CROP MONITORING USING INTERNET OF THINGS WITH OPENCV CAPABILITY

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INTRODUCTION

Project Context

Philippine agricultural farming is low in productivity and income. The farmers are additionally lacking insights in agricultural marketing strategies and high-quality production planning. Having a smart farming system with OpenCV, researchers can monitor the data temperature, humidity and the disease of plant. A OpenCV technology is an open source computer vision and machine learning software library, it was built was to provide common infrastructure for computer vision application use of machine product. The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. The basic idea of this concept is the pervasive presence around us of a variety of things such as sensors, actuators, mobile etc. The benefits to agricultural is to gather data or tons of data collected by smart agricultural sensors by monitoring the humidity, temperature and disease detection, Cost management and waste reduction to increase control over the production.

In accordance with industrialization, the application of automation technology to agriculture is attempting from the necessity of mass production of food or plant. Agricultural automation began with information technology and the collection of crop, the data collection requires a sensor to collect environmental and a server to store the data, and the farmer adjusts the environment and cultivates plants based on the collected data.

Chapter I

INTRODUCTION

Project Context

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A symptom of plant disease is visible effect of disease on the plant, it may include a detectable change in color shape or function of the plant as it responds to the pathogen.

Smart farming is the logical advancement of precision farming. The focus of precision farming was mainly on technological invention to allow for site-specific farming. Moreover, smart farm is about empowering today's farmers with the decision tools and automation measurement technologies that seamlessly integrate products, knowledge and services for better productivity, quality and profit. Technological advances in these areas gather increasing momentum and this means that maintaining an overview of latest developments becomes more and more of a challenge.

Modern agriculture is a highly complicated and complex system that synthesizes a wide range of disciplines, such as optimum farm management, precise climate prediction, and nutrition. There are many opportunities where augmented reality can contribute in the area of farm management. The goal of this study is to determine possible disease or damage of crops based on preliminary prediction using DHT11 which intends to determine temperature and humidity which are contributing factors of crop damage; and using of OpenCV which can contribute to efficiencies in farm management tasks as it has demonstrated in other domains (e.g. managing underground infrastructure.

Purpose and Description

The purpose of our study was to develop smart farming system for Farmers of Ilocos Sur Polytechnic State College Sta. Maria, Main Campus. It hoped to help the recipients/here factors to manage a farm area and determine or detect some problems of a plant. This is very useful to make their production more successful and efficient.

This study was specifically design for the following:

Farmers. The Farmers could outline the advantages offered by its campus, programs, and faculty.

ISPSC Administrators. The viewing smart phone focusing into a plant will help them to get a data needed.

Future Researchers. They would able to put into a practical development of their skills in programming would serve as an experience to utilize different software.

Objectives of the Project

The capstone aimed to develop Crop Monitoring using Internet of Things with OpenCV Capability.

Specifically, it sought to achieve the following:

1. To determine the existing crop monitoring management system of ISPSC.
2. To design and develop a crop monitoring management technology.

3. To establish a Crop Monitoring with the following: Temperature and Humidity monitoring in the crop area and Disease or Damage Detection.
4. To test the system functionally of the crop monitoring system.

Scope and Limitation

The study was conducted during the school year 2018-2019 at Ilocos Sur Polytechnic State College. The DHT11 was used for the purpose to monitor the humidity and temperature around the area and Raspberry Pi along with OpenCV was used for image processing in order to determine possible damage or disease of crops.

The study was limited to the DHT11 sensor in long stability, sensitive to dewing and certain aggressive substances. The OpenCV python was limited only for installing library dependencies.

Chapter II

REVIEW OF LITERATURE

Md Saifudaullah Bin Bahrudin and Rosni Abu Kassim (2013) presented a shrewd cultivating framework in a constant observing framework that distinguished the nearness malady plant and caught pictures by means of a camera introduced inside a room when a recognizing happens. The inserted frameworks used to build up this savvy cultivating framework were Raspberry Pi and Arduino Uno. The key element of the framework is the capacity to remotely investigated when a plant is recognized. At the point when the nearness of plant is identified, the framework will show a picture of the room state in a site page. The framework will require the client affirmation to report the occasion to the system utilizing a Short notification. The upside of utilizing this framework is that it will lessen the likelihood of false examination answered to the framework. The camera will just catch a picture, so this framework will devour just a little stockpiling and power.

Kumar, A. and Hancke, G. (2013) states that creature wellbeing checking framework (AHMS) is for observing the physiological parameters, for example, rumination, body temperature, and pulse with encompassing temperature and dampness. The created framework could likewise investigate the feeling of anxiety relating to warm stickiness models based sensor module was additionally grown effectively. The ZigBee gadget and PIC18F455 microcontroller were utilized in the execution of sensor module.

The graphical UI (GUI) is actualized in LabVIEW 9.0 as indicated by the standard.

According to Patil, A. et al. (2016) the outstanding smaller scale controller, is to acquire an information from sensors in a keen ranch. Nonetheless, it's anything but a simple assignment for ranchers to get to learning about this sort of innovation and these specialists proposed an approach to enable ranchers to access such data all the more effectively.

Chieochan, 0. et al. (2017) concludes that the Internet of Things (IoT) is a system of physical gadgets. Kevin Ashton (1999) from the Massachusetts Institute of Technology proposed this idea and characterized it as a system of things, including PCs, cell phones, coolers, entryways, and vehicles that associate with one another and share information over the Internet. There are comparative advancements that are firmly identified with IoT, for example, Machine-to-Machine (M2M), the Internet of Everything (IoE), pervasive registering, and inserted Internet frameworks. Physical things must contain microcontrollers and sensors so as to astutely associate with one another. These microcontrollers and sensors will send information to an IoT cloud server that capacities as a center point for information trade. The IoT has been broadly connected in different fields, in homesteads, the IoT is utilized to screen the earth of mushroom development houses.

Hardware and Software Tools

Raspberry Pi. Raspberry Pi is a small computer board working on the Linux operating system which connects to a computer monitor, keyboard, and mouse. Raspberry Pi can be applied to an electronic structure and programming network work, it can also serve as a personal computer and Apache Webserver, MySQL could be installed in the board. (National Popular Science industry. Raspberry Pi what is? From http://www.instrument.tmd.go.th. November, 2014).

Smart Farming is a farming management concept using modern technology to increase the quantity and quality of agricultural products. Farmers in the 21st century have access to GPS, soil scanning, data management, and Internet of Things technologies (www.schuttelaar-partners.com,2017).

Internet of Things. The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio-Frequency Identification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals. (D. Giusto, A. Iera, G. Morabito, L. Atzori (Eds.)2010).

DHT11 Sensor a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. (SUNROM TECHNOLOGIES,2012).

OpenCV OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. it was built was to provide common infrastructure for computer vision application use of machine product and implemented using Python Programming Language. (https://opencv.org/about.html

Raspberry Pi Camera the Raspberry Pi Camera v2 is the new official camera board released by the Raspberry Pi Foundation. The Raspberry Pi Camera Module v2 is a high quality 8-megapixel Sony IMX219 image sensor custom designed add-on board for Raspberry Pi, featuring a fixed focus lens. (https://thepihut.com/products/raspberry-pi-camera-module)

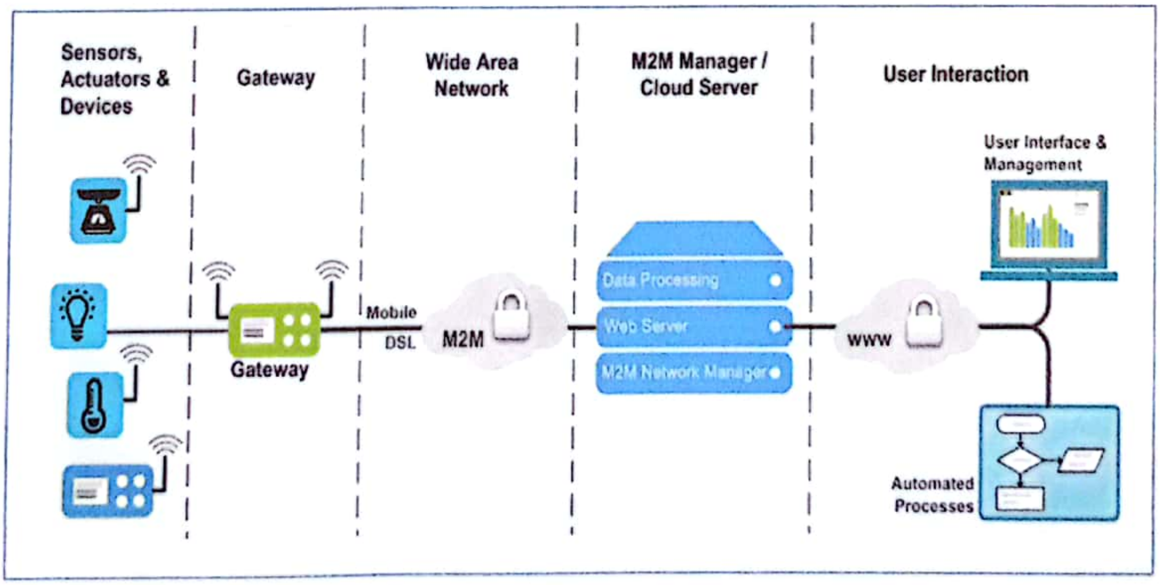


Figure 1. A Typical IoT System Architecture

The study was conducted at the Agricultural Field Area of Ilocos Sur Polytechnic State College, Main Campus, Santa Maria, Ilocos Sur. This research applied the use of the Typical IOT System Architecture. The Typical IOT System Architecture used by the researcher in order to analyze, develop, test, and monitor the conceptualization and designed layer based security mechanism for ISPSC the said process shown in Figure 1. In the first phase, the researchers brought the Internet of Things needed in the study. In the next phase, the researchers corrected the devise through the gateway, to the WAN; then to the M2M or Cloud Server. The last phase was the Interaction of the consumer or used to the system which was already the application of the system for the irrigation of the plants.

Chapter III

METHODOLOGY

Project Plan

ACTIVITIES	JAN				FEB				MAR				APR				MAY			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Sensors, Actuators & Devices Identification (Requirements Analysis)																				
Gateway																				
Wide Area Network																				
M2M Manager/Cloud Server																				
User Interaction																				

Figure 2. A Typical IoT System Architecture

Figure 2 shows the cycle of the methods and procedures that the researchers applied in the study.

Sensors, Actuators & Devices. This phase was utilized to determine the requirements needed in the study. Sensors and other devices were also included in the requirements gathering where the components that form the entry point of physical and network capable devices.

Gateway. These phases represent the components that aggregate and control multiple sensors, actuator or devices which is otherwise known as the access to the internet using the web interface and programming language used in the development of the smart farming with watering system technology.

Wide Area Network. This is a fabric of connected network equipment that provides the means of communicating the gateways with the cloud.

M2M Manager / Cloud Server. The application/business logic that processes the data coming from sensors or decides to act on the actuator.

User Interaction. The software that transforms the data into a presentable form for the users to consume and take action.

Table I Shows the distribution of the role requirement and responsibility of the researchers in gathering the data of the study.

Table 1. Role Requirements and Responsibility

Project Staff and Functions			
Project Leader	Lead team, Report studies, Review deliverables and assure quality	1	Jerwin Montero
Documenter	Create framework Content	2	Abdul Jalil Langco Lester Anselmo
Planner	Design the project performance Management tool	2	Maurice Manalo Loreto Sotelo
Plan Developer Review Team	Build the project performance evaluate and promote of use	2	Irvin Grad Diga

Table 1 shows that each member has their different tasks and respective designations. The project leader designated the members according to the skills to help and build a cooperative teamwork. Moreover, the project leader reviewed the deliverables and assured the quality of the output.

Data Gathering Procedures

The following were the methods used in gathering data needed in the conduct activity of this study.

Survey. The researchers gathered the necessary information to the faculty teachers, critic teachers, and system adviser to be able to know their opinion/feedbacks, for the researcher to gain another ideas or knowledge for the enhancement of the system.

Network Experiment/Development. The researchers conducted an experiment using Arduino Uno and Ethernet shield at Technical Service, ISPSC, Sta. Maria to monitor the humidity, temperature and the disease of the corn.

Internet. This tool was very useful in providing the background and literature of this study, some needed literatures can be found in the internet. Specially, published and unpublished researches will be the bases of this study.

Interview. The researchers conducted an interview. The researchers use a standardized or an open-ended interview, wherein the researchers asked questions freely. This approach facilitates faster interviews that can be more easily analyzed.

Chapter IV

RESULTS AND DISCUSSION

Requirement Analysis

Based from the interview conducted to PROF. BERNADETTE C. CALIBUSO, the current scheme in determining the temperature, humidity and crop damage or disease is through a manual process. Currently, there is no sensor technology being utilized by ISPSC to determine such factors affecting the health status of crops.

Functional requirements. The successive requirements specify the functions and units of the proposed system. They characterize the behavior of the system relating to necessity:

- Read the Temperature.
- Read the Humidity.
- Analyzing disease plants

Non-Functional requirements. The system does not include the tensor flow using mobile phone to analyze disease plant.

Hardware

- Raspberry Pi 3
- Pi Camera
- DHT11
- Monitor
- PS2 keyboard

- PS2 mouse

Software

- Raspbian Noobs (Operating System)
- Python Programming Language
- Terminal (installing dependencies)

Design of Software/Product/Process

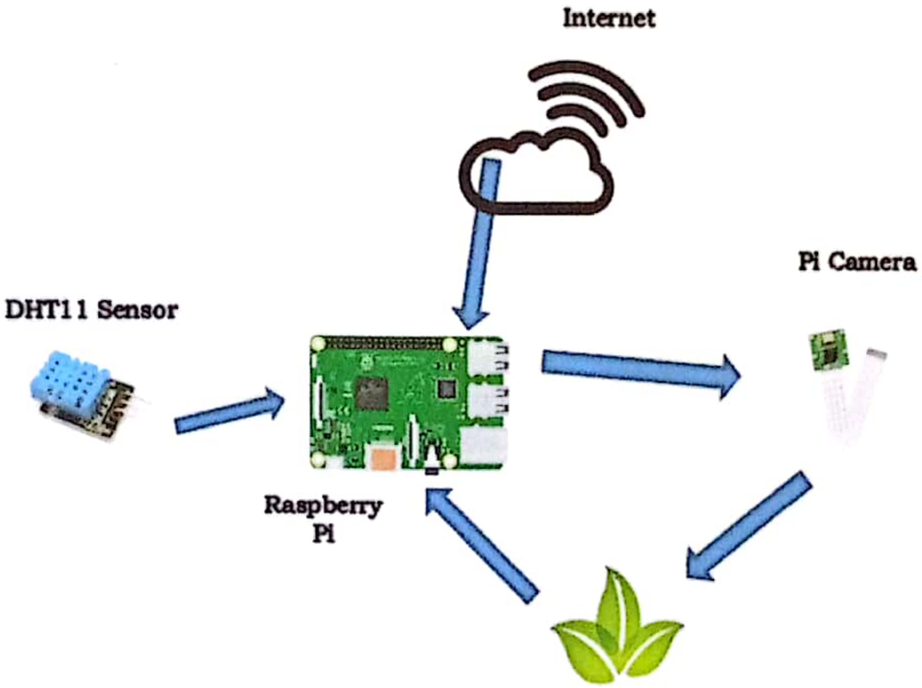


Figure 3. The Schematic Diagram of the System

The designed technology utilized Raspberry Pi as the microcontroller using sensors such as DHT11 for purposed of monitoring Temperature and Humidity of the crop area and a module was used which is known as the Pi camera along with OpenCV implemented in the Raspberry Pi running in the Raspberry Pi Controller. The system can capture and analyze the image through image processing using OpenCV in order to determine the damage of a crop.

Smart agriculture systems call on a variety of IoT capabilities to improve farming production and deliver new analyzing capabilities. Within that area, more traditional farming, DHT11 placed within the ground may real-time data on Temperature and Humidity.

Choosing sensor brands and types of sensors are typically one of the challenging tasks when building a smart agriculture system. Setting up analyzation and automation software dependencies to implement actions, such as DHT11, Pi Camera and raspberry Pi will require software expertise that some agricultural experts will find challenging. Software integration with sensors and agricultural equipment is a time-consuming activity, but also one where seasonal conditions and crop expertise need to be considered.

Description of the Prototype

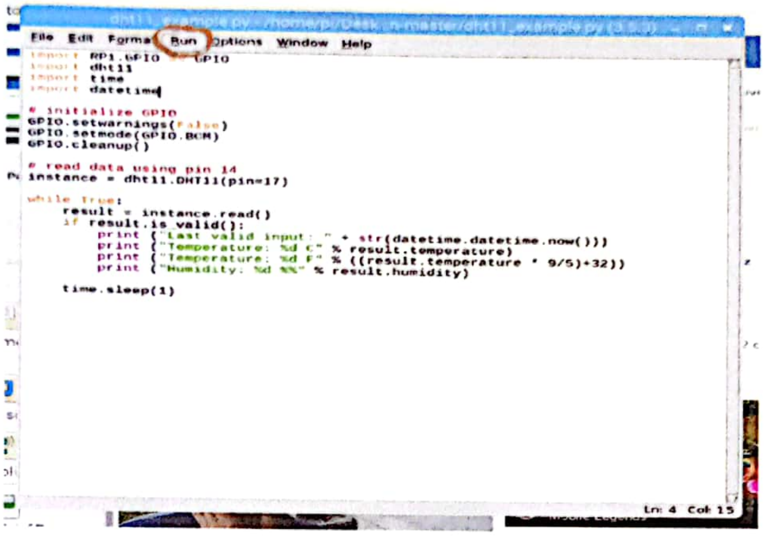
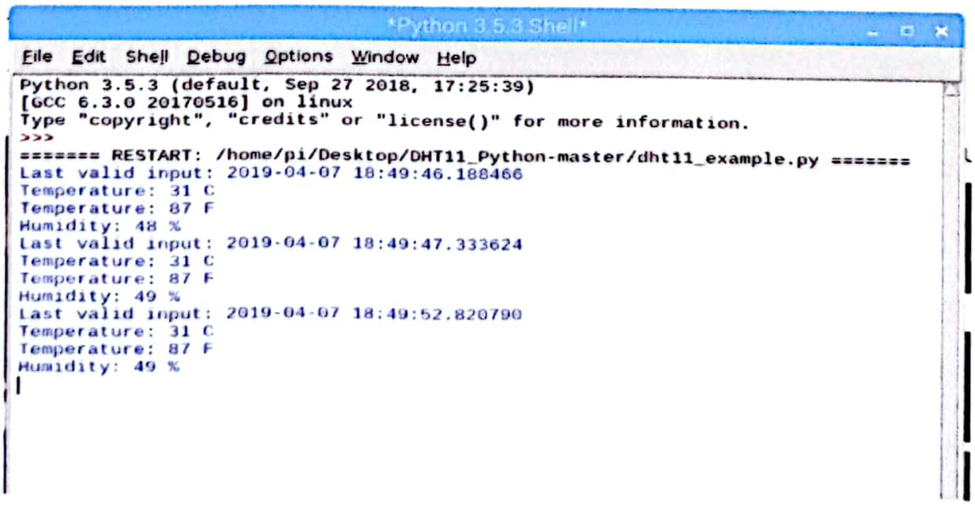


Figure 4. DHT11

Figure 4 shows the source code which was written using Python Programming applied in Raspberry Pi Controller to make the DHT11 function for its purpose to determine the temperature and humidity of the crop area.



ui.py - /home/pi/Desktop/PlantDiseaseDetection-master/ui.py (3.5.3)

File Edit Format Run Options Window Help

```
import tkinter as tk
from tkinter.filedialog import askopenfilename
import shutil
import os
import sys
from PIL import Image, ImageTk

window = tk.Tk()

window.title("Plant Disease Detector")

window.geometry("500x510")
window.configure(background ="white")

title = tk.Label(text="Click below to choose picture for testing disease....", b
title.grid()
def bact():
    window.destroy()
    window1 = tk.Tk()

    window1.title("Plant Disease Detector")

    window1.geometry("500x510")
    window1.configure(background="white")

    def exit():
        window1.destroy()
    rem = "The remedies for Bacterial Spot are:\n\n "
    remedies = tk.Label(text=rem, background="white",
                      fg="Brown", font=("", 15))
    remedies.grid(column=0, row=7, padx=10, pady=10)
    rem1 = " Discard or destroy any affected plants. \n  Do not compost them. \n
    remedies1 = tk.Label(text=rem1, background="lightgreen",
                      fg="Black", font=("", 12))
    remedies1.grid(column=0, row=8, padx=10, pady=10)

    button = tk.Button(text="Exit", command=exit)
    button.grid(column=0, row=9, padx=20, pady=20)

    window1.mainloop()
```

Ln: 2 Col: 19

Figure 5. Plant Disease Detection

The file name ui.py in python IDLE Shell creates open a code for plant disease detection, by clicking Run button in the navigation in the Run Module or by pressing F5 to run the program. We do a lot at this code to run correctly by fixing other errors we encounter at this program and the help of internet as our source code.

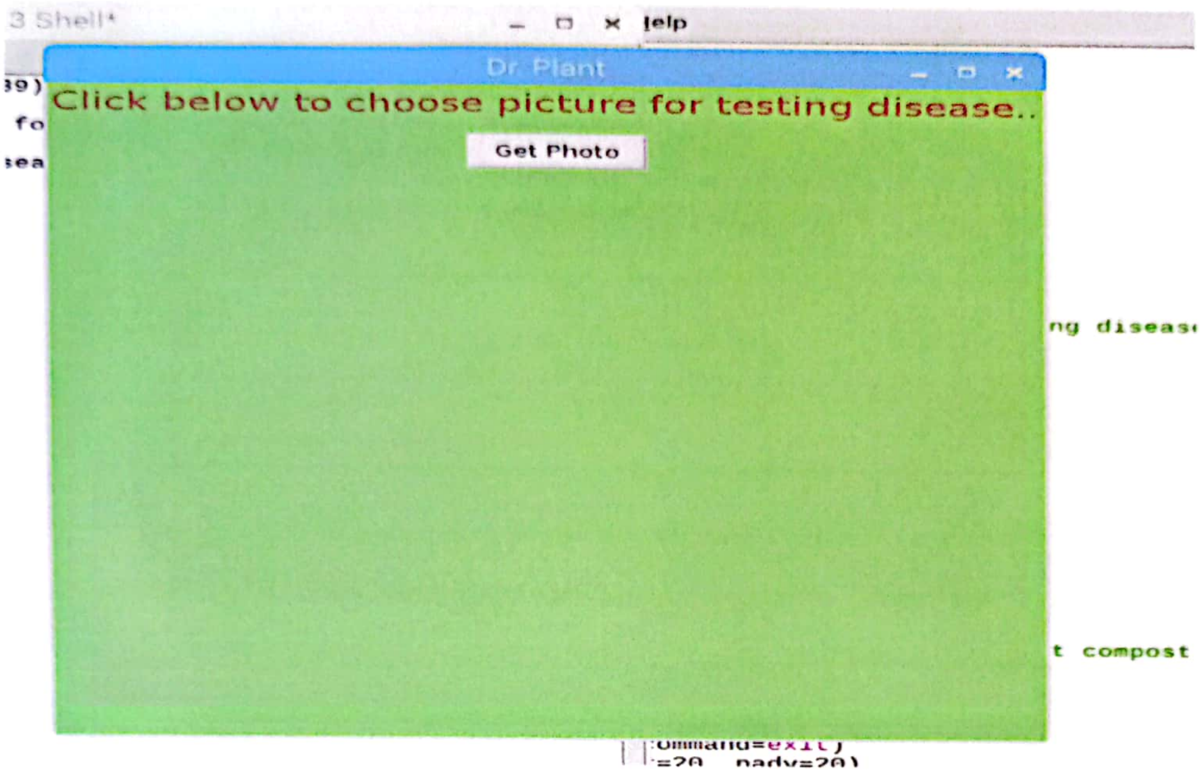


Figure 6. Get Photo

This figure is the output of the code that we run. We get some picture of different plants having a disease and healthy leafs stored in the computer. When clicking into the Get Photo button it will redirect into next window as shown below and click the folder that you see to redirect into the next window.

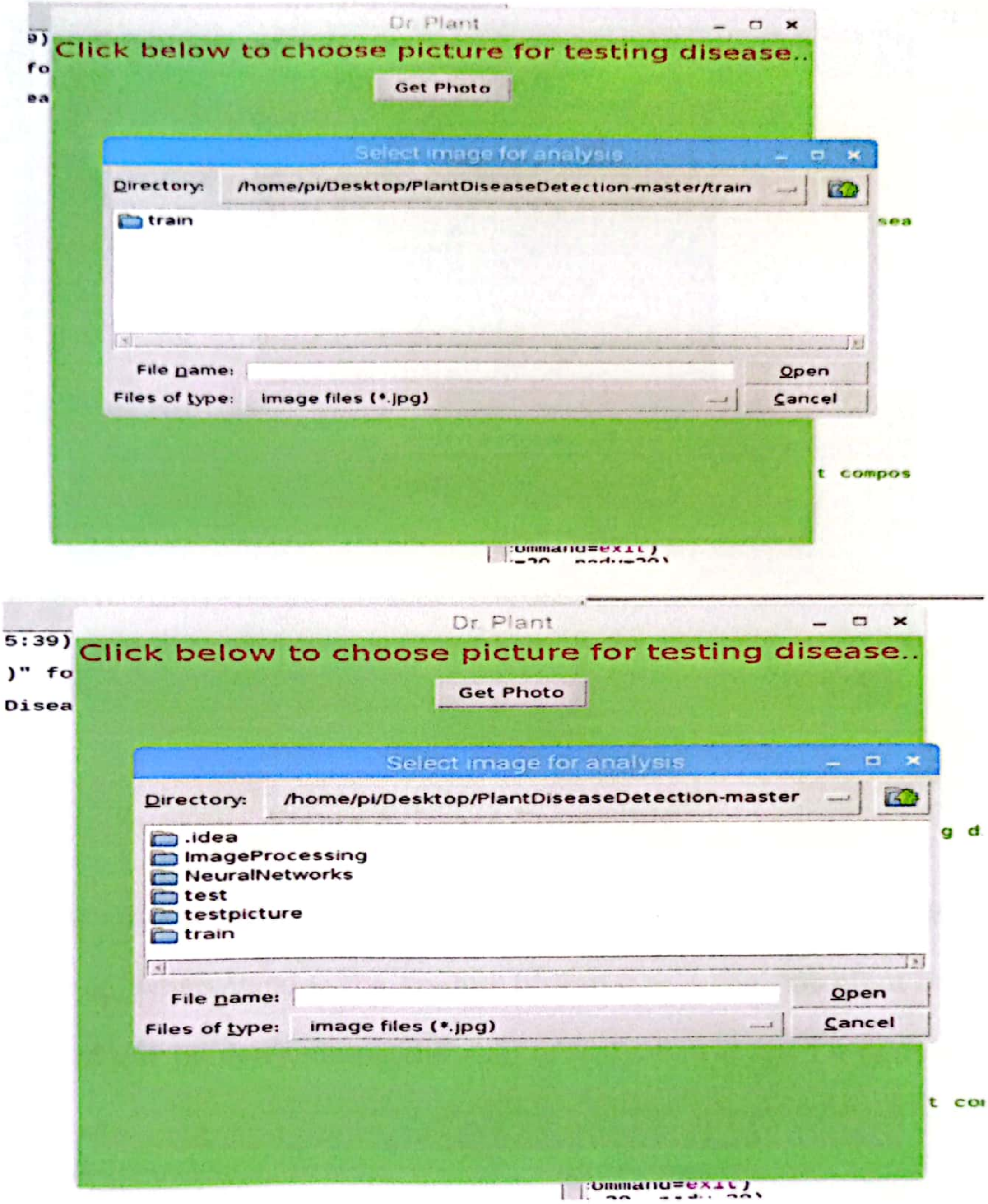


Figure 7. Image Training

This enables the farmers browse the image of crops or plants to be analyzed using the python program developed by means of using OpenCV for image processing

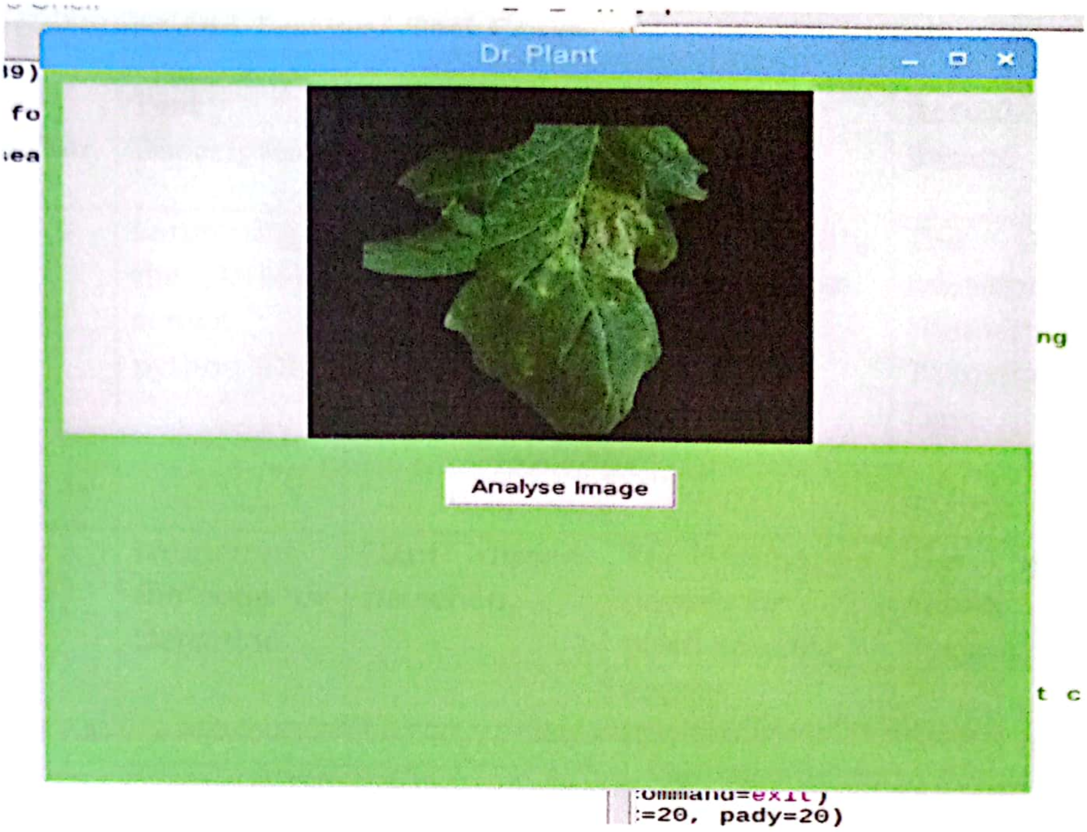


Figure 8. Image Processing

Plant analysis is the process of getting an information from the picture were selected, when clicking the Analyze button it tells that the plant having a disease of not by determining the skin of leaf when it have a damage or affected area.

Development and Testing/ Test Cases

Test Number	Test Description	Test Data	Expected Result	Actual Result
1	Launching the DHT11 sensor in python IDLE	Humidity and Temperature	The data testing should appear	The DHT11 releasing the Humidity and Temperature Data
2	Launching the code for Detection	Plant disease Detection	The information needed for plant should appear	The system shows the output.

Chapter V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

In summary the study aimed to develop a smart farming using Internet of Things with OpenCV Capability. Specifically, it sought to answer the following: 1) To determine the existing smart farming management system on ISPSC; 2) To design and develop a Smart farming management technology and; 3) To establish a Smart Farming with the following: Temperature and Humidity monitoring in the crop area and Disease or Damage Detection. Based on the findings relative to the analysis of requirements, currently there is no technology used to monitor the temperature, humidity and damage of a crop. The technology developed using DHT11 sensor, OpenCV implemented using Python Programming Language can determine the temperature, humidity and damage of a crop. The methodology was use is A Typical IoT System Architecture were researcher based on the Sensors, Actuators and devices, to identify the needed of the system. A Gateway and WAN to communicate and access all the devices, and a user interaction to transform a software into data to be in a presentable form.

Conclusion

Based from the data gathered during the study, the following conclusion were drawn:

1. Currently, there is no technology used to monitor the temperature, humidity and damage of a crop at ISPSC.
2. The technology developed can utilize DHT11 sensor, OpenCV implemented using Python Programming Language for the purpose in the establishment of sensor device for crop monitoring.
3. The developed system was tested using test cases or unit testing.

Recommendations

The proponents together with the review committee recommend the following:

1. The crop monitoring system can be used for ISPSC.
2. Python Programming Language along with Raspberry Pi and other essential sensors can be used in the development a crop monitoring product.
3. The system developed can be continuously improved by future researchers

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