethernet cable cat5 with Rj45 connecters in both side And an Ethernet switch. Two computers have been used here to make the identification process more realistic, the data are being transferred from one to the other and then received again.

OPC is a compatibility framework for transferring data securely and reliably in the industrial automation and other industries. It is platform that irrelevant and ensures a smooth flow of data between devices from various manufacturers., OPC., it based on the client server model as shown in Fig. 4.

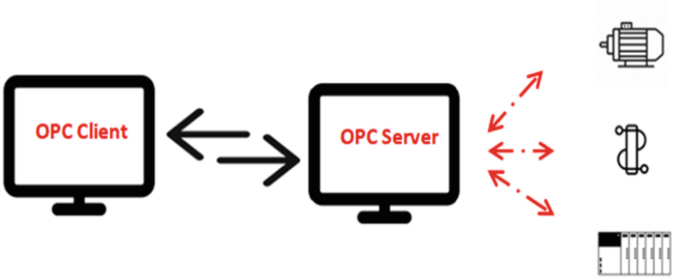

Fig. 4. OPC server.

The OPC software used in this paper is KEPSERVER, this platform's design enables users to connect, manage, monitor, and control various automation devices and software applications via a single user interface.

Each one of the computers must be given a specific IP address through the Ethernet switch, one of the computers will be the OPC server "KRPSERVER" and the other computer will be the OPC client "MATLAB" Fig. 5 below shows the hardware and software topology.

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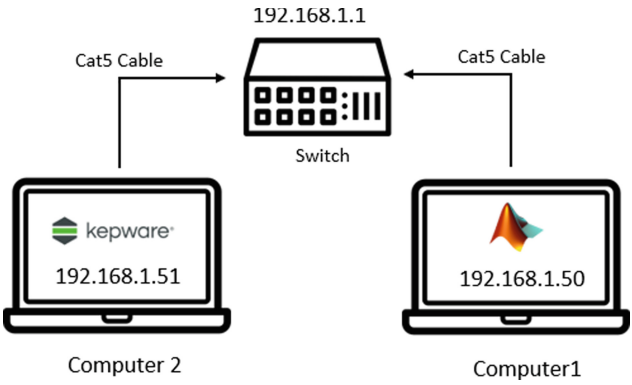

Fig. 5. Network architecture.

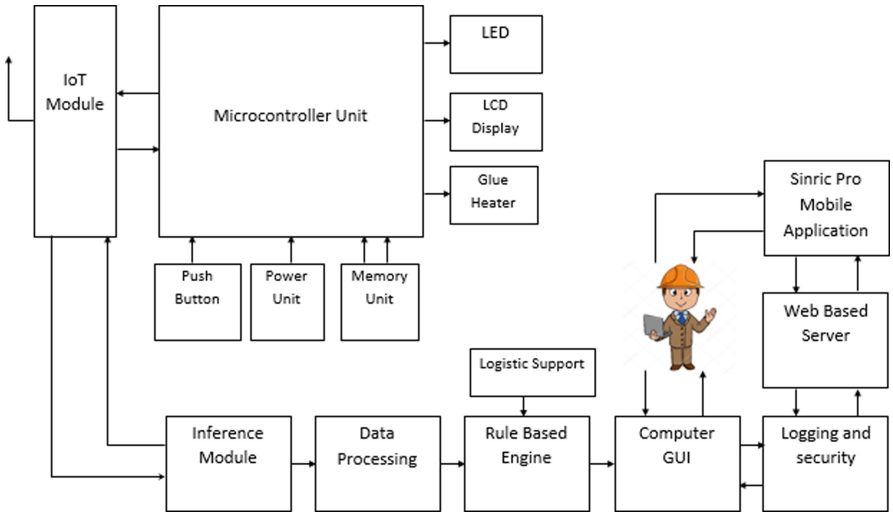

Fig. 6. System block diagram.

As you can see from Fig. 5, both computers must be in same subnet mask OPC Client - computer 1 is configured with "192.168.1.50" IP address and OPC Server – computer 2 is configured with "192.168.1.51" IP address. The developed system consists of IoT Kit, microcontroller unit, GSM module, LCD display, LEDs and glue heater unit as shown in Fig. 6.

3 The Developed IoT System

In this section, we describe the proposed IOT system. The proposed system consists of a collection of hardware and software, as illustrated in Fig. 1. The hardware module includes a microcontroller (Arduino Uno), which is connected to a relay set of type Songle Relay (SRD) as shown in Fig. 7. The relay acts as a switch. It can switch to high voltage using low power circuits. The SRD relay has three pins (IN, GND and VCC).

Fig. 7. SRD relay.

The "IN" pin of the first relay is connected to a pin on the microcontroller to switch the relay on/off and thus turn the glue heater on/off with respect to the a command either from amazon Alexa or mobile app. All appliances are working on 220 voltage.

A Java code is developed to communicate with the serial port to which the IOT is connected (Fig. 8).

Fig. 8. IoT kit.

In our experiment, we have the following sound command ("Heater on," "Heater off,"). The IoT kit received the voice command from amazon alexa (Fig. 9) or from mobile app and then it sends and order to the serial port to which the IOT is connected.

Fig. 9. Amazon Alexa.

The IOT Kit is an easy to deal with in both hardware and software. It contains everything needed to support the work of microcontroller. It can work as stand alone device or it can communicate with other software in PCs through a USB cable.

The IOT kit is programmed using the Arduino Development environment simply through connecting the board to computer via USB. The programming is considered easy task with Arduino compared with other devices that typically need an external programmer. IOT Kit receives input from the environment through a variety of sensors. The received data will be processed through the microcontroller unit and the output can affect the surrounding by controlling Buzzers, LCD, LEDS and other devices s. Arduino is an open-source electronics prototyping platform.

A prototype design for Monitoring System is successfully developed as shown in Fig. 10. This prototype design is responsible for receiving data from Alexa or mobile app. The system will be connected to PLC Unit shown in Fig. 11.

A mobile application has been developed using Sinric Pro to send commands to glue heater. The mobile application GUI is shown in Fig. 12.

The full system GUI that shows all the operation conditions of the heater and the instant temperature is shown in Fig. 13.

The following is the pseudo-code for the proposed system that is developed to make IoT performs as designed with connection ability to Alexa and Sinric Pro Mobile App. It explains how the proposed system controls the glue heater. This system provides quick response rate than the manual methods. Such systems will increase the productivity of the production line.

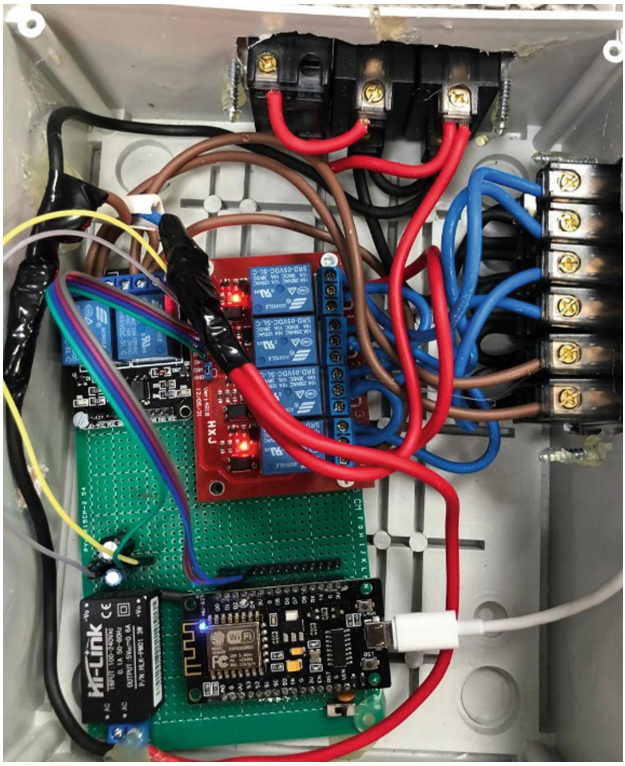

Fig. 10. System prototype.

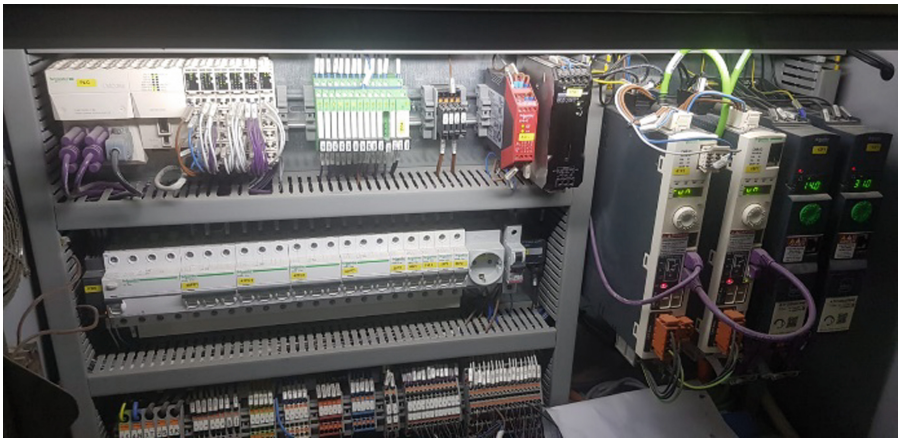

Fig. 11. PLC unit.

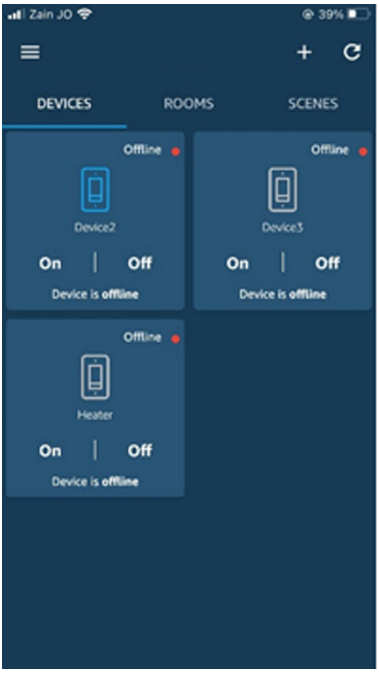

Fig.12. Mobile App.

Fig. 13. System GUI.

```
struct RelayInfo {
  String deviceId;
  String name;
  int pin;
};

std::vector<RelayInfo> relays = {
    {"60c9dbe18cf8a303b939f888", "Heater", D1},
    {"60c9dbf88cf8a303b939f88a", "Device2", D2},
    {"60c9dc0d8cf8a303b939f88c", "Device3", D3}};

bool onPowerState(const String &deviceId, bool &state) {
  for (auto &relay : relays) {                                    // for each relay configuration

    if (deviceId == relay.deviceId) {                                    // check if deviceId
matches
      Serial.printf("Device %s turned %s\r\n", relay.name.c_str(), state ? "on" : "off"); // print
 relay name and state to serial
      digitalWrite(relay.pin, !state);                                  // set state to digital pin
/ gpio
      return true;                                                  // return with success true
    }
  }
  return false; // if no relay configuration was found, return false
}
void setupRelayPins() {
  for (auto &relay : relays) {   // for each relay configuration
    pinMode(relay.pin, OUTPUT);    // set pinMode to OUTPUT
  }
  pinMode(D4, OUTPUT);
  digitalWrite(D4,LOW);
}

void setupWiFi() {
  Serial.printf("\r\n[Wifi]: Connecting");
  WiFi.begin(WIFI_SSID, WIFI_PASS);
  while (WiFi.status() != WL_CONNECTED) {
    Serial.printf(".");
    delay(250);
  }
  Serial.printf("connected!\r\n[WiFi]:              IP-Address              is              %s\r\n",
WiFi.localIP().toString().c_str());
}
void setupSinricPro() {
  for (auto &relay : relays) {                    // for each relay configuration
    SinricProSwitch &mySwitch = SinricPro[relay.deviceId];    // create a new device with
deviceId from relay configuration
    mySwitch.onPowerState(onPowerState);                    // attach onPowerState callback to
the new device
  }
  SinricPro.onConnected([]() { Serial.printf("Connected to SinricPro\r\n"); });
  SinricPro.onDisconnected([]() { Serial.printf("Disconnected from SinricPro\r\n"); });
  SinricPro.begin(APP_KEY, APP_SECRET);
}

void setup() {
  Serial.begin(BAUD_RATE);
  setupRelayPins();
  setupWiFi();
  setupSinricPro();
}

void loop() {
  SinricPro.handle();
}
```

4 Conclusion

IoT system is used to monitor machines in the wet wipes paper factory and operating the machines remotely. Where sensors are installed on all the machines in the factory to monitor the factory and the entire production line. In this paper, IoT is used to solve the problem of melting glue using two ways, the mobile application or sending message online to the machine. The machine is controlled remotely by turning it on or off. IoT system can be applied in many areas, because of its great benefits in solving problem, that appear suddenly or outside working hours. The developed system saves time and efforts and contributes in increasing profit and maintaining property.

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