RpiScope-An Effective Tool For Farmers

A project report submitted in complete fulfillment of
the requirements for the degree of

Bachelor of Engineering

by

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April 16, 2018

This work is dedicated to all farmers who feed the entire humanity yet continues to live in poverty and the mercy of nature.

Internal Approval Sheet

CERTIFICATE

This is to certify that the project entitled **"RpiScope-An Effective Tool For Farmers"** is a bonafide work of **Marc Mathew(7321), Rachel Joseph(7340), Rubina Parveen(7343)** submitted to the University of Mumbai in fulfillment of the requirement for the award of the degree of **Bachelor of Engineering** in **Electronics**

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Approval Sheet

Project Report Approval

This project report entitled by **RpiScope-An Effective Tool For Farmers** by **Marc Mathew, Rachel Joseph, Rubina Parveen** is approved for the degree of Bachelor of Engineering

Examiners

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Marc Mathew (Roll No. 7321) **(sign)**_____

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Date: April 16, 2018

Abstract

Agriculture plays a vital role in the Indian economy.The monetary losses due to biotic factors account to millions of dollars per annum. It is too tedious and cumbersome for the farmers to travel far and get the sample examined. This paper works on the digitization and automation of a compound microscope by using a Raspberry Pi kit and a Pi camera module. The captured data from the Raspberry pi kit can undergo diagnosis instantly by the biologist/expert and the focus adjustment of the microscope can also be done remotely by the expert. The main concern of this paper is to bridge the gap between a farmer and a biologist by providing instant remedial solution to the farmer without further delay.

Acknowledgments

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Chapter 1

Introduction

In India about 58 percent of the rural households still depend on agriculture as their principal means of livelihood. The total farm yield losses in India due to biotic factors ranges between 10 to 30 percent. The crop losses must be curtailed by adapting a suitable crop protection or enhancement method. The overall crop yield can be easily improved by timely detection of the pathogens affecting the plant and taking obligatory actions. However, since majority of the farmers in India are uneducated and due to primitive methods of agriculture still being used the detection of pathogens cannot be carried out by the farmer.

Plant pathologists study the growth of various bacteria using a microscope. Since the traditional microscope does not provide a digital output the image cannot be sent or stored for further use. Digitization of a microscope would help reduce the inconvenience faced by pathologists as it will provide a better view of the microbes and save the important sample data for future use. [1] Video capturing of the microbes makes it possible to continuously monitor the living cells and send it to any other place in minutes. [2]

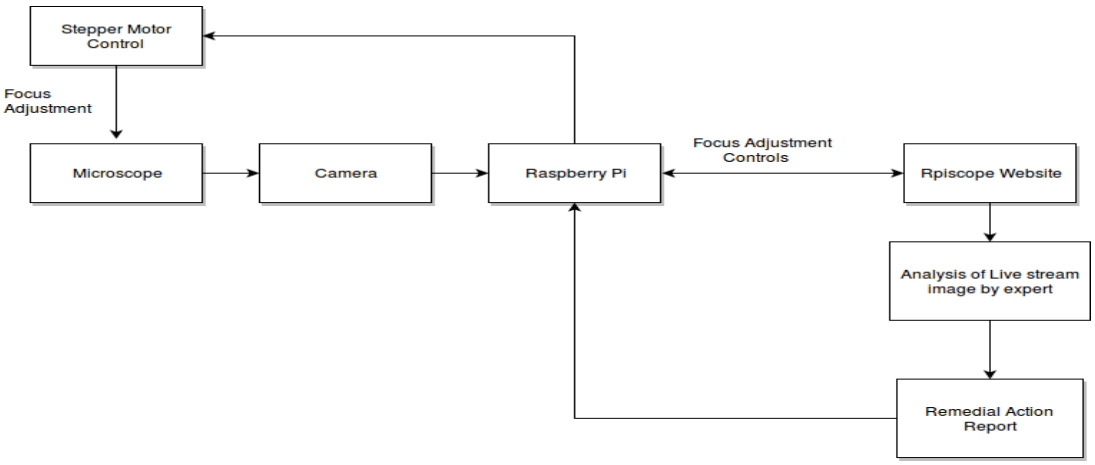

Figure 1.1: Basic Block diagram of the System

This project aims at installing a special setup in each village. This setup consists compound microscope which comes with different lens options of 10x, 15x for eyepiece and 10x, 45x and 100x for the objective lens. The microscope is digitized using a raspberry pi 3B module which performs the functions of a mini computer, camera which gives a picture quality of maximum 5MP, motors and driver circuits for focus adjustment.

The microscopic images are acquired using a Raspberry Pi camera module and then sent real time to a central monitoring location. This central monitoring location can be a small section of any Agricultural Institute of India. An expert (generally a pathologist of this institute) analyzes this image and sends a message back to the farmer explaining the solution for the plant infestation. An added feature is that the expert can control the focus of the microscope over the internet.

1.1 Motivation

In India, about 194.6 million (approximately 15 percent)of the population is undernourished inspite of the fact that it is the largest producer, consumer and exporter of wheat, rice and spices.It is believed that farm yield losses ranges between 10 to 30 percent. Hence,crop losses must be minimized and crop protection, enhancement methods need to be adopted.The sector has huge unrealized potential for growth, given the presently very low levels of application of crop protection chemicals, as compared to the global norms coupled with fast increasing awareness in young, educated farming class. The sector faces many challenges and solution to same can lead to India becoming a global manufacturing hub of quality crops. The overall crop yield can be easily increased by timely detection of the pathogens affecting the plant and taking necessary action.

1.2 Objectives

This project aims at designing a semi-automatic microscope for detection of pathogens affecting the commonly grown crops and provide immediate remedial solutions after analysis.

The proposed methodology of the project is:

1. To integrate Raspberry Pi 3 and its camera module with the microscope.
2. To semi-automate the microscope using appropriate belt- motor mechanism.

3. To make a website which demonstrates the live-streaming of the bacteria acquired using a Raspberry Pi Camera. Also information of various diseases which are very common in Indian crops, control buttons to adjust the focus of the microscope and an option to provide a remedial solution.

4. To analyze agricultural samples under the microscope and determine the microbes present by an expert present at any corner of the world.

5. To send a remedial solution back to the farmer based on the evaluation results.

Chapter 2

Literature Review

2.1 Construction and Working of a Compound Microscope

2.1.1 Construction

A compound microscope consists of the following parts:

1. **Objective lens:**

   The objective lens of a compound microscope is a convex lens of very short focal length (F_o) $<$ 1cm. The object to be seen is kept very close to the objective lens.

2. **Eye piece:**

   The eye piece of a compound microscope is also a convex lens of short focal length F_e . But $F_e > F_o$.

3. **Microscope tube:**

   The objective lens and the eyepiece are mounted coaxially (having a common axis) at the ends of two brass tubes which can be made to slide into each other so that the distance between the two lenses can be adjusted.

2.1.2 Working

The ray diagram given below gives the principle of a compound microscope. The object is mounted on the stand below the microscope tube. The objective lens forms a real, inverted and magnified image (I_1) of the object. The image I_1 acts as an object for the eye piece. The position of the eyepiece is so adjusted that the image lies within the focus of the eyepiece (F_e). The eyepiece acts like a magnifying glass and forms a virtual erect and magnified image of the object.

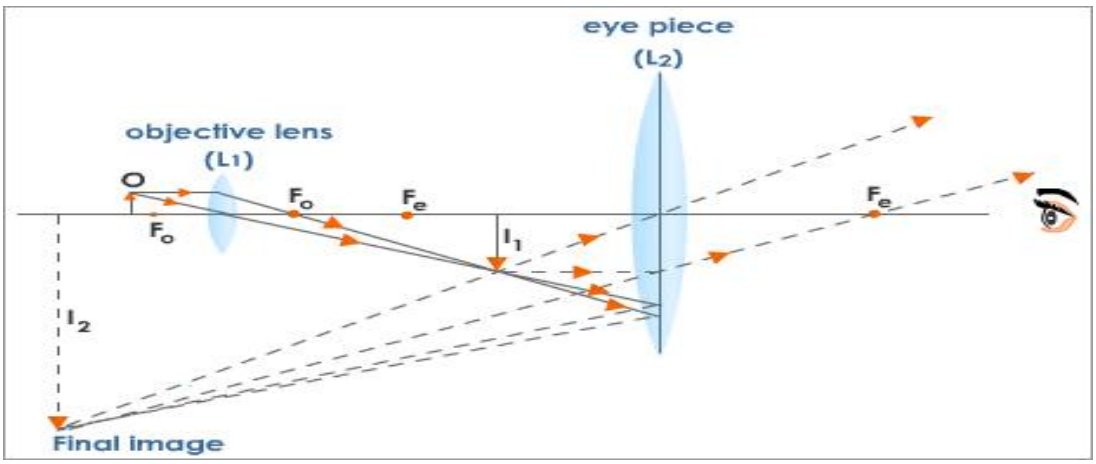

Figure 2.1: Image Formation In Compound microscope

The object (O) is placed just outside Fo, the principal focus of the objective lens. Fe is the principal focus of the eye lens.

A real, inverted magnified image I_1 is formed.

The magnified image I_1 acts as an object for the eye lens.

The final image $I_2$is virtual and is magnified still further. It is inverted compared with the object.

I_2 may appear 1000 times larger than the object.

2.1.3 Magnifying Power

The magnifying power of a compound microscope is defined as the ratio of the size of the final image (I2) as seen through the microscope to the size of the object as seen with a naked eye.

Total magnification is equal to the product of the magnification produced by the objective and the eyepiece.

$$m = m_o * m_e \tag{2.1}$$

where,

m_o is magnification produced by the objective

m_e is magnification produced by the eyepiece

2.2 Important diseases of wheat

1. **Rusts of Wheat** -caused by the fungus *Puccinia*

(a) Stem or black rust: Puccinia graminis f. sp. tritici

Figure 2.2: Black rust(pustulesteliospores) in Wheat

(b) Brown rust or leaf rust : Puccinia triticina (Syn. P. recondita) and

(c) Yellow or stripe rust :Puccinia striiformis f. sp. tritici.

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Figure 2.3: Yellow Rust(Puccinia Uredosporangium)in Wheat

2. **Smuts of Wheat Bunts**:caused by the smut fungus*Lilletia*

(a) Hill bunt or Common bunt or stinking smut or covered smut: two very closely related fungi, Tilletia tritici (syn. Tilletia caries) and T. laevis (syn. T.foetida).

(b) Karnal or Partial bunt:Tilletia indica (Syn. Neovossia indica)

(c) Loose smut :Ustilago nuda (Syn. U. segetum)

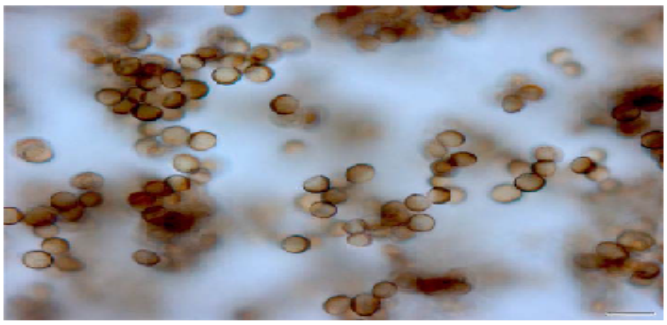

Figure 2.4: Loose smut in Wheat

(d) Flag smut:Urocystis agropyri

3. **Powdery mildew of wheat**:Blumeria graminis (DC.) fungus*Speer*

4. **Tundu disease of wheat**:Calvibacter tritici associated with ear cockle disease (caused by the fungus*Anguina tritici*.

2.3 Python

Python is a widely used high-level programming language for general-purpose programming. Python has a design philosophy that emphasizes code readability (notably using whitespace indentation to delimit code blocks rather than curly brackets or keywords), and a syntax that allows programmers to express concepts in fewer lines of code than might be used in languages such as C++ or Java.

Python is a multi-paradigm programming language:object-oriented programming and structured programming are fully supported, and many language features support functional programming and aspect-oriented programming (including by metaprogramming and metaobjects (magic methods).Many other paradigms are supported via extensions, including design by contract and logic programming.

Python can serve as a scripting language for web applications.With Web Server Gateway Interface, a standard API has evolved to facilitate these applications.Python has been used in artificial intelligence tasks.As a scripting language with modular architecture, simple syntax and rich text processing tools, Python is often used for natural language processing tasks.

Python has also seen extensive use in the information security industry, including in ex-

ploit development.The Raspberry Pi single-board computer project has adopted Python as its main user-programming language.We will be using python to control our motors to do the stage and focus adjustments.

2.4 Stepper Motors

A stepper motor or step motor or stepping motor **is a brushless DC electric motor that divides a full rotation into a number of equal steps**. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed.

The stepper motor is known by its **property to convert a train of input pulses (typically square wave pulses) into a precisely defined increment in the shaft position**. Each pulse moves the shaft through a fixed angle.

Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. The electromagnets are energized by an external driver circuit or a micro controller. To make the motor shaft turn, first, one electromagnet is given power, which magnetically attracts the gear's teeth. When the gear's teeth are aligned to the first electromagnet, they are slightly offset from the next electromagnet. This means that when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one. From there the process is repeated. Each of those rotations is called a "step", with an integer number of steps making a full rotation. In that way, the motor can be turned by a precise angle.

There are three main types of stepper motors

- **Permanent magnet stepper:**
  Permanent magnet motors use a permanent magnet (PM) in the rotor and operate on the attraction or repulsion between the rotor PM and the stator electromagnets

- **Hybrid synchronous stepper**
  The Hybrid Stepper Motor is a combination of the features of the Variable Reluctance Stepper Motor and Permanent Magnet Stepper Motor. In the center of the rotor, an axial permanent magnet is provided. It is magnetized to produce a pair of poles as North (N) and South (S) .

- **Variable reluctance stepper**

  Variable reluctance (VR) motors have a plain iron rotor and operate based on the principle that minimum reluctance occurs with minimum gap, hence the rotor points are attracted toward the stator magnet poles.

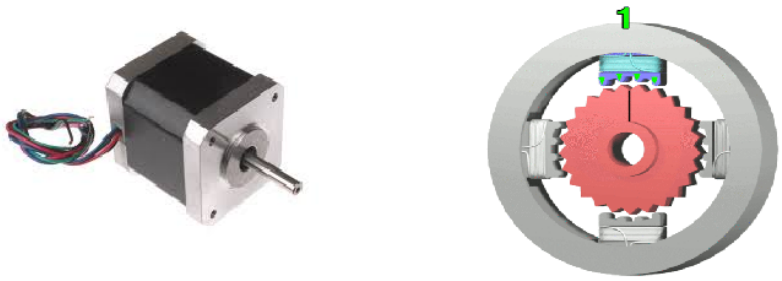

Figure 2.5: Stepper Motors

2.4.1 Need of Steppper Motors

- **Positioning :**

  Since steppers move in precise repeatable steps, they excel in applications requiring precise positioning such as 3D printers, CNC, Camera platforms and X,Y Plotters. Some disk drives also use stepper motors to position the read/write head.

- **Speed Control :**

  Precise increments of movement also allow for excellent control of rotational speed for process automation and robotics.

- **Low Speed and Torque :**

  Normal DC motors don't have very much torque at low speeds. A Stepper motor has maximum torque at low speeds, so they are a good choice for applications requiring low speed with high precision.

Chapter 3

Report on present investigations:

3.1 Accessing websites over the internet

In order to access any website an address known as a Uniform Resource Locator (URL) is required. A URL is made up of several section all of which have their own functions. Here is a generic example of a webpage URL:

Protocol	Third-level domain	Second-level domain	Top-level domain	(Path)	(File)
http://	www.	exampledomain	.com	/directory	/index.html

Figure 3.1: URL structure

The World Wide Web (WWW) is a system of electronically stored hypertext documents. The hypertext transfer protocol (HTTP) is used in the World Wide Web in order to transfer webpage data from the web server to the browser. In addition to HTTP, there is also an encrypted version of the protocol: Hypertext Transfer Protocol Secure (HTTPS). The HTTP protocol header is followed by the hostname, which consists of a second-level and top-level domain (in this order). If a URL points to a specific directory or file, the relevant information will be placed after the hostname.

3.1.1 DNS server:

URLs are generally comprised of letters, meaning that people can easily remember them. Computers, on the other hand, use a combinations of numbers (known as IP addresses) to find a server on the internet. An additional step is required in order to access content from the web browser. This step requires **translating a webpage URL**

into the corresponding IP address. The task is carried out by DNS servers, which are responsible for managing the Domain Name System.When a web address is entered into the search bar of the browser, the browser looks for the requested domain in its cache. If it is not available, it requests the operating systems DNS server to find the required IP address. A **DNS server is a directory of IP addresses**. Since requesting the domain name system takes some time, the IP addresses of sites that have already been visited are usually stored in the operating system or the browsers DNS cache. This cache keeps IP addresses at hand for future visits to the website. This lightens the load of the DNS server and speeds up the webpage loading time.

3.1.2 NAT-Network Address Translation:

NAT translates the IP addresses of computers in a local network to a single IP address. This address is often used by the router that connects the computers to the Internet. The router can be connected to a DSL modem, cable modem, T1 line, or even a dial-up modem. When other computers on the Internet attempt to access computers within the local network, they only see the IP address of the router. This adds an extra level of security, since the router can be configured as a firewall, only allowing authorized systems to access the computers within the network.

Public IP address A public IP address is the address that is assigned to a computing device to allow direct access over the Internet. A web server, email server and any server device directly accessible from the Internet are candidate for a public IP address. A public IP address is globally unique, and can only be assigned to a unique device.

Private IP address A private IP address is the address space allocated by InterNIC to allow organizations to create their own private network. There are three IP blocks (1 class A, 1 class B and 1 class C) reserved for a private use. The computers, tablets and smartphones and the personal computers within an organizations are usually assigned private IP addresses.

Class	Starting IP Address	Ending IP Address	# of Hosts
A	10.0.0.0	10.255.255.255	16,777,216
B	172.16.0.0	172.31.255.255	1,048,576
C	192.168.0.0	192.168.255.255	65,536

Figure 3.2: IP blocks reserved for private IP addresses

When a computer is assigned a private IP address, the local devices see this computer via it's private IP address. However, the devices residing outside of your local network cannot directly communicate via the private IP address, but uses your router's public IP address to communicate.

Once a system from outside the network has been allowed to access a computer within the network, the IP address is then translated from the router's address to the computer's unique address. The address is found in a "NAT table" that defines the internal IP addresses of computers on the network. The NAT table also defines the global address seen by computers outside the network. Even though each computer within the local network has a specific IP address, external systems can only see one IP address when connecting to any of the computers within the network.

To simplify, network address translation makes computers outside the local area network (LAN) see only one IP address, while computers within the network can see each system's unique address. While this aids in network security, it also limits the number of IP addresses needed by companies and organizations. Using NAT, even large companies with thousands of computers can use a single IP address for connecting to the Internet.

3.2 Live streaming over the internet

To access the Raspberry Pi over the internet from another computer or a mobile device the commonly used methods are:

3.2.1 Port forwarding

Port forwarding is a way of making a computer on the home or business network accessible to computers on the internet, even though they are behind a router. To do this, one must change the configuration of the router to forward all inbound traffic from the internet onto a specific port to the local IP address of your Raspberry Pi.It enables the user

to create a permanent translation entry that maps a protocol port on the gateway/router machine to an IP address and protocol port of a private LAN device(here the Raspberry Pi). It's a transparent process, meaning network clients cannot see that port forwarding is being done.

Most routers have this feature available. However, every router is different so one will need to consult the router's user manual for instructions. The settings can be tricky if the Raspberry Pi is behind a firewall or if there is more than one router. One disadvantage of port forwarding is that it exposes a network port on the private LAN to the public internet. Thus the main diadvantage of port forwarding is that it leads to **security vulnerability** and must be managed carefully.

3.2.2 Dataplicity

An alternative solution to port forwarding is an online services available called Dataplicity.The main advantage of Dataplicity is that it offers functionality similar to SSH(secure shell protocol), but it doesnot need any complex set-up to get it working behind firewalls and NAT.It is essentially a VPN(Virtual private network)for the Raspberry Pi. It not only lets one connect to the Pi remotely but also creating a web server through the system, allowing one to run a mini website.It is a aims to simplify the process of connecting to devices over the internet.

Dataplicity also has an extra feature called 'Wormhole'. This allows one to host a website or create a web interface on the Pi and access it via a fixed URL of the form https://<yourdevice>.dataplicity.io/. Port forwarding, firewall exceptions and Dynamic DNS are not required. This feature enables the user to easily share files, run a website or stream video online.

It can be enabled with a single click and your Pi is given a unique URL. This URL appears just above the terminal window and can be clicked or copied as required.When one installs the Dataplicity Agent on the device, it will opportunistically establish and maintain a secure HTTPS connection to the Dataplicity IoT Router.

When one connects to the Remote Shell via the Dataplicity website, or to the redirected web interface via the device Wormhole URL, the connection will be routed between browser and the device via IoT Router.The opportunistic connection between Raspberry Pi and the Dataplicity IoT router makes port forwarding and dynamic DNS redundant.

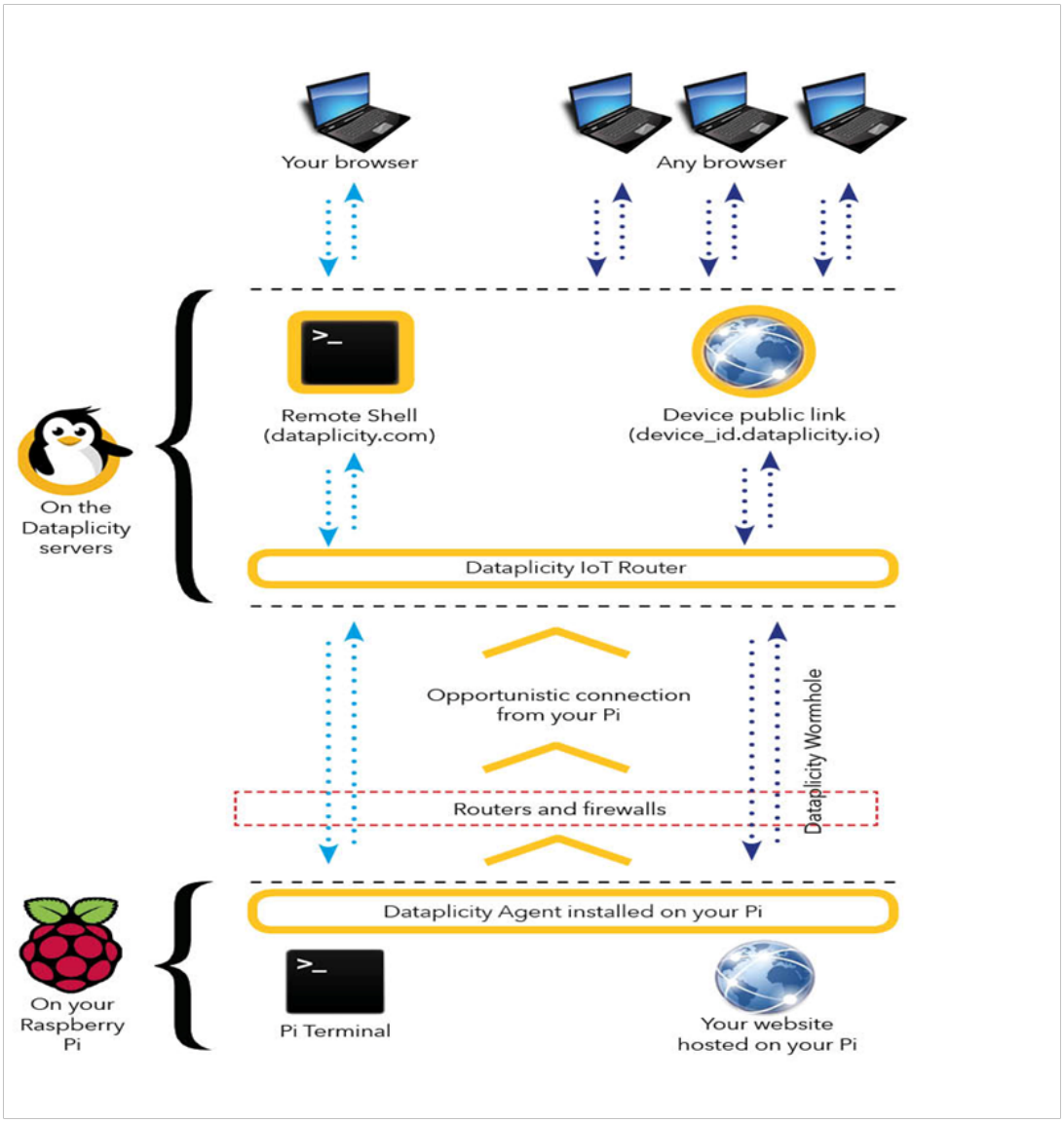

Figure 3.3: Flow Chart of live streaming using Dataplicity

Thus one can access the devices covered by Dataplicity anywhere in the world if they have a viable internet connection. The traffic is routed using encrypted websocket connections, and is robust enough to be used in instances where the internet coverage is flaky. Because the device itself is the originator of the connection, traditional impediments to remote access (such as NAT, firewalls and dynamic IP addressing) are no longer an issue.

3.2.3 MJPG-streamer

MJPG-streamer is a command line application that copies JPEG frames from one or more input plugins to multiple output plugins. It can be used to stream JPEG files over an IP-based network from a camera to various types of viewers such as Chrome,

Firefox, Cambozola, VLC and other software capable of receiving MJPG streams.MJPG-streamer includes a lightweight web server, which can embed the streaming video into a webpage, MJPEG-streamer program that gets the MJPEG data from V4L2 and send it through a HTTP session. MJPEG-streamer automatically generates a set of html pages that illustrates different methods to stream the video over your browser. MJPG-streamer includes a lightweight web server, which can embed the streaming video into a web page.Thus using dataplicity and MJPG streamer it is possible to livestream the data over the internet and can be accessed on both the MJPEG streamer and on the Rpiscope webpage designed by us.

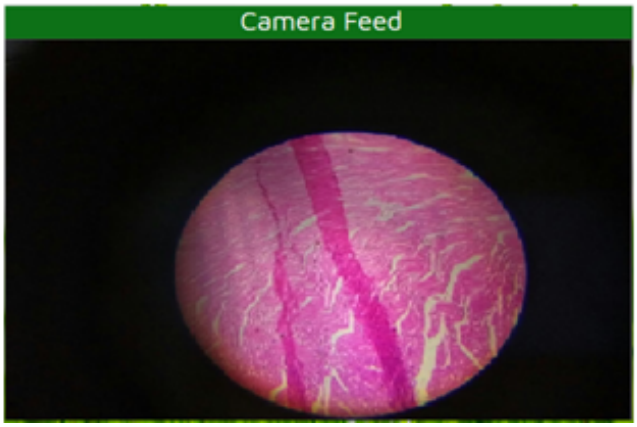

Figure 3.4: Live streaming using MJPG

3.3 Actuating the Motors

Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time. It behaves as an open-loop controller. The stepper motor consists of a rotor that is generally a permanent magnet and it is surrounded by the windings of the stator. As one activates the windings step by step in a particular order and let a current flow through them they will magnetize the stator and make electromagnetic poles respectively that will cause propulsion to the motor. With a computer controlled stepping one can achieve very precise positioning,speed control and high holding torque capacities.The stepper motor providing a high torque requires a 12V,2A supply.Since the Raspbeery Pi can provide a maximum of 5V only an L298N motor driver circuitry is used.It provides the required phase energization sequence using a full step sequence.The full step sequence provides a minimum step angle of 1.8 degree.

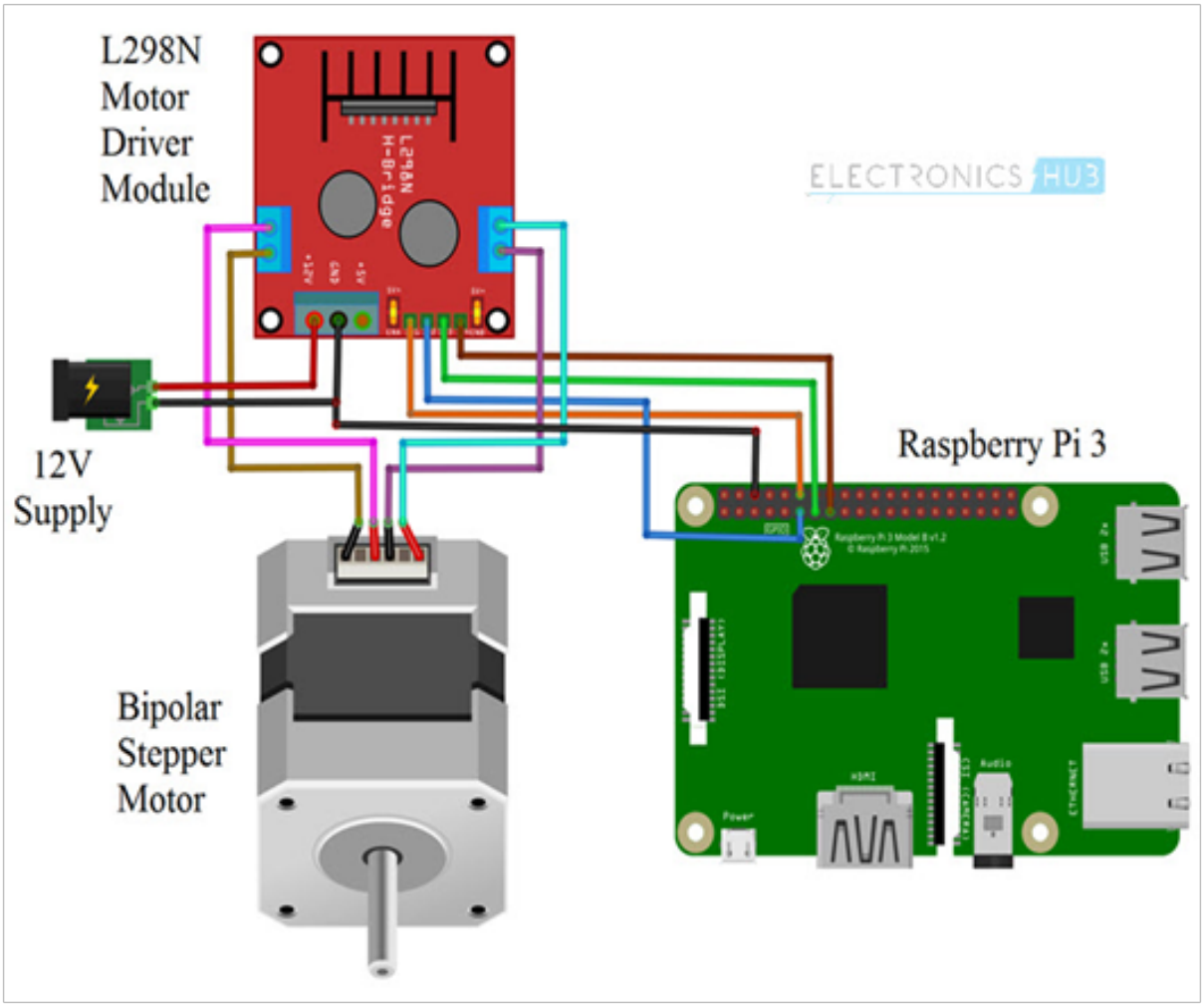

Figure 3.5: Connection of the stepper motor

3.4 Flask- Web Server

A web server is simply a computer program that provides web pages as they are requested. The machine the program runs on is usually also called a server. When a user enters an address into an internet browser like Internet Explorer or Firefox, the browser sends a request off into the internet asking to view the web page found at that address. The web server is the program or machine that responds to that request, and delivers the content of the page back to the user.We have used a Python web framework called **Flask** to turn the Raspberry Pi into a **dynamic web server**.There are many different web servers like Apache or lighttpd that serve the files from your board to clients. Most of the time, servers like these are sending HTML files and images to make web pages, but they can also serve sound, video, executable programs, and much more.

Flask is called a micro framework because it does not require particular tools or

libraries. It is a new breed of tool that extend programming languages like Python, Ruby, and JavaScript to create web servers that dynamically generate the HTML when they receive HTTP requests from a web browser. This is a great way to trigger physical events, store data, or check the value of a sensor remotely via a web browser.Flask is small but powerful web framework with good community and documentation. It depends only on two external library and gets a lot of extensions. It is a good choice to start web development with Python.The advantage of a dynamic webpage is that its content changes depending on the input supplied by the browser.Thus when the user clicks on the focus adjustment button the server detects it and can be used to actuate the stepper motors.

Chapter 4

Implementation

This system uses a compound microscope which comes with different lens options of 10x, 15x for eyepiece and 10x, 45x and 100x for the objective lens. The microscope is digitized using a raspberry pi 3B module which performs the functions of a mini computer, camera which gives a picture quality of maximum 5MP, motors and driver circuits for focus adjustment.

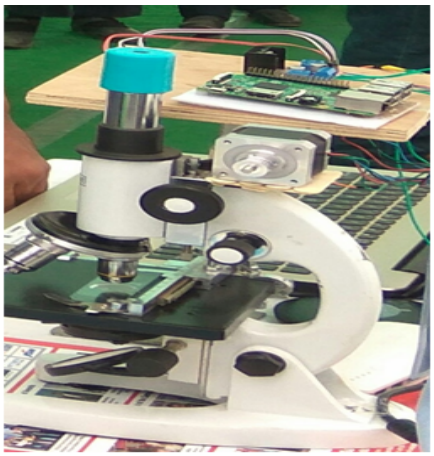

Figure 4.1: The RpiScope System

4.1 Live Streaming

The camera module is placed on the microscope's eyepiece which gives an enlarged image of the sample which is placed on the stage [2]. To obtain a clear image from the Raspberry Pi camera a special cap on which the raspberry pi camera can be mounted was developed. This acquired image is live streamed onto the website. The IP address provided to the raspberry pi by the router is local to the network and non-static due to which it cannot be accessed outside the local network. By using the concept of port forwarding and applying a static IP address to the raspberry pi it is possible to access it

over the internet. [6]

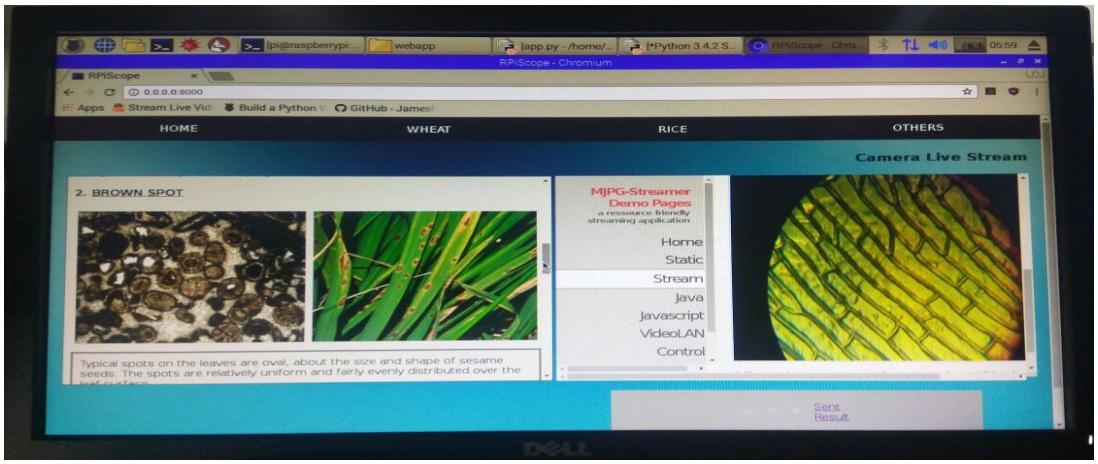

Figure 4.2: Live streaming over the internet

Port forwarding redirects the data to a specific port address (here port 80). The live streaming is done by making the raspberry pi as a web server which uses port 80 to stream the live video captured by the camera. The main purpose of setting up a web server is to store, process and deliver web-pages to clients as per their requirements. Here the raspberry pi is set up as the server and the expert is the client who accesses data from the server. Live streaming of the microscopic bacteria is first recorded and then converted into a webpage. This webpage is then accessible over the internet using port forwarding technique. This live streaming can be viewed by a microbiologist or an agricultural expert who will be able to easily analyse the sample and send a remedial solution back to the farmer. This system will help the agricultural expert present at any corner of the world to remotely check the samples. The expert can then give a remedial solution within 5 minutes to farmers in villages where traditionally getting an expert advice would take minimum 2-3 days time.

4.2 Focus Adjustment

Adjustment of the focus is very important factor in obtaining a clear image of the sample. For proper image acquisition the focus of the microscope needs to be set accurately. This provision is given to the expert, who can use the buttons provided in the website to remotely control the focus adjustment of the microscope. A 12V, 2A Stepper motor is attached to the coarse adjustment knob of the microscope via a belt mechanism. Stepper motor is an electromagnetic device, which converts discrete electrical pulse signals

into mechanical angular displacement [3]. A stepper motor has certain unique features over normal motors. This includes fine step size (minimum step size=1.8 degree for full-step sequence) and high holding torque. Due to other advantages such as low cost, ease of control and no accumulation of errors stepper motors are widely used in applications were precise control is required. It is being driven by a L298n motor driver as the raspberry pi GPIO pins provides an output voltage of maximum 5V only.

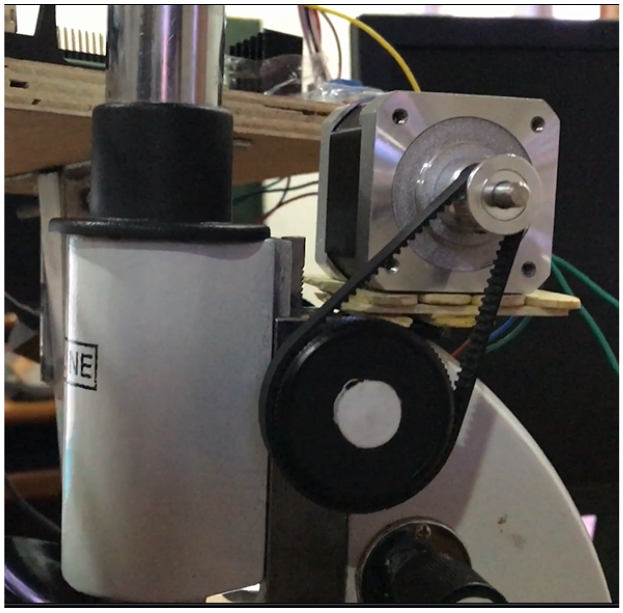

Figure 4.3: Motor mechanism for the adjustment of focus

The code for the stepper motor is written in python. The website has control buttons to move the coarse knob of the microscope up or down depending upon the requirement to obtain a clear image There are four buttons on the webpage RESET, UP, DOWN and STOP. On clicking the RESET button, the lens column of the microscope moves up to an extreme end. The UP button is provided to move the lens column up and the DOWN button to move it down. The STOP button is provided to stop the motor. By varying the step-size and delay, the coil energization of the stepper motors can be varied. This can be used to change the steps required for focal adjustment.

4.3 Local LAN implementation using ethernet

Ethernet is a network protocol that controls how data is transmitted over a LAN. Technically it is referred to as the IEEE 802.3 protocol. A LAN (Local Area Network) is a network of computers that covers a small area like a room, an office, a building or a campus. In order to connect two devices present in the same network to transfer data a

wired ethernet connection is an efficient technique. For the implementation of this system on local LAN the machines are needed to be configured on the same network with adjacent IP addresses. Both computers must have same IP addresses, same subnet mask ,same default gateway.The IP address is also configured to static.

First the Raspberry Pi is connected to the mobileâĂŹs hotspot and the IP address,subnet mask,default gateway(if applicable) is noted. One can pick any private IP address but it must be set on both computers for the default gateway. Now either the cross connect Ethernet cables can be used to connect a computer to the Raspberry Pi system or the two can be connected using normal Ethernet cable via a switch. The IPv4 address properties of the computer(of the expert) is changed so as to get an IP address nearly same as that of the hotspot IP address that was noted earlier and the subnet mask is also changed.Lastly, the value for the default gateway should be the same on both machines. For example, if the Raspberry Pi has an IP address of 192.168.0.1, then the second computer(of the expert)must have an IP of 192.168.0.2.The subnet mask is generally 255.255.255.0.

By doing so a local network is created between the mobile phone, Raspberry Pi system and the other computer. The hotspot can be switched off as the system is now connected via Ethernet. When commands for the live streaming is given to the Raspberry Pi, the streaming can also be seen on the other computer without any lags.

4.4 Website

A website is developed using html script which is hosted on the internet and can be accessed by the expert from anywhere. Every lab setup will have a login and password and also an E-mail ID of its own. The main page of the website consists of the live stream window where the expert can see the microscopic image of the sample. The page also consists of information of various diseases which are very common in wheat, rice and some information about the samples like the onion cells which was used in this project.

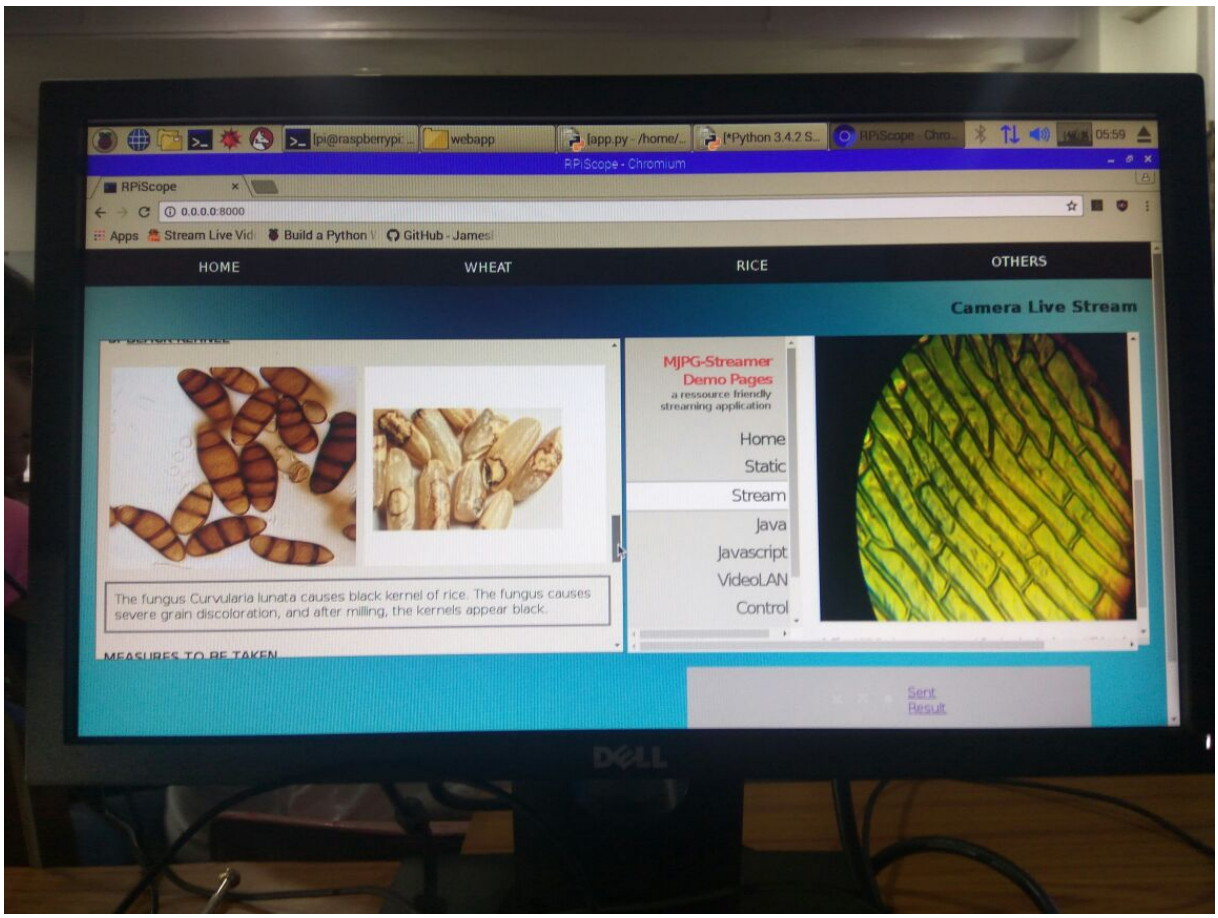

Figure 4.4: Initial Website with livestream

The website was hosted online successfully and we are able to get live stream of the various samples which are placed on the microscope on the webpage and are also able to control the movement of the focus adjustment column.This was the initial prototype website.

The website was further modified with a better user interface and was **hosted online**through a third party website called as **000webhost.com** This website can be accessed from anywhere in the world with the URL *https://enigmarc19.000webhostapp.com/home.html*. The following are the images of the final version of the website.

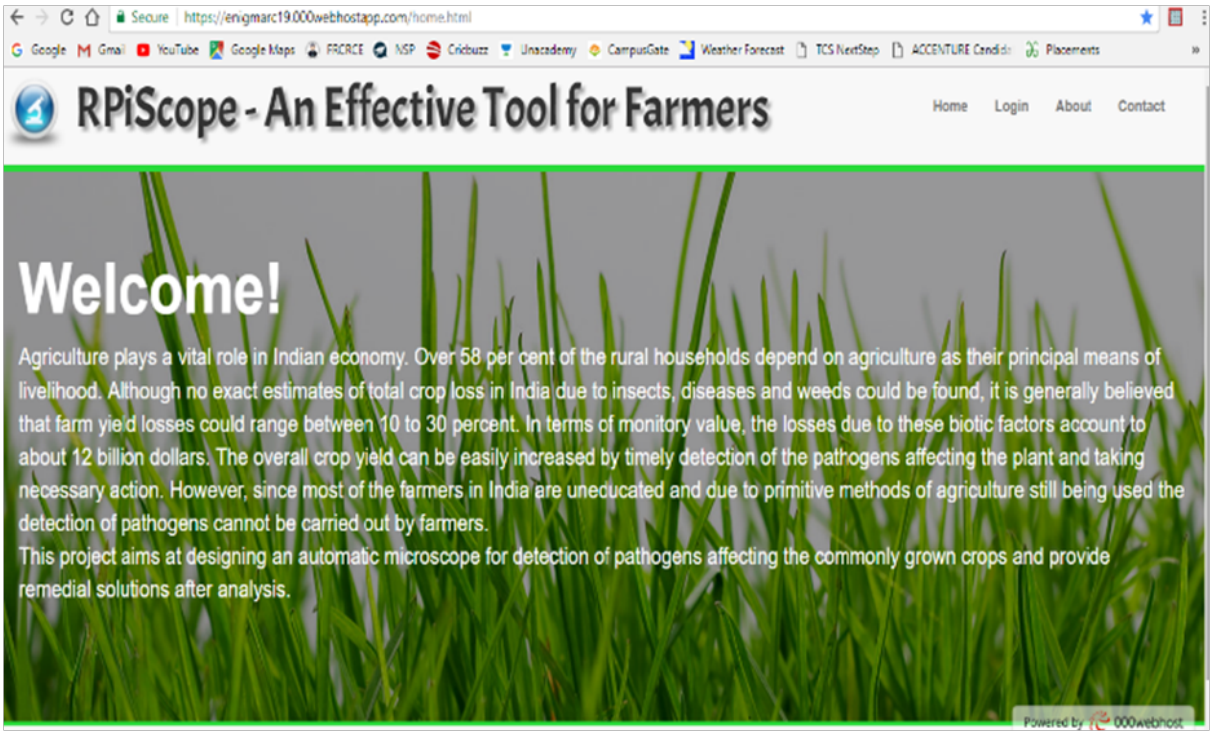

Figure 4.5: Welcome-page of designed website

The Welcome page consists of a small abstract of the project.It also contains the Home,Login,Contact information.

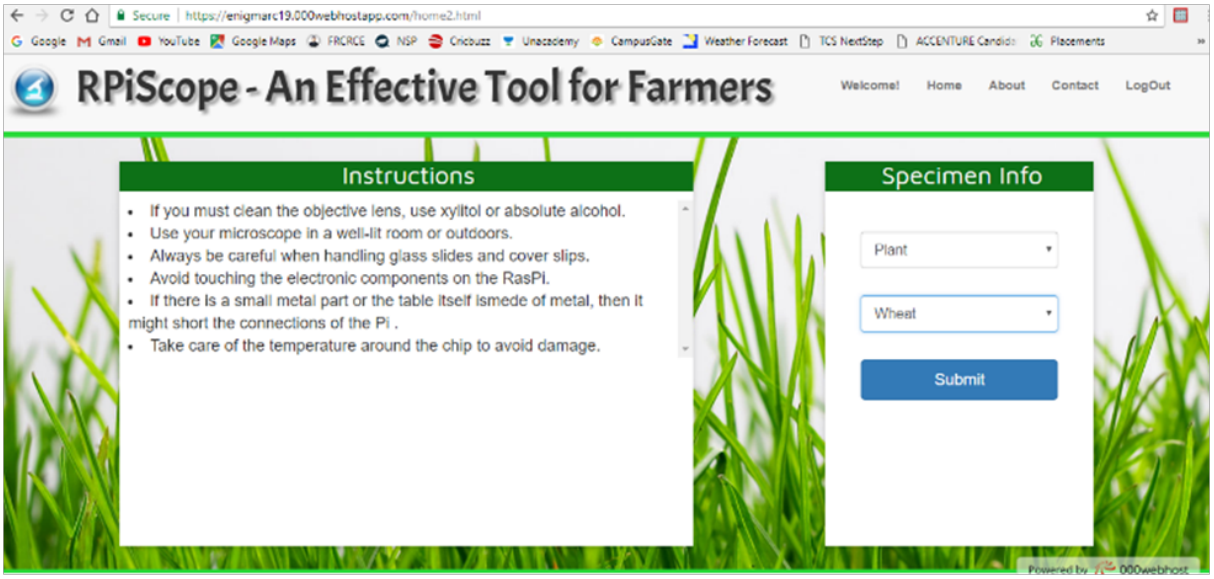

Figure 4.6: Webpage2 of designed website

Figure 4.6 represents the webpage which consits of some basic instructions on handling the microscope.The feed includes information regarding the specimen name.The expert then enters the necessary information on the specimen info block.The specimen in-

cludes crop,water sample.Type includes various varieties of crop e.g.wheat,rice,jowar,etc.

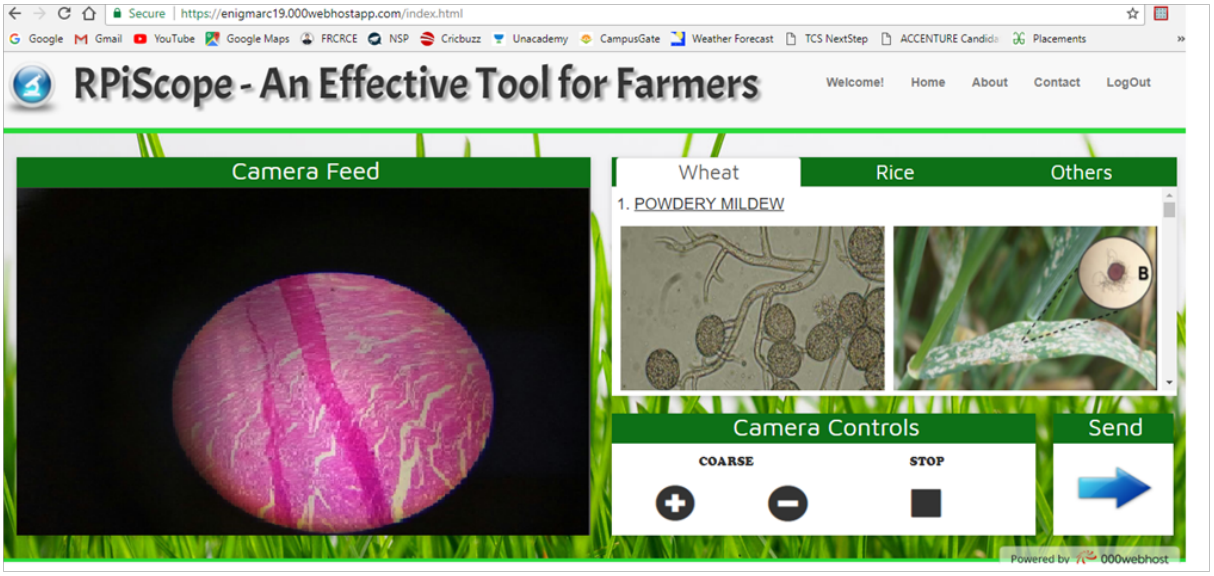

Figure 4.7: Webpage2 of designed website

Figure 4.7 represents the webpage consisting of a **Camera Feed** block ,**Specimen Problem block** and**Camera Control** block and **send option**.The Camera Feed contains a realtime video obtained from the Raspberry Pi camera attached to the compound microscope.The Specimen Problem block is a database consisting of images of the various pathogens affecting the crop and the remedial solution.The Camera Control block is used to adjust the various stepper motors attached to the microscope, to obtain a highly resolved image.The send option is used to send a remedial solution to farmers.

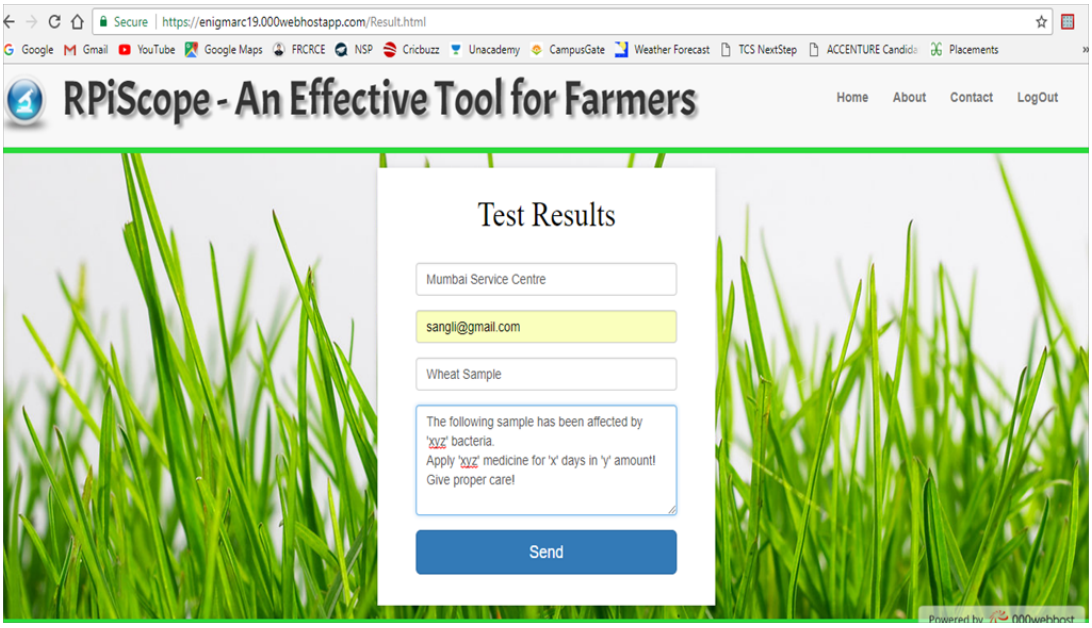

Figure 4.8: Test Results page of designed website

On clicking on the **Send Option** ,a new webpage opens where the expert location is written.The expert then selects the email-id of the farmers centre.The type of sample is listed.The expert then writes the type of pesticide,the quantity and duration for which it needs to be applied.This e-mail is immediately send to the farmer .

Chapter 5

Results

5.1 Observations

In order to obtain a clear image from the Raspberry Pi camera the focal length of the microscope needed to be adjusted.This was done by developing a special cap on which the Raspberry Pi camera was mounted. For live streaming on local host VLC Media Player can be used .However the major drawback is that this live stream cannot be added to a webpage easily.Another method is using the WLAN technique in which the IP addresses of devices are almost matched providing a very clear live stream.

The transfer of a video from Raspberry Pi to another remote device is a difficult task. The raspimotion command has a lot of drawbacks and fails to provide a proper video feed.The mjpg-streamer helps reduce the video lag to a great extent.

There are various methods to control the Raspberry Pi camera from another device.The Dataplicity gives a good platform to stream live videos.It eliminates the need of static IP addresses and Dynamic DNS.It also is less vulnerable to external attacks.The only drawback is that if the internet connection is slowthen there will be some lag in the streaming.

HTML is a very easy framework for designing a webpage.By adding the .jss and .css stylesheet technology more flexibility when defining styles for webpages is possible making it better presentable.

Stepper Motor which are used for the focal length adjustment of the motors play a very crucial role in the entire design.Selection of the stepper motors should be such that they provide the necessary torque to rotate the coarse adjustment dial.Here to actuate the coarse adjustment knob a stepper motor with 50 kg/cm torque is needed.

The stepper motor and driver circuitry provide a minimum step angle of 1.8 degree when

the full-step sequence is used. The step size angle and delay were set for this purpose . On varying the step-size and the delay the speed of focal length adjustment of microscope can be varied. The stepper motor has a rating of 12V,2A so L298N motor driver is used.A belt mechanism attached to the motor enables the movement of the focus adjustment knob.

5.2 Future Scope

The utilization of the semi-automated microscope can be extended beyond pathogen detection in commonly grown crops.

- A database can be added which maintains a record of all the samples which are analyzed.
- A special feature can be added which the live-stream is automatically redirected to another expert if an expert is currently unavailable.
- The horizontal and vertical adjustment of the microscope stage can be controlled with motors enabling to concentrate on certain areas of the slide.
- It can be used to study the trends of crop infestation in different parts of the country.
- Auto-focusing feature needs to be added which reduces the work of the expert.[4]
- It can also be used to analyze water and soil samples.
- It can also be used for analysis of blood samples which can help detect various diseases like tuberculosis, malaria,etc.

Chapter 6

Conclusion

In summary, the use of RPiScope (Raspberry Pi integrated with a microscope) for timely determination of pathogens was demonstrated. The results from this proposed system show that the live streamed image can be easily used by the expert for analysis. After research and various experimental analysis we were able to acquire a clear image of the pathogen from the Raspberry Pi camera .The focal length was adjusted by designing a special cap for the Raspberry Pi camera.

The focus of can be precisely controlled with the help of motors enabling the expert to determine the cause of damage on the crop. A website sketch containing a database of the common crop infestations and its solutions has been designed. Analysis of the various stepper motors available and the most suitable one was selected for focus adjustment. The remedial solution provided to the farmer is instantaneous preventing further damage.

Chapter 7

References

[1] Yu-Jen Chen, Yu-Sing Yeh, Ming-Shing Young, YanChay Li, Chen-Song Chiang, Sun-Lon Jen, e-Nung Huang *The study of a handheld digital microscope for biomedical applications*IEEE,2008.

[2] Komalpreet Kaur,Jaspal Singh *A Review for Digital Microscope Using Raspberry Pi* International Journal on Recent and Innovation Trends in Computing and Communication(IJRITCC) ,2017.

[3] Zhicong Chen *Control Technology of Stepper Motor Driver and its Design for Applications* May2008.

[4] I. Ming Yang, Li Luo, *A Rapid Auto-focus Method In Automatic Microscope*IEEE,2008.

[5] *Practical Microscopy* by L.C. Martin and B.K. Johnson.

[6] *Data Communication and Networking* by Behrouz Forouzan.

[7]*www.raspberrypi.org*