Smart Farming Monitoring System

Ruhul Quddus Tamim, Md Yusuf Bin Forkan, Shafi Ahmed, Syafiq Ibnu Ramadhan, and Fadly Maulana Nasution

Abstract—In current days, various parameters and measurements in agricultural environments are required to be observed. Hence traditional strategy cannot attain the ideal control effect. This monitoring system provides high quality and productivity of crops by using wireless sensor networks and web application. To obtain appropriate results there are important items which come into play like temperature, humidity, light intensity, soil moisture, wind speed and soil pH which are essential for precision agriculture. The proposed system has several nodes and base station, while each node consists of microcontroller (ESP32) and number of sensors to collect data then sending them to a raspberry pi using Wi-Fi technology and MQTT protocol. In the last step, the events data record is uploaded into an online database program and then retrieved via internet using web application.

Index Terms—WSN, ESP32, Sensors, Raspberry pi, Wi-Fi, MQTT protocol.

1 Introduction

Agriculture plays a vital role in human life because it's the main source of food and one of development of the country's economic factors. Due to the increment in population and decrement in rainfall amount, there is a fundamental scarcity of food – Hence, the importance of precision agriculture [1]. Precision agriculture can be defined as the skill and ability of using modern technology to improve and increase crop production. and decrease human effort. WSN is one of the methods that can be used in monitoring and controlling different parameters in the agriculture field. WSN is a low cost, low power consumption. It is made up of groups of sensor nodes that monitor several conditions, such as temperature, humidity, moisture, etc. [2]. WSN in agriculture assists in collecting data, monitoring environment s parameters, suitable water and fertilizer give to plants for good crop production and helping farmers in real time data gathering [3].

2 Problem and Solution

2.1 Problem Statement

The problems in the current state that the farmers are facing:

I. Due to the weather condition, water level increasing farmers get lot of distractions which is not good for Agriculture. Water level is managed by farmers in both Automatic/Manual using that mobile application.

II. Security incidents may be accidental or intentional. Animals, farm working, and machinery can easily access farming environments and cause incidents. Additionally, smart systems comprise heterogeneous devices and software from distinct manufacturers installed between growth areas and the cloud. These specific features might make several security breaches and could result in incidents that compromise the smart system.

2.2 Proposed solution

In this paper a proposed system has been implemented for real time monitoring agricultural field depending on WSN which contain a numbers of sensor nodes, base station node and various sensors. Each sensor node is equipped with light, temperature, humidity and soil moisture sensors which collect data at certain intervals then send these data to be stored in a database at base station by using Wi-Fi technology and MQTT protocol. The data is then displayed on web page that works as a user interface for real time monitoring as shown in (figure.1). The suggested system has two portions: hardware side and software side.

2.3 Hardware part

This part consists of sensor nodes and base station. Specification of each sensor can be shown in Appendix-A.

A-1 Sensor node

The node consists of ESP32 and several sensors. 32 (figure.2) is a chip microcontroller with Bluetooth and Wi Fi capabilities. It is low priced and flexible for developing applications for low power consumed systems.

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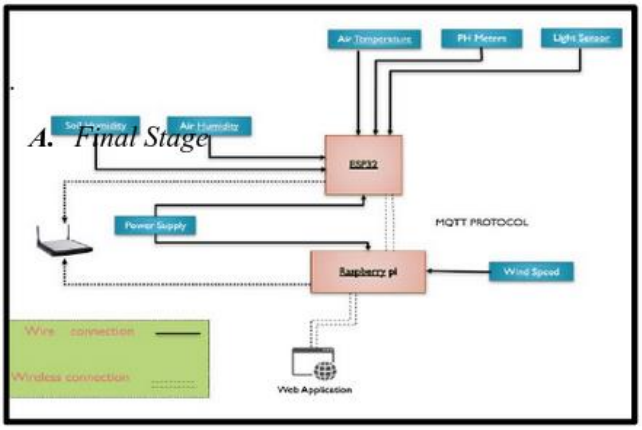


Figure (1) real time monitoring system

Digital temperature and humidity sensor (DHT22) can be shown in (figure.3). It employs a capacitive humidity sensor and a thermistor for temperature's air measurement and its signal on the data pin was digital [11]. Soil moisture sensor (FC-28) has both digital and analog outputs (figure.4) [12].

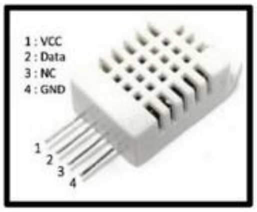


Figure (2) ESP32 Microcontroller

Figure (3) DHT22 sensor

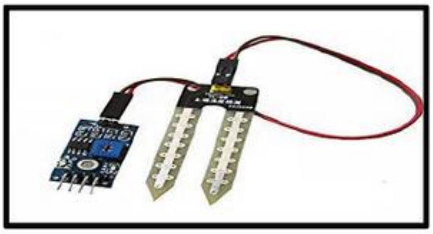


Figure (4) FC-28 sensor

Light intensity sensor module (GY-30) has 16-bit AD converter (figure.5). The data from this module is light intensity measured with lux unit. It is appropriate for getting ambient light data and observing a wide range at high resolution. It communicates with micro-controller board through I2C bus. An anemometer (figure.6) is a device used for measuring wind speed in the farm field [13]. pH sensor module (figure.7) used to calculate the acidity or alkalinity of a solution.

Figure (5) GY-30 sensor

Figure (6) Windspeed

Figure (7) pH Sensor Module

A-2 Base station

Raspberry Pi3 model B (figure.9) is a low cost, and fast processor. It has a Broadcom quad core Processor running at 1.2 GHz that is 10 times faster than the first-generation Raspberry Pi. It has Wi-Fi and Bluetooth low energy connectivity on board with 40 GPIO pins and micro-USB socket operating at 5.1 V, 2.5 A rating. It is used in this paper as a base station where database was created, and data was stored [14].

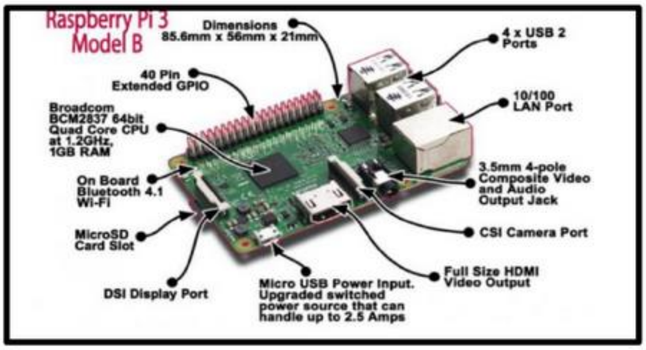


Figure (8) Raspberry Pi 3 Model

A-3. MQTT protocol

Message Queuing Telemetry Transport (MQTT) is simple, lightweight, data-centric, and open protocol used in the application layer. It uses publishing/subscribing data where all devices publish and subscribe data to the broker. This broker will manage conveying data to subscribers (figure.10). MQTT is used to ensure that the reliable data delivery in constrained devices such as IOT devices and it's useful in low bandwidth and unreliable communication [15].

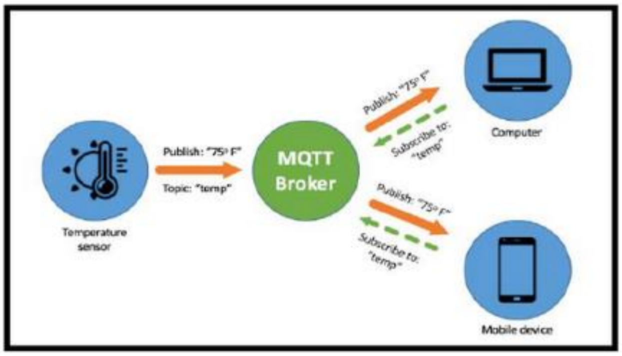


Figure (9) MQTT protocol

2.4 Software Part

MySQL database is used to store the gathered data by sensors and Apache2 Web Server is exploited as a server to the database. The web application is performed using Laravel framework and php. Laravel has been used because it's an Open-Source framework, robust, makes jobs easier, saves lot of time and provides high security [16].

3 Results

As mentioned earlier, the software part (web pages) receives its data from the hardware part (raspberry pi). Where the MySQL database has been used to store sensors data that come from sensor nodes to raspberry pi. Figure.17 is a screenshot of database humidity and temperature readings tables at different times. The interface of the web page is simple, easy to use and user friendly. The user can use the web page for fully monitoring the farm and its sensors reading to specify the amount of water and fertilizer planet needs. Figure.10 shows the main page that first appears to the user. Figure.11 presented login page. Figure.12 shows the home page that contains the number of nodes used in the system, active nodes, and plant crops. Clicking any node will display the name.

Figure (10) main page

Figure (11) login page

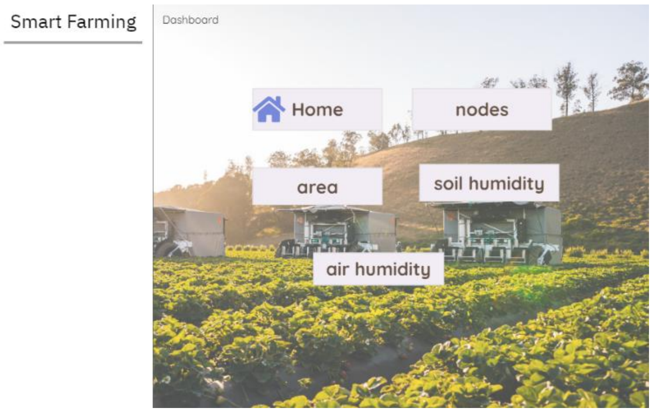


Figure (12) home page

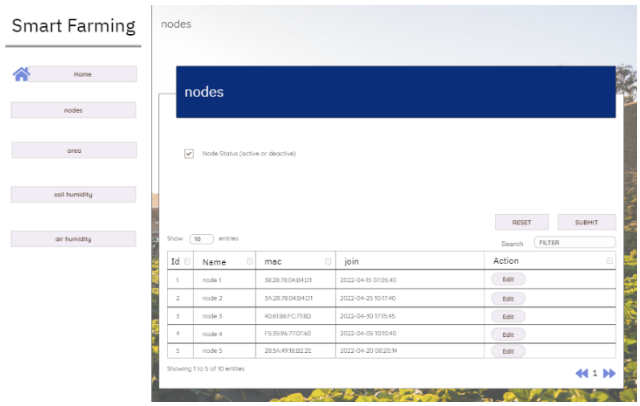


Figure (13) node page

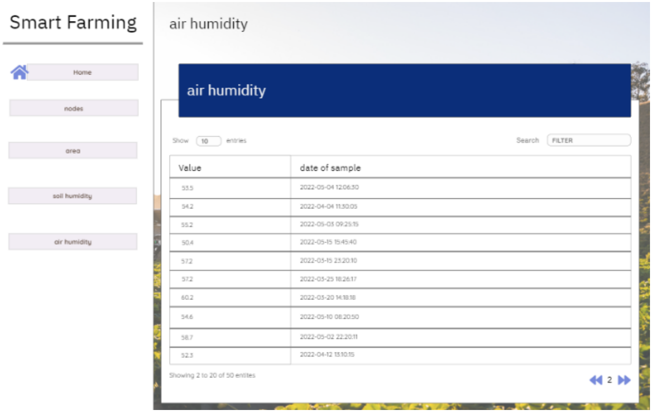


Figure (14) air humidity page

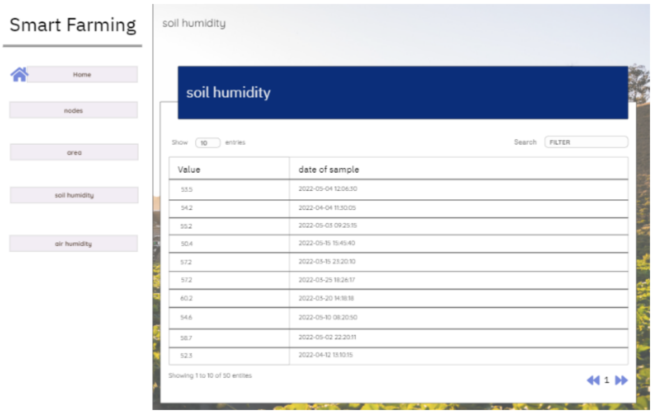


Figure (15) soil humidity page

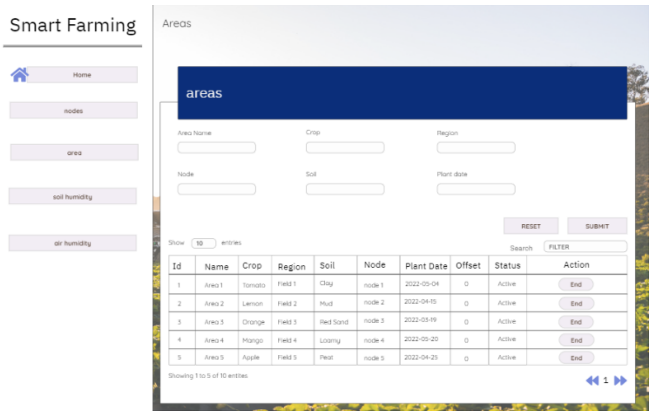
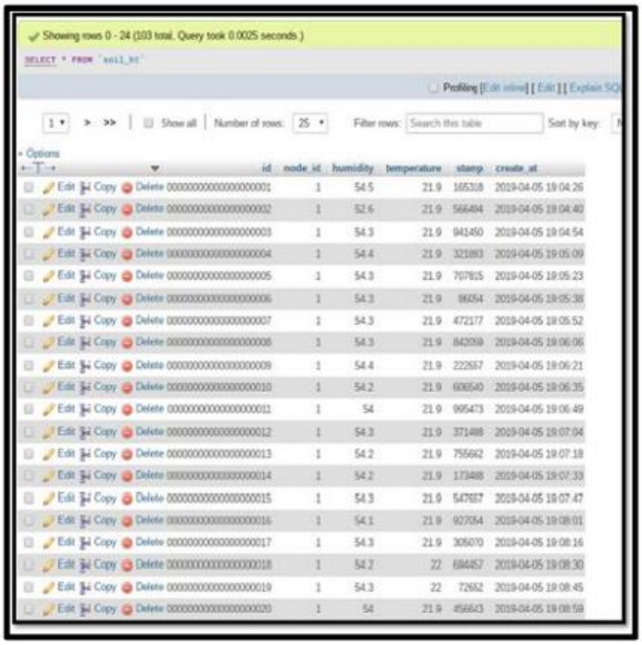


Figure (16) crop page



id	node_id	humidity	temperature	stamp	create_at
00000000000000000001	1	54.5	21.9	165318	2019-04-05 19:04:26
00000000000000000002	1	52.6	21.9	566494	2019-04-05 19:04:40
00000000000000000003	1	54.3	21.9	941450	2019-04-05 19:04:54
00000000000000000004	1	54.4	21.9	321083	2019-04-05 19:05:09
00000000000000000005	1	54.3	21.9	707815	2019-04-05 19:05:23
00000000000000000006	1	54.3	21.9	86054	2019-04-05 19:05:38
00000000000000000007	1	54.3	21.9	472177	2019-04-05 19:05:52
00000000000000000008	1	54.3	21.9	842059	2019-04-05 19:06:06
00000000000000000009	1	54.4	21.9	222657	2019-04-05 19:06:21
00000000000000000010	1	54.2	21.9	606540	2019-04-05 19:06:35
00000000000000000011	1	54	21.9	995473	2019-04-05 19:06:49
00000000000000000012	1	54.3	21.9	371488	2019-04-05 19:07:04
00000000000000000013	1	54.2	21.9	755662	2019-04-05 19:07:18
00000000000000000014	1	54.2	21.9	173488	2019-04-05 19:07:33
00000000000000000015	1	54.3	21.9	547657	2019-04-05 19:07:47
00000000000000000016	1	54.1	21.9	927054	2019-04-05 19:08:01
00000000000000000017	1	54.3	21.9	305070	2019-04-05 19:08:16
00000000000000000018	1	54.2	22	684457	2019-04-05 19:08:30
00000000000000000019	1	54.3	22	72652	2019-04-05 19:08:45
00000000000000000020	1	54	21.9	456643	2019-04-05 19:08:59

Figure (17) temperature and humidty reading

4 DEPTH OF ANALYSIS CONCURRENT PROBLEM AND SOLUTION

Here in our project 2, we found out the concurrent problem when sending the data to the valve unit and at the same time turning on/off the valve to release water. When the data from the sensors are passed to valve unit, for example, temperature data, pH data and humidity data at the same time together to the valve unit. It will schedule the process first. It takes in data and at the same time it decides whether to turn on or off the valve. During this time, the shared process of taking in data and turning on or off the valve unit can be solved using concurrent programming.

Hence, we came up with a solution called Violating Mutual Exclusion to solve this issue. In this problem, there is a collection of asynchronous processes, each alternately executing a critical and a noncritical section, that must be synchronized so that no two processes ever execute their critical sections concurrently.

Each process will enter the valve unit and decide to turn on or off water supply, after the process has finished, it will leave the critical section and if another process is waiting in the queue, that process will take the token from the previous process and will enter the critical section and decide whether to turn on or off the valve unit and son on and so forth.

5 Implementations of Solution to Concurrent Problems

We implemented the solution using java programming language. First, the menu will show to request or release the critical section. Once, we choose to request the critical section, it will ask to select which process to perform The selected process will hold the token and enter into critical section The menu will display whether to release or re-quest the critical section if the process is not yet released, it will show which process that is in critical section and the next process that is requested will be entered in a queue waiting to enter in the critical section Once the process is released, the token is passed to the next process to enter critical section.

First, we chose to request the critical section by choosing one process which sends to the valve unit
We can see the critical section is occupied by process 1 and there are no processes in the queue
Then, once I select another request to enter the critical section which is process Turn on/off water, the process will be waiting and enter the queue. If we add another request, it will still enter the queue.

Here is proof of implemented the solution using Net-Beans -

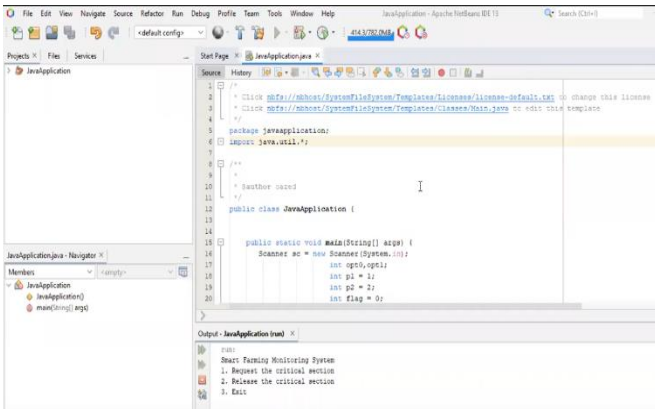


Figure 18. Running the solution

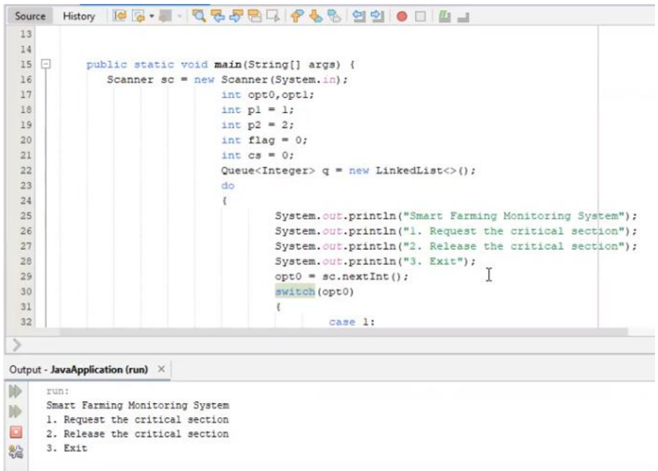


Figure 19

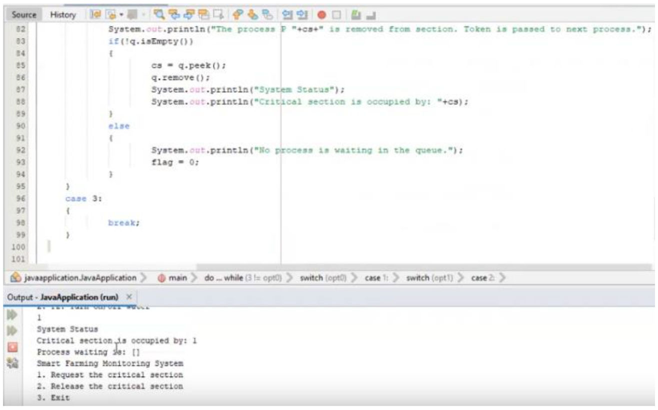


Figure 20. Request a process

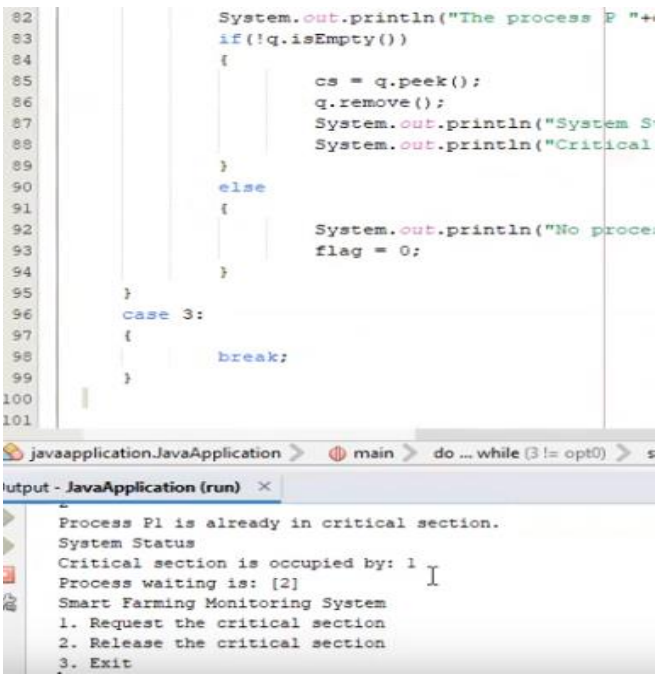


Figure 21. Request another process which is in the queue

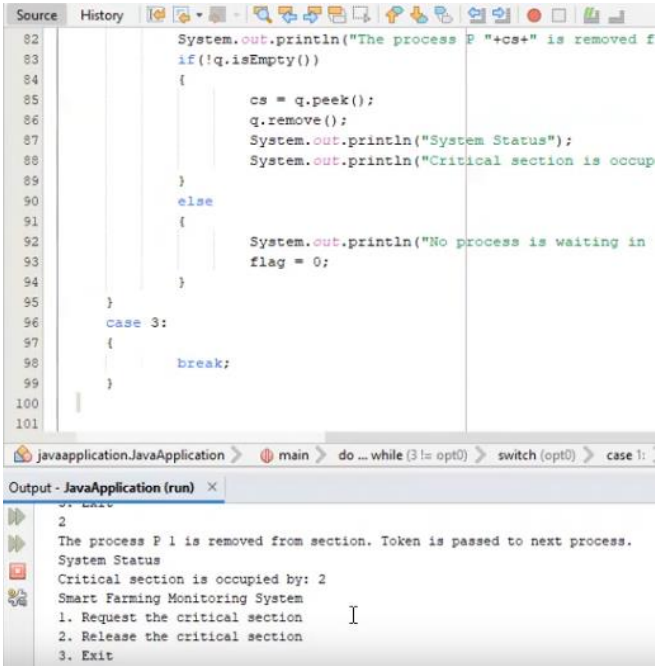


Figure 22. Release a process from critical section and another process entered the queue

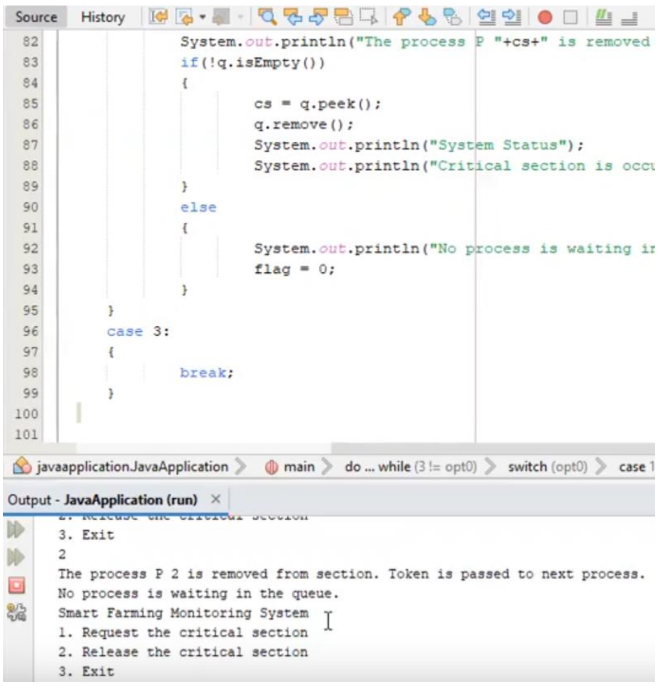


Figure 23. Released all the processes from critical section and no processes in the queue

6 Conclusion

In this paper, an agriculture environment monitoring system with low priced, low power consumption has been proposed to obtain high crops productivity and reduce human effort. Many commercial sensors have been combined with microcontrollers to form a simple node which transmits the sensors data to a web application to display the results. The monitoring system is based on wireless sensor network and Web application for high quality and productivity of crops. The appropriate results have been obtained for temperature, humidity, light intensity, soil moisture, wind speed and soil pH which are essential for precision agriculture. The system shows the possibility of allowing farmers to monitor and track farms using a web application.

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