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Structured Computer Programming
(ENG 224)

ABUAD Farm Irrigation Management Software

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a.) <u>Software Development Cycle</u>

(contains solutions to questions b, c and d)

Conceptualisation

The major annual problems that the dry season brings to ABUAD Farms as regards to the irrigation system include;

1. Low soil moisture content
2. Insufficient water supply to allow for irrigation
3. Indiscriminate watering of plants
4. Extreme soil temperatures
5. Public access to crop water supply

My software, through integration into farm machinery (such as sprinklers, etc) solves these issues by the following means;

- Reading the temperature of the soil and ascertaining the soil moisture content by incorporating soil moisture sensors and soil temperature sensors to farm machinery. This solves problems 1 and 2.
- Proper management of water supply through creation of a watering and irrigation schedule and implementation of an automatic sprinkler system solves problems 3 and 4
- Notifying farm personnel/manager when;
  - soil temperature is too high or too low,
  - soil moisture levels fall below a tolerable level (which is also calculated by the software by taking into consideration type of crop as well as atmospheric and soil conditions),
  - and when unauthorised personnel attempt to use this irrigation management software.

  This further solves problems 1 through 4.

  *Note that farm personnel who are authorised to use the software are notified on pagers when the above stated conditions are met.

- Sounding an alarm when the water tank has insufficient water to allow for optimal irrigation, which solves problem 5.

Specifications

b.) <u>Software and Hardware Specifications</u>

Software

- User Interface: This displays a password entry screen when not in use and can only be accessed by authorised farm personnel. After a password has been entered, it displays a screen with options to track soil condition data, Start or Stop Irrigation Process (which perpetually runs in the background by default according to a generated watering schedule) and to change the values for the tolerable range of soil temperature and soil moisture.
- Password entry point
- Session Timeout feature: This is necessary since the software operates with a password feature, or else the session would run forever and anyone would have access to the software.
- Date & Time: This is necessary for proper functioning of the alarm system.
- Notification feature: The farm manager should be notified on an hourly/ daily basis the readings taken by the sensors so that he can monitor the conditions of the soil and water tank levels. Also, according to this data, the software will prepare an irrigation schedule that will be sent to him. He will also be notified when there is an unauthorised attempt (incorrect password entered) to use the software.

Hardware

- Soil Hygrometer: This feeds data on the soil moisture to the alarm system, sprinkler system, and farm manager.
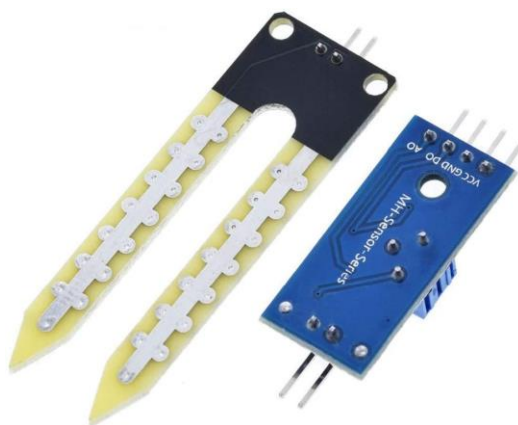
ARCELI Soil Hygrometer Moisture Detection Water Sensor Module YL-69 Sensor and HC-38 Module;

✓ Operating voltage: 3.3V-5V Module dual output mode, digital output, analogue output more accurate.

- Soil Thermometer: This feeds data on the soil temperature to the alarm system, sprinkler system, and farm manager.

Soil Temperature Sensor Probe FS200-SHT10;

✓ Operating voltage: 3.3V-5V
✓ 20 ℃ ~ 100 ℃ range

- Water Level Sensor: This collects data on the available amount of water in the tank. If it reaches a critical level, the alarm goes off and the Farm manager is notified.

Solinst Levelogger Edge;

✓ Submersible sensor used for measuring the level of liquids in deep tanks or water in reservoirs. Pressure water level loggers provide accuracy and reliability across a wide range of applications.

*The above sensors are to be incorporated into the farm machinery and take readings while work is being done on the farm.

- Sprinklers: Automatic sprinklers that go off when soil moisture is too low or soil temperature is too high.
- Alarm system: The alarm system is triggered by the soil moisture sensor and soil temperature sensor. When they read an intolerable value, the alarm is set off and it blares a horn or a ring to notify workers to take necessary action and the sprinklers are set off depending on the conditions.
    - Buzzers
    - Speakers/Ringers/Horn
   - Above mentioned sensors
    - Pagers

- Pagers: These pagers are only held by farm workers who have access to the software and receive notifications from the software through these pagers.

Apollo Programmable Alpha Pager AL–924 / AF–924;
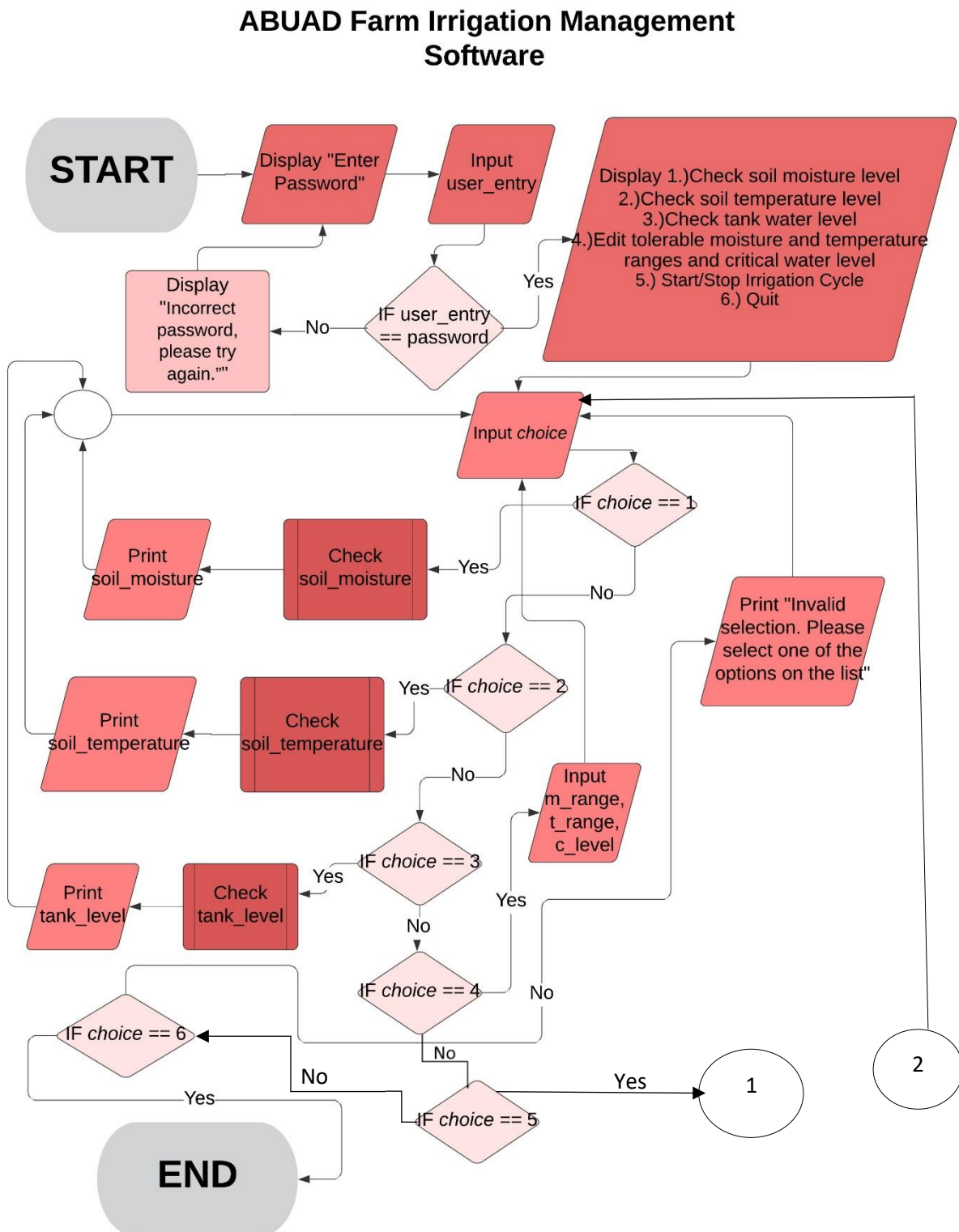
✓ Operating frequency: 450-470MHz

- Display Device (Vacuum Fluorescent Display): VFDs were chosen for their simplicity and ease with which they can be read. They display date, time and values of soil temperature and soil moisture.
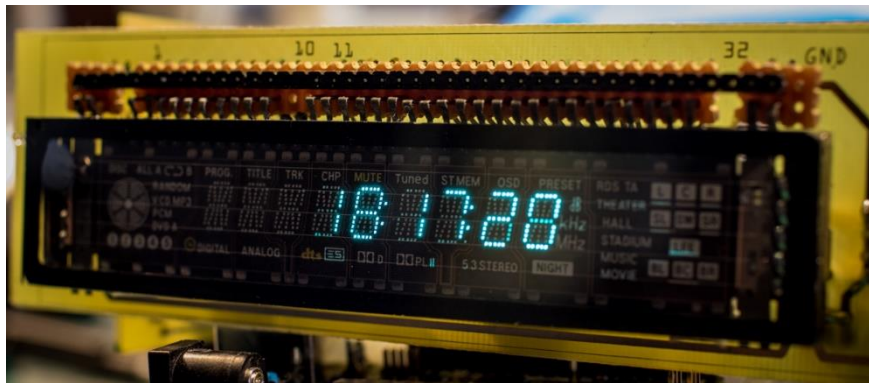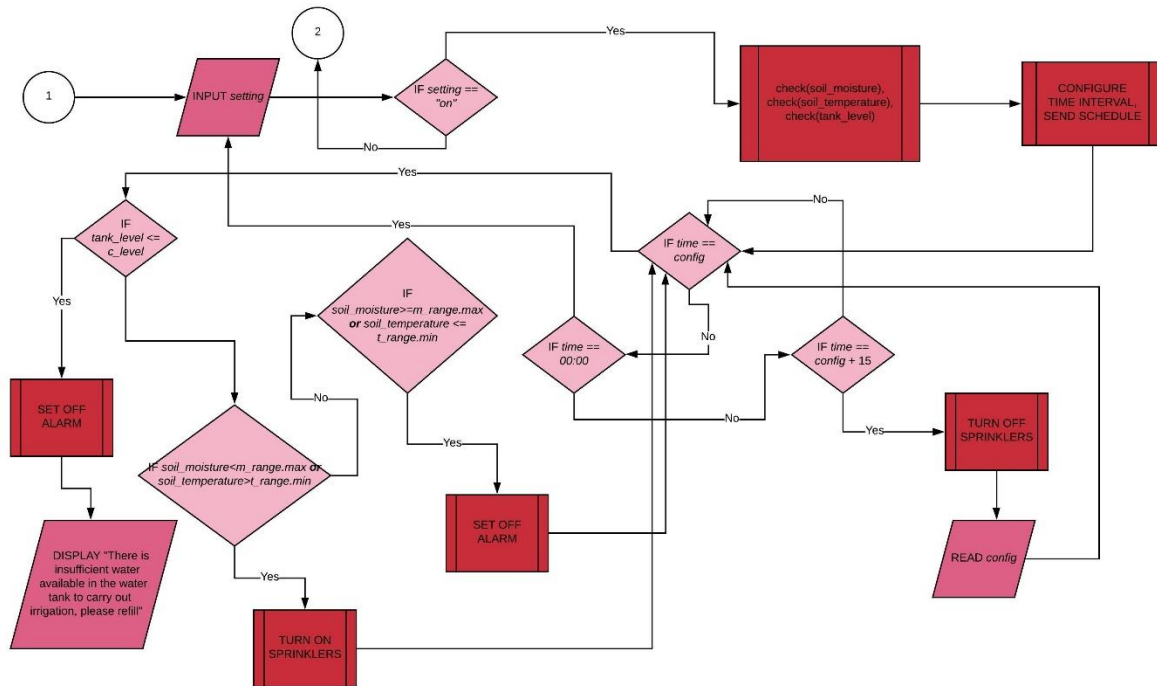
Design

c.) <u>Flowchart and Algorithm</u>

Flowchart:

ABUAD Farm Irrigation Management Software

START

Display "Enter Password"

Input user_entry

Display 1.)Check soil moisture level 2.)Check soil temperature level 3.)Check tank water level 4.)Edit tolerable moisture and temperature ranges and critical water level 5.) Start/Stop Irrigation Cycle 6.) Quit

Display "Incorrect password, please try again.""

IF user_entry == password

No

Yes

Input choice

IF choice == 1

Check soil_moisture

Print soil_moisture

Yes

No

Print "Invalid selection. Please select one of the options on the list"

IF choice == 2

Check soil_temperature

Print soil_temperature

Yes

No

Input m_range, t_range, c_level

IF choice == 3

Check tank_level

Print tank_level

Yes

No

Yes

IF choice == 4

No

IF choice == 6

No

No

IF choice == 5

Yes

Yes

END

1

2

Algorithm:

1. START
2. *password* = //specific string or code set by farm manager
3. INITIALISE *m_range, t_range, c_level, soil_moisture, soil_temperature, tank_level, time, config*
4. DISPLAY "Enter Password: "
5. INPUT *user_entry*
6. IF (*user_entry == password)*;
   7. DISPLAY
      """"""

      - Check soil moisture level (1)
      - Check soil temperature level (2)
      - Check tank water level (3)
      - Edit tolerable moisture and temperature ranges and critical water level (4)
      - Start/Stop Irrigation Cycle (5)
      - Quit (6)

      """"""

8. INPUT *choice*
9. IF (*choice = 1*);
   a. check(*soil_moisture)*
   b. DISPLAY *soil_moisture* **then go to line 8**

10. ELIF (*choice* = 2);
    a.   check(*soil_temperature)*
    b. DISPLAY *soil_temperature* **then go to line 8**
11. ELIF (*choice* = 3);
    a.   check(*tank_level)*
    b. DISPLAY *tank_level* **then go to line 8**
12. ELIF (*choice* = 4);
    a. INPUT *m_range, t_range, c_level* **then go to line 8**
13. ELIF (*choice* = 5); //This is a The Irrigation Cycle loop, it perpetually runs in the background until it is stopped i.e (*setting* == off)
    a. INPUT *setting* = //Boolean value (on/off) set by farm manager
    b. IF (*setting* = "on");
        i.   check(*soil_moisture)*
        ii. check(*soil_temperature)*
        iii. check(*tank_level)*
        iv. CONFIGURE TIME INTERVAL
        v. SEND SCHEDULE
        vi. IF (*time* == *config*);
            1) IF (*tank_level* <= *c_level*);
                i.   SET OFF ALARM
                ii. DISPLAY "There is insufficient water available in the water tank to carry out irrigation, please refill."
            2) IF (*soil_moisture* < *m_range.max* **or** *soil_temperature* > *t_range.min*);
                i.   TURN ON SPRINKLERS
                ii. **Go to line 13-b-vi**
            3) ELSEIF (*soil_moisture* >= *m_range.max* **or** *soil_temperature* <= *t_range.min*);
                i.   SET OFF ALARM
                ii. **Go to line 13-b-vi**
        vii.   ELSEIF *time* == *"00:00"* **then go to line 13a** //a new irrigation schedule is created everyday
        viii.   ELSEIF *time* == *config+15;*
            i.   TURN OFF SPRINKLERS //this enables the sprinklers to be turned off 15 minutes after being turned on
            ii. READ next *config*

ix. ELSE **go to line 13-b-vi**

    c. ELSE; **go to line 8** //i.e. *setting* = "off"
14. ELIF (*choice* = 6) **then go to line 18**
15. ELSE;
16. PRINT "Invalid selection, please select one of the options on the list" **then go to line 8**
17. ELSE;
    a. DISPLAY "Incorrect password, please try again." **then go to line 2**
18. END

<u>GUIDE</u>

*red indicates a compulsory element

***blue** indicates additional feature

**"CONFIGURE TIME INTERVAL" is a complex function by which the software prepares a schedule to turn on the irrigation system based on the soil conditions checked

**SEND SCHEDULE is a complex function by which the software sends the configured irrigation time intervals to farm workers on their pagers.

**"SET OFF ALARM" is a complex function that involves blaring alarm horns and notifying all farm personnel with pagers that a certain condition has been exceeded on their pagers

** "check()" is a complex function that allows the software to retrieve real-time moisture, temperature or water level values from the respective sensors based on the argument passed

**setting is a variable that contains Boolean data type and its value is gotten from the main app. When *setting* == "on", it indicates that the software is actively sending notifications and watering crops based on checked soil conditions, *setting* == "off" indicates that the program is running but not actively checking soil conditions.

*time is a variable that contains time of day

*config is a variable that contains the value for the time at which crops are meant to be watered. It is created when the CONFIGURE TIME INTERVAL function is called.

soil_moisture – the value for the water content

*soil_temperature* – the value for the temperature of the soil

tank_level – the value for the level of water available for irrigation in the water tank

m_range – consists of *m_range.max* and *m_range.min* which are the maximum and minimum values for the tolerable moisture level of the soil set by the farm manager

t_range – consists of *t_range.max* abd *t_range.min* which are the maximum and minimum values respectively for the tolerable temperature level of the soil set by the farm manager

c_level – the critical water level is the lowest level of water with which irrigation can be done. It is a constant value set by the farm manager.

d.) <u>Top-Down Design:</u>
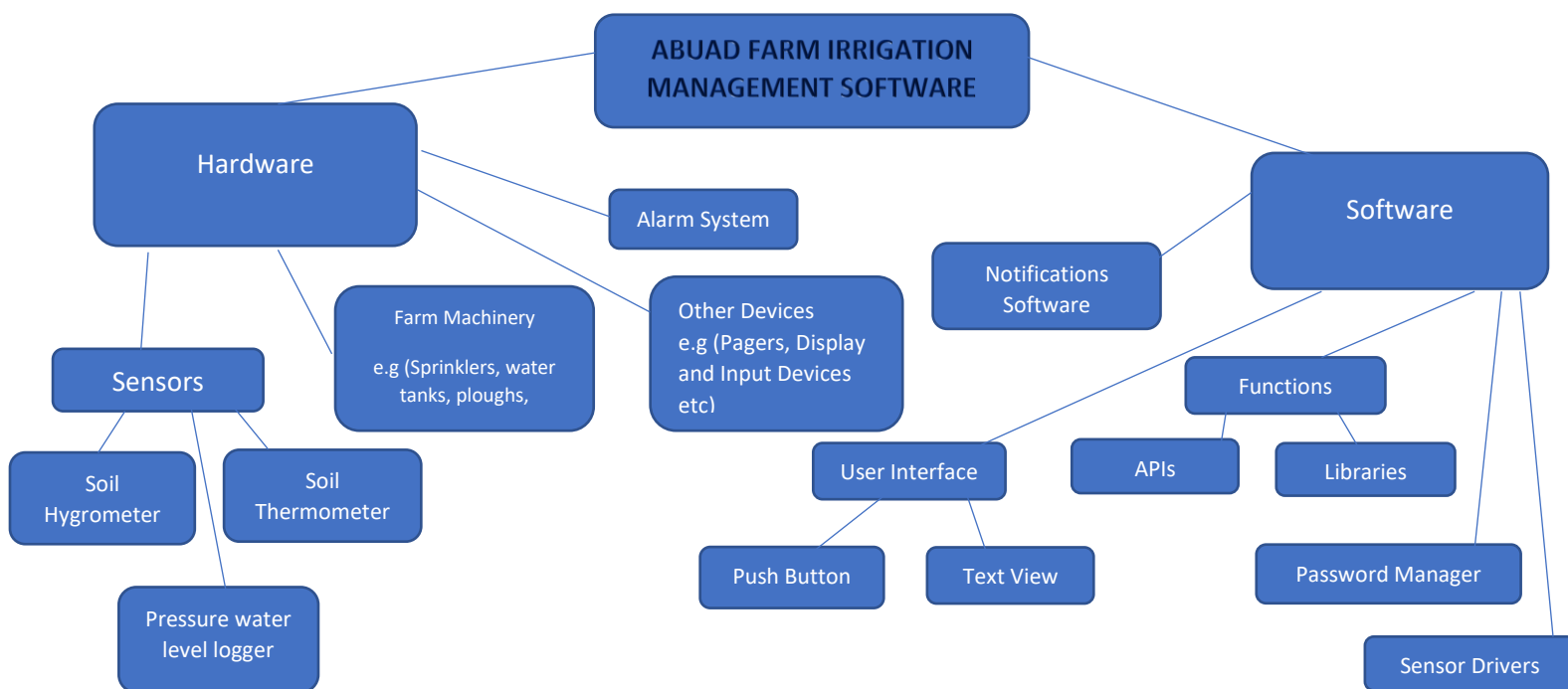
Design of ABUAD Farm Irrigation System Management Software using Top-Down Approach

Implementation

The main software will be implemented using Python on PyCharm for efficient coding using Object Oriented Programming and Arduino for sensors (such as the Soil Hygrometer) on Arduino Development Environment

Testing and Debugging

Before the official release of the software to ABUAD Farm, a beta version of the software will be made available to test its functionality on a small garden.

It will frequently be tested for bugs using the bug life cycle;

BUG LIFE CYCLE Diagram:
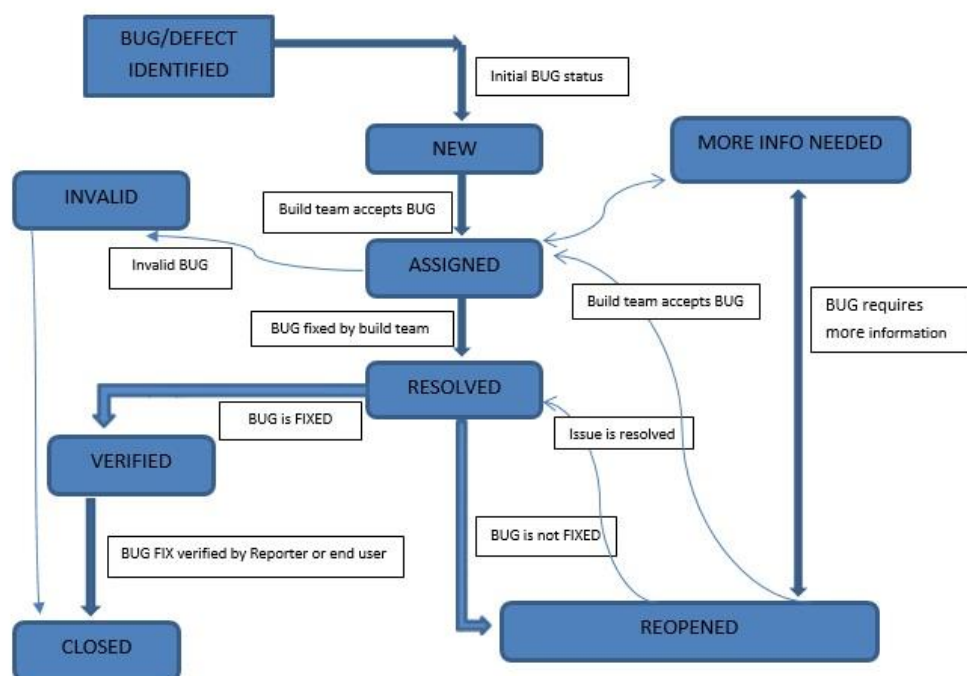
Release and Update

If the software proves to be efficient in performing all specified functionalities, as well as some extra features added and passes all tests, it will be released to the Farm for official use in November 2020 just before the commencement of the Harmattan season.

It will be updated whenever the Farm management requests for new features or when I, the developer discover ways of making it more efficient.