NAME: OLAWOYIN SADEEQ BABALOLA

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DEPARTMENT: MECHATRONICS ENGINEERING

COURSE TITLE: STRUCTURED COMPUTER PROGRAMMING

COURSE CODE: ENG 224

QUESTION: As a software developer for Abuad farm, you are mandated to develop a software that interacts with the machine due to irrigation problems. The software should be able to read the temperature of the soil, determine the moisture content, configure a time interval for water based system, trigger an alarm if the water available is not sufficient for irrigation and also enable password for the system. The following steps should be followed:

A. Discuss the application development following the software development cycle.

B. Critically discuss the hardware and software features.

C. Support your answer with a flowchart and an algorithm.

D. Draw the Top-down or Bottom-up design approach of the application

SOFTWARE DEVELOPMENT CYCLE

1. **Conceptualization:** Due to the irrigational challenges faced by ABUAD farm during dry season, the software to be developed and incorporated into the suitable farm machines is to be of use in reading soil temperature at specific intervals to be able to determine changes in temperature and times water will be sprinkled on the farmland due to temperature changes, determine moisture content of the soil so as to know the type of irrigation system to use and crops that can grow on that portion of the farm, trigger an alarm into the sound system of the farm to notify the farm workers if water available in the tank will not be sufficient for irrigation. A password is also required for the system so it will not be accessible to unauthorized officials.

2. **Specification:** The software being one to be incorporated into machines for irrigational purpose should have:

a. Clock System: This will be enable the software set a time interval for the machines or sprinklers to spray water on the farm when the calculated time has been reached.

b. Soil Temperature Sensor: Soil temperature sensors come in a variety of designs using thermistors, thermocouples, thermocouple wires, and averaging thermocouples. The electrical

signals transmitted from the sensors in the machines to the software data loggers can be converted to different units of measurement, including °C, °F, and °K. These temperatures detected from the sensors in the machine will enable the software to read the soil temperature and trigger the sprinkler or irrigation system when the temperature is too high.

c. Soil Moisture Sensor: The soil moisture sensor is used to measure the volumetric water content of the soil. It uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil is measured. The software will read the water content and reference it to the standard soil water content for the crop on the land. If the soil water content or soil moisture is low, the irrigation system is triggered and the moisture of the land will be returned to its specific requirement.

d. Alarm System: A water alarm system is also programmed into the software in such a way that when water is below the level suitable for irrigation, it sets of an alarm to notify the farm workers about the need to pump more water into their reservoirs or tanks.

e. Passcode: Before the software can trigger or set off the irrigation system, the operator will be required to input a 7-digit passcode and the machine will only start if it is the authorized passcode. An option for unlocking with fingerprint will be made available in case the operator forgets the passcode.

3.**Design:** The design of the software comprises of both the algorithm and flowchart.

ALGORITHM

1. Start

2. Input passcode

3.If passcode= true

Continue to select the operation to be performed

Else passcode= False

4. Enable fingerprint scan option

5 If fingerprint is authorized {

Continue to select the operation to be performed

Else fingerprint is unauthorized

End

6. Select Operation to be performed

Read soil temperature

If soil temperature is too high

Set off irrigation system

Else

Proceed to check moisture content

If moisture content is low

Start irrigation process

Else

Configure system interval

7. Check water level in tank

If water available is not sufficient for irrigation

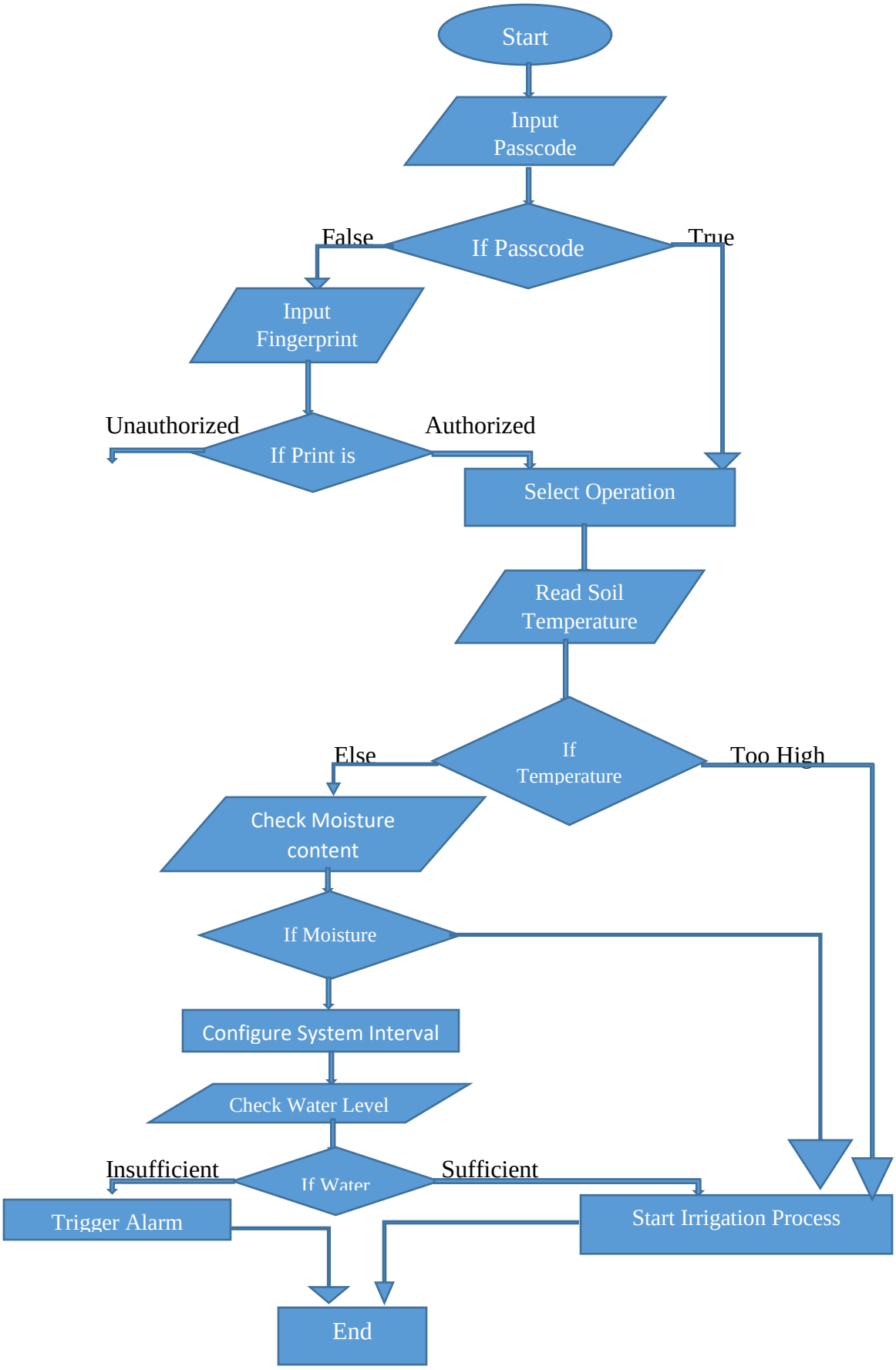
Trigger Alarm system

Else

Proceed with Irrigation process

8. End

FLOWCHART


Start
Input Passcode
If Passcode
False
True
Input Fingerprint
If Print is
Unauthorized
Authorized
Select Operation
Read Soil Temperature
If Temperature
Else
Too High
Check Moisture content
If Moisture
Configure System Interval
Check Water Level
If Water
Insufficient
Sufficient
Trigger Alarm
Start Irrigation Process
End

4. **Implementation:** The machine automation (software is implemented into the machine) using Arduino. In the proposed Irrigation system, all the information that are received from the sensors and the various parameters are given to the Arduino uno microcontroller as an analog input. A preset value of soil moisture sensor is fixed in microcontroller and also for fencing. When it goes beyond the particular threshold value water is automatically irrigated to the crops and once the required amount of water is fulfilled it stops. The Microcontroller transmits that information on the internet through a network of IoT in the form of wifi module ESP8266 that is attached to it. This enhances automated irrigation as the water pump can be switched on or off through information given to the controller. This approach is for the advancement of irrigation process by automatic method without manpower by measuring various parameters related to the field and thus improves irrigation.

5. **Testing and Debugging:** This is one of the most crucial part for success of software being developed. It is done prior to the release. Testing and debugging is done using automated testing tools such as Ranorex, Sahi, Watir, ToscaTestsuite, Telerik TestStudio, Katalon Studio, Selenium etc. Some debuggers like Radare2, winDbg, Valgrind are also used.

6. **Release and Update:** At the end of the development cycle, the software is released for use by different users. In order to improve on the software or make it more effective for use, updates will be released from time to time in order to make it more accessible and easy for use.

HARDWARE AND SOFTWARE FEATURES

HARDWARE FEATURES

- Soil Temperature Sensor: Soil temperature sensors come in a variety of designs using thermistors, thermocouples, thermocouple wires, and averaging thermocouples. The particular soil temperature sensor to be used on the irrigation machine is the **CS230 Temperature Profiler.** It uses SDI-12 digital technology for simple integration. SDI-12 does away with analog measurement inaccuracies and susceptibility to electrical noise.

  The advantages of the CS230 profiler include its ability to measure a very hight temperature, minimal warmup time of less than 10 seconds and resolution of 0.0078 degree Celsius.

- Automated Clock: The software is designed in such a way that the automated clock on the machine can be given time intervals at which water will be sprayed on the farmland.

Automated Clock

- Soil Moisture Sensor: The moisture sensor simply checks the volumetric capacity of water in the soil. For the machine, WaterTec™ S100 is used. The WaterTec S100 comes with an auto-calibration capability. After the soil has been saturated, the screen will flash between “CAL” “24H” and the current moisture reading. The 24 hour auto-calibration function will then be initiated.

- Alarm System: Water level sensor is attached to the irrigation tank. This sensor is programmed to trigger an alarm when the water level is below the one required for irrigation.
- Arduino: Arduino is the brain of the system and all sensors are monitored by it. An LCD is provided to monitor the Soil Status, Ambient Temperature and Status of Water supply(Water Pump).

SOFTWARE FEATURES

- User Access Control: The software is designed in such a way that only a user with the correct 7-digit passcode will be able to access it. In case the password is forgotten, a user whose fingerprint is authorized in the software can also access the machine for use.
- An interface that displays the all the operations that can be performed using the machine.
- An interface that allow the user to set the threshold or limit for each operation.
- A sensor that shuts down the machine in case of any malfunction like loose wires, low fuel or oil, overheating.

- A section to show the graphical representation of the temperature changes over the period of a month.
- User choice in preferred unit for measurement of temperature.
- An interface that display readings for the soil temperature, moisture and water level.

TOP-DOWN DESIGN APPROACH