Early detection of basal stem rot biology essay

Science, Biology

CENTRAL RESEARCH FUNDRESEARCH PROPOSALA multispectral machine vision method for early detection of basal stem rot (Ganoderma boninense) infection of oil palm plant: An aerial remote sensing approach for crop protectionHeru P. Ipung, 12121015 – Team LeaderAbdullah Muzi Marpaung, 23120736 – Team MemberInformation Technology and Food TechnologyIT and Life Sciences Faculty2013Swiss German University Tel. +62 21 3045 0045EduTown BSDCity Fax. +62 21 3045 0001Tangerang 15339 info@sgu. ac. idINDONESIAwww. sgu. ac. id

Approval Page

Title of Proposal : A multispectral machine vision method for early detection of basal stem rot (Ganoderma boninense) infection of oil palm plant: An aerial remote sensing approach for crop protectionName of Team Leader : Heru Purnomo IpungResearch Center : Research Center for Novel and Creative Solutions in Business and TechnologyE-mail : heru. ipung@sgu. ac. idMobile phone : 0811 811 1041Duration of CR Program : 6 Months; from March 2013 to August 2013Proposed Budget : Rp. 34. 200. 000,-Budget from Other Source : NoneEduTown, BSDCity, TangerangDate: 16 February 2013

Team LeaderHead of Research CenterVice Rector Academic

For Novel and Creative

Solutions in Business and

Technology

Heru P. Ipung, Ir. M. EngDr Samuel PD AnantadjayaDr. rer. nat. Filiana Santoso(NIK: 12121015)(NIK:)(NIK: 11110507)

Background

Oil palm has become an important crop in Indonesia. The country is one of the world’s largest exporter of palm oil. However, a basidiomycete fungus, species of Ganoderma, which cause basal stem rot (BSR) disease in oil palm [1], devastate thousands of hectares of plantings in Southeast Asia especially in Malaysia and Indonesia [2]. The disease has been found to infect oil palms as early as 12 to 24 months after planting, with increased incidence on 4 to 5 years old palms. The disease is presently the most prevalent and devastating disease in oil palm cultivation, especially in mature palm Areas, BSR can kill up to 80% of the stand by the time when the palms are halfway through their normal economic life span [1]. The effects of Ganoderma infection on productivity decline in palm crops have been of considerable concern ever since replanting of oil palm land began in South-East Asia, especially in Malaysia and Indonesia [2]. The International Workshop on Awareness, Detection and Control of Oil Palm Devastating Diseases in Kuala Lumpur, Malaysia has identified BSR disease as a single major devastating disease constraint to oil palm production in the region [3]. Little is known about the spatial and temporal pattern of BSR disease in oil palm plantations. Such information is needed for fully understand disease dynamics, develop more accurate sampling plants and better assesses crop loss in relation in relation to disease intensity. A disruption to the photosynthesis of the palm oil plant has been investigated [4] due to the severity of BSR infections which among those symptoms of BSR are wilting of the leaves and plant malnutrition. The study involves determining the inorganic element content of normal and infected leaves. Si, Mo, Cl, K, Ca

and Mn had been identified as the major elements. There has been a study to map the infection degree with the sensing palm canopy structure with hyperspectral data to look at the correlation at the palm oil plant that already infected and shown the symptions physically [5] at Padang Estate of Sinar Mas (SMART) Plantation with the level of severity as follows.

Infection degree

Evolution of stem conditions

Evolution of canopy structure

Level 1Presence of mycelium in the stem bark, or crumbly woodYellowing or drying of some leaves. One or two new leaves remain as unopened spears. Level 2Presence of fruiting bodies(mushrooms) at the bottom ofthe stemApparition of leaf necrosis. Three to five new leaves remain as unopened spears. Declination of older leaves. Level 3Rotten stemLargely spread leaf necrosis. No new leaf. No new bunch.« Skirt-like» shape of crown due to total leaf declination.

Research Problem

Many methods have been attempted to control BSR, but to date, no method gives good control of Ganoderma Boninense infection in established plantations and some have technical limitations in application [15]. The main problem is that once the palm has been in the level 1 severity, it has been too late and most of the cases are needed to be replanting [1] which this is a considerable lost of potential revenue as well as waste of planting and maintenance cost which this only shown after years of plantation. Once this is visible, majority of infected plants cannot be saved, therefore requires a

replanting [15]An earlier detection on this may have been needed, there is a chemical testing to take sample from the stem to look at the early existence of BSR, but looking at the size of plantation take million of trees, this may have been unpractical. Since the presence of this pathogen effects the distribution of certain nutrition [4] needed for photosynthesis. Multispectral Imaging may hold the key to detect a changes on the disruptive photosynthesis before it is visible to the naked eyes as sympton as level 1. Early damaged is visible in image spectrum outside the visible spectrum [6].

Objectives and Outcomes

The objective is to earlier detect the presence of BSR before it shows the sympton of level 1 from aerial remote sensing on palm oil canopy images. This may accelerate the detection of the presence of BSR from remote sensing which potentially save cost and prevent lost. The outcome is to prove a machine vison method to correlate the leave image pattern in Ultraviolet and Near Infrared with the presence of BSR which detected with laboratory test for the presence of such BSR in microbiology lab.

Literature Review

4. 1. Leaf Reflectance as Indicator of Plant Health.

A non destructive analysis of a plant health can be done using Imaging Techniques [7]. One of them is to use NDVI (Normalized Difference Vegetation Index) that has been developed by NASA Goddard Center and widely used for remote sensing of vegetation from satellites. This uses imaging technology to extract the normalized light spectrums with can be done with combination of thermal and chlorophyll fluorescence imaging [8]

[9] to detect plant stresses. Optical Technologies has been widely used for detecting plant health as well[10]. Leaf spectral reflectance provides a vast data resource for assessing plant health based on the impact of biotic and abiotic stresses on leaf biochemistry and anatomy which in turn produces distinct changes in leaf optical properties. Leaves absorbance of light sources is shown in figure 1. Key regions of a reflectance spectrum are: 1. Blue region (400 – 499 nm) which is strongly influenced by absorption of chlorophylls and carotenoids. 2. blue-green edge (500 – 549 nm) leading to the green peak at 550 nm. 3. Red edge (650 – 699 nm) associated with strong chlorophyll absorption. Figure 1The property light absorption and reflectance of sun light is shown in figure 1 [11]. The chlorophyll a, b absorb some light spectrums and reflect the rest not needed. Notice that green light are mostly reflected, therefore most of the plant leaves are green. Identification of leaf area of plant is one of key image preprocessing technique that is important to agricultural engineering in order to do further analysis and monitoring of the plant. Example is NDVI (Normalized Difference Vegetation Index) measurement for plant health indicator based on plant photosynthesis activities. For remote sensing, this may not be a problem, since the sensor is a remote from plant canopy in the vast area of plantation. But this is an issue for monitoring in short distance from the plant object. There is a distortion of background image, soil and other objects. A paper has been written [12] to propose a method that taken into account of photosynthetic light absorption and reflectance of plant leaf of near infrared (above 700nm) and near ultraviolet spectrum (below 400nm). The method is to suppress visible light spectrum with a band reject optical filter (400nm to

700nm) in order to remove variation of color of plant leaves as well as to take into account unique property of photosynthesis in absorbing and reflecting sun – light spectrum, a NIR-UV Leaf Identification method is proposed. Because of this technique does not need intensive image processing and pattern recognition techniques. This will requires less computing power therefore that may be a good candidate for application in agriculture engineering that often real time in nature. The key principle of this study is to use NDVI Formula with looking at only Red Band and Near Infra Red (NIR) Band with this formula: NDVI = (NIR – RED) / (NIR + RED)The resulting value ranges from -1. 0 to 1. 0, however for vegetation in remote sensing within range 0. 3 to 0. 8 depending on the leaf reflectance pattern. If the chlorophyll in the leaves is not performing well due to many plant stresses, there absorbance pattern will change. In general the less NDVI index is the less healthy the plant is.

4. 2. Early Pathogen Detection

Plant Leaf will react and show patterns of infection in the present of pathogen in leaf as in figure 2 [13]. This is the basis of early identification by otherwise it is not possible to be detected in visible Spectral image [13]. A combination of Thermal and Chlorophyll-Fluorescence Imaging Distinguish Plant-Pathogen Interactions is used at an Early Stage. Figure 2 shows both visible Human eye spectral bands and hyper spectral bands that able to detect early pathogen. This Image is taken using UV Spectral Image and combination with thermal (Infrared) analysis [14]. Figure 2

4. 3. Microbiology Test to confirm the presence of BSR

There is range of testing on the presence of this infection form PCR, ELISA to culture tissue testing methods [15]. However, the objective is to detect the presence of such BRS in Palm Oil Stem. Therefore, for this purpose the initial method is to grow the sample in associate media culture to detect the presence of such BSR.

Proposed Aerial Remote NIR/UV Sensing

This flying aerial sensing are consist of the three main components:

Parallax Elev-8 Quadcopter,

The reason to choose this type of flying machine due to: Known on its stability on Air to be mounted for aerial photographyAble to fly up to 100 Meter above with Microcontroller Stability controlAble to be mounted a payload up to 1 Kg (2 Lbs)

Basic Android Phone

Basic android phone is good for this purpose because it is known no optical filter on its CMOS (in comparison to high-end one), therefore it can be used for UV and NIR Camera given appropriate Optical Lenses Filter on 300-400nm and 700-100nm light spectrums as well as it has embedded features like: GPS SensorTime Lapse Camera Capture Software is available in Android Market with ability to records or to post the images to cloud storage on timely basis.

Optical Filter Lenses

There are two optical filter lenses needed to be installed to the android phone: UV Band Pass FilterNIR (Near Infrared) Band pass FilterThere is another tool needed for this research that available in IT Lab: Matlab Tool and its computer vision modules for image processing, features extraction and pattern recognition purposes. Therefore the overall diagram is as follows:

Methods

The main idea is to correlate the palm oil leaf pattern in NIR and UV Images with the chemical test of the present of BSR, therefore the steps are as follows: 5. 1. Research Preparation5. 1. 1. Research Material Procurement5. 1. 2. Field Worker / Assistant and Microbiology Assistant Preparation5. 1. 3. Research Project Tool Preparation5. 2. Development Pattern Recognition Method of Palm Canopy in UV and NIR Spectra. 5. 3. Prepare microbiology testing procedure for the presence of BSR5. 4. Field sampling on the surrounding Palm Oil Plants that close proximate to the infected plant, as the pathogen is a soil borne disease. 5. 5. Image Patterns Extraction on the UV/NIR Images Taken5. 6. Microbiology Lab testing on the samples for confirming the degree of BSR presence5. 7. Data analysis correlation from both Image Patterns and Lab tested samples. In summary, the workflow is as follows: The detail of the activities, purpose, methods and PIC is as follows:

Main Activity

Detail Activity

Purpose

Methods

PIC

1. Research Preparation1. 1. Resources MobilizationTo brief team members on the tasksHeru P. Ipung1. 2. Procurement PreparationTo contacts vendors for detail procurement timelineHeru P. Ipung /Abdullah Muzi Marpaung1. 3. Contact and follow-up Target Oil Palm PlantationsTo contacts the company or owner of Oil Palm PlantationsHeru P. Ipung2. Multispectral Machine Vision Development2. 1. Aerial Remote Quadcopter Kit Development2. 1. 1. Material ProcurementTo purchase Quadcopter, Android Phone and 2 Optical FiltersHeru P. Ipung2. 1. 2. AssemblyTo assembly Aerial Remote QuadcopterIT Research Assistant2. 1. 3. Automatic Images Capture DevelopmentTo configure android tools and programs requiredIT Research Assistant2. 2. Multispectral Early Detection Assessment and Development2. 2. 1. Preprocessing Method Assessment and DevelopmentTo adjust previous method to detect leaf area only for image preprocessingUV/NIR Leaf Image Pre-Processing MethodHeru P. Ipung / IT Research Assistant2. 2. 2. Features Extraction Methods Assessment and DevelopmentTo find the appropriate features extraction for Oil Palm Leaves ImagesPotential Images Transform Methods SelectionHeru P. Ipung / IT Research Assistant2. 2. 3. Pattern Recognition Methods Assessment and DevelopmentTo find the appropriate pattern recognition methods for Oil Palm Leaves ImagesPotential Pattern Recognition Methods SelectionHeru P. Ipung / IT Research Assistant2. 2. 4.

Development and Testing of selected methods on Matlab ProgramsTo assembly the methods required for Image Processing and Pattern Recognition AnalysisIT Research Assistant3. Microbiology Testing Method Development3. 1. Ganoderma Boninense Sampling and Testing Kit Development3. 1. 1. Material ProcurementTo purchase Quadcopter, Android Phone and 2 Optical FiltersAbdullah Muzi Marpaung3. 1. 2. AssemblyTo assembly Aerial Remote QuadcopterAbdullah Muzi Marpaung3. 2. Ganoderma Boninense Microbiology Testing Methods Development3. 2. 1. Development of Method for SamplingTo find the appropriate method for physical sampling to eliminate contaminationPotential Physical Sampling MethodsAbdullah Muzi Marpaung3. 2. 2. Development of Method for Lab TestingTo find cost effective method for testing the existence of Ganoderma BoninensePotential Microbiology Testing MethodsAbdullah Muzi Marpaung4. Field Sampling4. 1. Identify Potential Infected Oil PalmTo find healthy palm surrounded a physically known infected palmApprox 5 x 2 Days of field works to get at least 50 SamplesHeru P. Ipung/Field Worker/IT Assistant4. 2. Aerial Sensing of targeted Oil PalmsTo capture NIR/UR Images of targeted oil palmApprox 5 x 2 Days of field works to get at least 50 SamplesHeru P. Ipung/IT Assistant4. 3. Physical Sampling of the bark of Oil Palm for Microbiology TestingTo take for lab testingApprox 5 x 2 Days of field works to get at least 50 SamplesHeru P. Ipung/Field Worker5. Image Processing and Pattern Recognition Analysis5. 1. Multispectral Early Detection Assessment and DevelopmentTo executes the selected Image, Feature and Pattern Recognition Methods on Images NIR/UV SamplesHeru P. Ipung5. 1. 1. Preprocessing Method ExecutionTo execute the preprocessing methodIT

Research Assistant5. 1. 2. Features Extraction Methods ExecutionTo extracts image features on images samplesIT Research Assistant5. 1. 3. Pattern Recognition Methods ExecutionTo analyze patterns on image samplesIT Research Assistant5. 1. 4. Matlab Image Processing, Features Extraction & Pattern RecognitionTo run batch program that may take some times on large images dataIT Research Assistant5. 2. Features and Pattern Data Collection of Images SamplesTo collect and organize Features and Pattern Data on the Image SamplesHeru P. Ipung6. Microbiology Lab Testing6. 1. Ganoderma Boninense Microbiology Testing Methods ExecutionTo execute the selected methodAbdullah Muzi Marpaung/Microbiology Lab Assistant6. 2. Ganoderma Boninense Microbiology Data CollectionTo collect data on the samplesAbdullah Muzi Marpaung/Microbiology Lab Assistant7. Data Analysis7. Data AnalysisTo analysis the correlation of data finding of Aerial Sensing and Physical Microbiology Data FindingsDepending on the result of both Features/Patterns Data and Microbiology Testing Data, the analysis is to find the correlation so to suggest what is the image features and patterns as candidates for potential automatic early detectionHeru P. Ipung / Abdullah Muzi Marpaung

6. Activities and Time Schedule

The main idea is to correlate the palm oil leaf pattern in NIR and UV Images with the chemical test of the present of BSR, therefore the steps are as follows:

7. Job Description and Research Load of CR Team

Lead Researcher (IT): To conduct the overall research and especially on the 5. 1, supervision on 5. 4 and 5. 6. As this is mainly IT based activities, this will be conducted by lead researcher from IT Faculty. Team Member (Life Sciences): To assist and propose the experiment with mostly on 5. 2 and supervision of 5. 5 activities and 5. 6. Field Worker / IT Research Assistance: Main duty to assist on the implementation of 5. 1, execution of 5. 3 and 5. 4. Life Sciences Research Assistance: Main duty is to assist on the implementation of 5. 2, execution of 5. 3 and 5. 5.

Estimated Required Budget