APPLICATION: AUTIRRI

APPLICATION DEVELOPMENT

- **CONCEPTUALIZATION**

AUTIRRI gotten from automated irrigation, is an application designed to assist with irrigation in ABUAD farms. At ABUAD farm, an irrigation device that controls the water supply exists, the device which is mechanical but not automated is unable to function on its own without simple instruction. AUTIRRI has been developed to serve as the brain of the machine, making it fully automatic and bringing the need for human intervention to zero. ABUAD farm is located at Ekiti, where the rainfall is less than that needed for the plants to thrive during the dry season and with a variety of trees dependent on a water source poses a problem. AUTIRRI when implemented will; Read the temperature of the soil and determine the moisture content of the soil.

As earlier stated, ABUAD farm is home to a variety of plants and the need for controlled amounts of water at certain time intervals gives rise to another feature of AUTIRRI, which is the configuration of time intervals for the water system based on the moisture content. AUTIRRI will even trigger an alarm if there is insufficient water in the tank for the irrigation.

To counter the need for a highly skilled professional. AUTIRRI has an easy to use interface.

A password for the system will also be enabled to prevent; errors, accidents and mishandling of irrigation machine during the irrigation process.

- **SPECIFICATION**

AUTIRRI has several modules; the input and output, controllers, operator interface and memory amongst others.

AUTIRRI with the existing machine would generally use sensors and actuators for the input and output functions. While sensors convert the physical parameters to a signal that can be measured electrically, actuators uses signal to control the system. Some of the sensors include the TDR sensor for soil moisture measurement and the STP01 soil temperature sensor.

The system sequence is controlled by a programmable logic controller (PLC) as it utilises standard interfaces for sensors and actuators to control the process. The operator interface is simple with a keypad and text display to allow for the manipulation of field devices controlled by the PLC. The memory stores information to be used by the system such as the passwords and the time interval configuration which is constantly updated and optimizes the overall system performance, It is also accessible in real-time.

- **DESIGN**

A text based user interface (TUI) is used in AUTIRRI as it is efficient, simple, clear and convenient. Transferring information in text form requires less bandwidth and whatever is typed would usually have a higher variance than what is entered with a mouse.

Python is the programming language used to develop AUTIRRI. Python is object-oriented and functional. Iwas used for this automation because of its simple syntax for functions and command line versatility.

Other details of the design are given in the algorithm and flowchart at the end of this document.

- **IMPLEMENTATION.**

The codes required for the application to function efficiently are written, that is in python, following all specifications. Pastilda, an open-source hardware password manager, is also used to manage the credentials securely.

At this point all instruction set and micro sets have been designed and the application is developed for practical use.

- **TESTING AND DEBUGGING**

In Testing, bugs and errors in AUTIRRI are found. Unit testing is done by the software tester, missing requirements are also detected and fixed in the debugging phase. UX tools are also used to track how users interact with it. In the Debugging phase all bugs or errors found in the testing phase are fixed.

- **RELEASE AND UPDATE**

There is a need to constantly update the system as new developments arise. The application is then released to ABUAD FARM after all requirements have been satisfied.

HARDWARE AND SOFTWARE FEATURES

The **hardware features** of AUTIRRI are categorized mainly into input, output and processors.

These include:

- Sensors: The sensors detect the physical quantities, the quantities measured for the irrigation process are:
  - Temperature: The temperature of the soil was measure using an STP01 soil temperature sensor.
  - Moisture content in soil: The sensor used to measure the moisture content was The TDR 350 and it was chosen because it accurately measures soil moisture across the full range of soil conditions. It has an improved ergonomic design which provides quick and easy measurements.
  - Water pressure: The water pressure sensor is used to determine the water level of the tank. A Hydrostatic pressure level sensor which is titanium with a 0-5.75 feet water column and 25 feet polycable is used.
- Actuators
  - Rotary Valve Actuator: It produces the rotational motion needed to operate the valves
  - Stepper motors (DC motor) are electromechanical, converting a digital pulse into rotational movement or displacement.
  - Linear actuators: These move an object along a straight line, generally in back and forth motion. Inserting some of the sensors into the soil would require a linear actuator.
- Display unit: AUTIRRI uses a liquid-crystal displays (LCD) for its output. Large-sized figures are also used to improve readability
- A key pad: The keypad contains buttons for alphanumeric operations such as inputting passcode. It also has the direction arrows (up, left, down, right) to select operation and makes functions such as deleting easier.

- Nodes: A node represents a physical control device in the process (typically a PLC). Each node has a logical node number that is used to identify the PLC.
- Password manager: Patilda, an open source password manager hardware was used. Pastilda works as a middleman between AUTIRRI and keyboard. It provides easy and safe access to the system. It also stores encrypted passwords in its memory.
- Valve: A valve regulates, directs or controls the flow of water by opening, closing, or partially obstructing the various passageways. A ball valve is used, it is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball to control flow through it
- Brake: A brake is typically installed above the motor to prevent the fluid pressure forcing open the valve. If no brake is installed, an oscillation would be setup (open, close, open ...) and the motor and actuator will eventually become damaged.
- RAM: Program and data memory in a PLC is contained in RAM (Random Access Memory). This type of memory can be overwritten often. The program itself is in one area of RAM and must be kept in memory even when the PLC is powered off.
- Power supply: An 8VM power supply from Omron is used. The unit uses combinations of LEDs to indicate whether the voltage loss is due to a momentary power interruption, an overload, or a drop in the power supply itself from aging. Compact device is available in ratings from 15-150 W and voltage capacities from 5-24 V dc. It can operate at 100% load rate at temperatures of 50 °C. S8VM meets global environmental and safety standards.
- Alarm system
  - Alarm device: The alarm device gives an audible alarm signal when the water level in the tank is low. The Alarm device is outfitted with a siren.
  - Alarm control panel: The alarm control panel is the central hub of the set up. The alarm control panel is also used to activate AUTIRRI and the irrigation machine.

The **software feature** AUTIRRI are given below

- UI: A major feature that falls under the software is the UI. The UI makes up all the elements that enable the user to interact with a product or service. A Text User Interface (TUI) is used. It reflects a dependence upon the properties of computer terminals and not just texts. It also uses colour and structures the display using special graphical characters.

- PLC: A PLC or programmable logic controller, another important software feature, is a system which makes the machinery work automatically. It incorporates the basic features of input, process, and output where everything has to go along well and harmoniously. The input or data should go along with the suitable operation or process in order to produce the intended result or output. An example of such operation is the triggering of the alarm system when the water level in the tank falls below that which is sufficient for irrigation.

Other features are the sound, display, reading, override, passcode, clock and memory which are further detailed below:

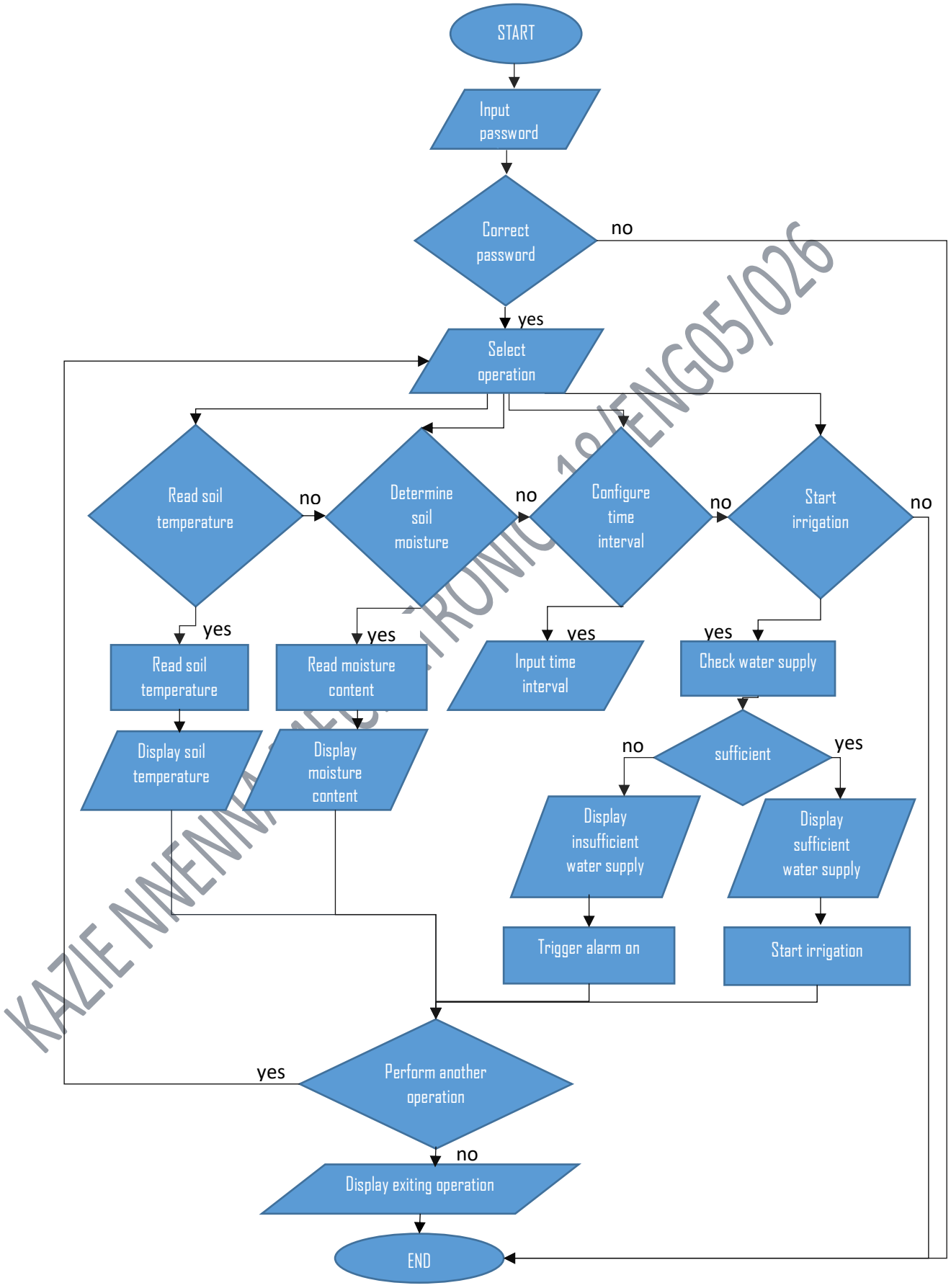
- Sound: These are vibrations that send waves of energy and stimulate the ears. The sounds in this system come from tapping of buttons, to enhance user experience, and also from the alarm. It goes on and off depending on the existing condition.
- Display: The display as the name implies produces an output for the user. The output produced is gotten from the sensors values read such as temperature and moisture. For easier readability; the font, size and colour of information displayed can be altered.
- Reading: The values of all the sensors are read here. The temperature, moisture in soil, water pressure. The reading will give the user information about the parameters and would be used as input which will enable the required actions to be performed by other processes.

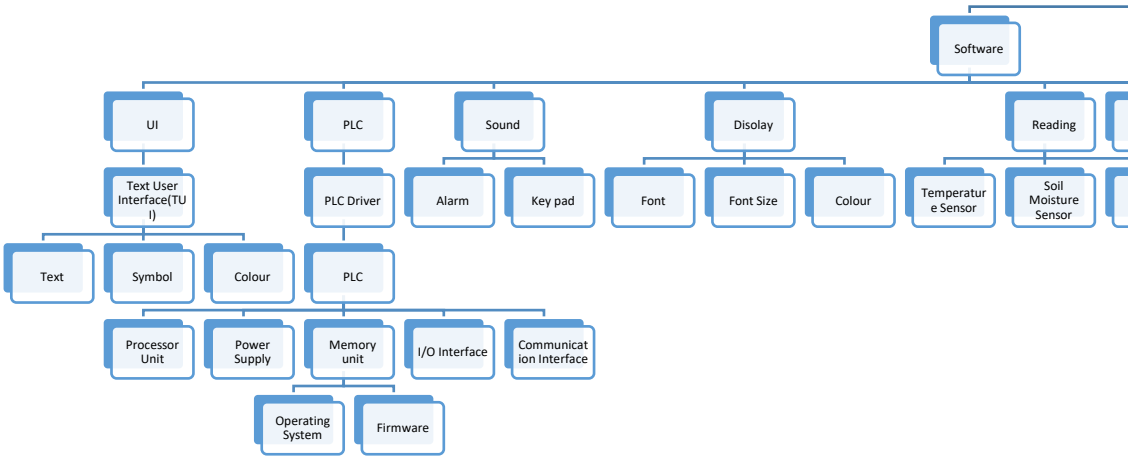
- Override: The override interrupts the action of AUTIRRI in order to take manual control. An automatic system would execute functions based on the program written, when a condition not defined occurs, the override would help restore the system back with minimal damage.
- Passcode: The passcode can either be a password (i.e. an alphabet, alphanumeric or complex character type) or PIN, which is numeric, and is used to authenticate a user accessing a system.
- Clock: The clock measures, keeps, and indicates time. AUTIRRI is responsible for the provision of controlled amounts of water at certain time intervals. The clock helps set the time interval into days, hours and minutes.
- Memory: Memory is the part of the system by which data or information is encoded, stored, and retrieved when needed. The data may be sensitive such as password. The memory also store instructions that will be needed for the other processes to run efficiently.

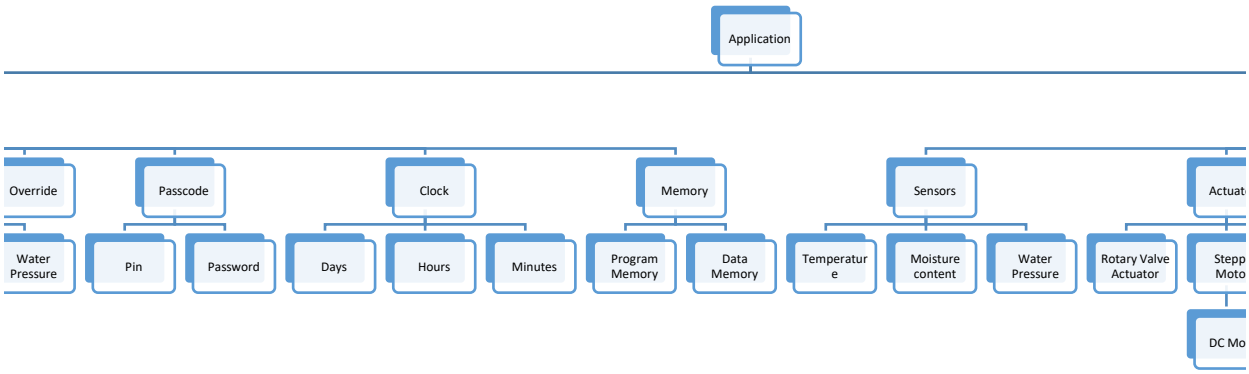
Algorithm

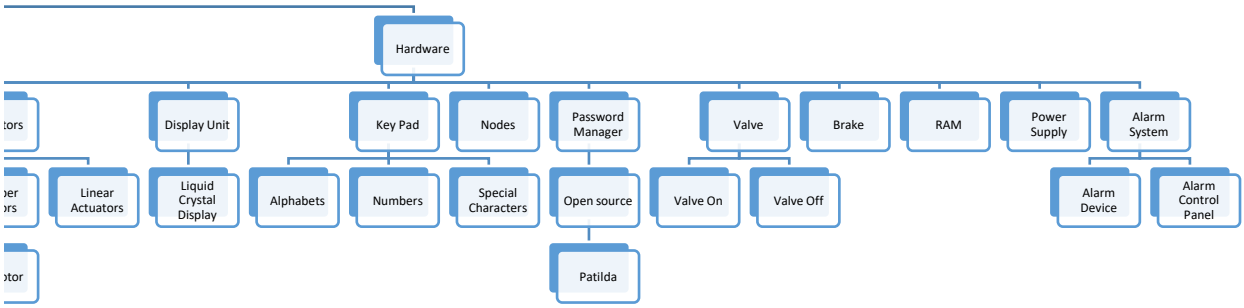
```
STEP 1: START
STEP 2: INPUT PASSWORD
        IF PASSWORD IS CORRECT
                CONTINUE
        ELSE
                END
STEP 3: SELECT OPERATION
        IF OPERATION==READ SOIL TEMPERATURE
                READ SOIL TEMPERATURE
                DISPLAY SOIL TEMPERATURE
        ELSE IF OPERATION ==DETERMINE MOISTURE CONTENT OF THE SOIL
                READ MOISTURE CONTENT OF THE SOIL
                DISPLAY MOISTURE CONTENT OF THE SOIL
        ELSE IF OPERATION==CONFIGURE TIME INTERVAL FOR SYSTEM
                INPUT TIME INTERVAL FOR THE SYSTEM
        ELSE IF OPERATION==START IRRIGATION
                        CHECK FOR WATER LEVEL IN TANK
                        IF WATER LEVEL IN TANK IS INSUFFICIENT
                                DISPLAY"INSUFFICIENT WATER SUPPLY"
                                TRIGGER ALARM ON
                        ELSE
                                DISPLAY"SUFFICIENT WATER SUPPLY"
                                START IRRIGATION PROCESS
        ELSE
                END

STEP 4: DISPLAY"WOULD YOU LIKE TO PERFORM ANOTHER OPERATION"
        IF INPUT==YES
                RETURN TO STEP 3
        ELSE
                DISPLAY "EXITING OPERATION"
STEP 5: END
```

FLOWCHART




Software
UI
PLC
Sound
Disolay
Reading
Text User Interface(TUI)
PLC Driver
Alarm
Key pad
Font
Font Size
Colour
Temperature Sensor
Soil Moisture Sensor
Text
Symbol
Colour
PLC
Processor Unit
Power Supply
Memory unit
I/O Interface
Communication Interface
Operating System
Firmware


Application
Override
Water Pressure
Passcode
Pin
Password
Clock
Days
Hours
Minutes
Memory
Program Memory
Data Memory
Sensors
Temperatur e
Moisture content
Water Pressure
Actuat
Rotary Valve Actuator
Stepp Moto
DC Mo


Hardware
tors
Linear Actuators
tor
Display Unit
Liquid Crystal Display
Key Pad
Alphabets
Numbers
Special Characters
Nodes
Password Manager
Open source
Patilda
Valve
Valve On
Valve Off
Brake
RAM
Power Supply
Alarm System
Alarm Device
Alarm Control Panel