Rice Pollen Analyzer
Submitted by
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Rice Pollen analyzer

Agenda

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Introduction

- In rice research laboratories, analysis of fertility and sterility of rice pollen grains plays a key role for the process of breeding.

- Sterility has been a major barrier for the utilization of strong heterosis (outbreeding enhancement) between different species.

- Current manual procedure:
  - The pollen grains samples are first stained in 1% potassium iodide-iodine (I-KI) solution.
  - Then stained sample is placed under a trinocular microscope for image capture and analysis.
### Categories of rice pollen and their features

<table>
<thead>
<tr>
<th>Categories of pollen</th>
<th>Shape and staining behavior</th>
<th>Appearance</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstained withered sterile (UWS)</td>
<td>Withered and undeveloped, unstained</td>
<td>![Image]</td>
<td>Sterile</td>
</tr>
<tr>
<td>Unstained spherical sterile (USS)</td>
<td>Spherical and smaller, unstained</td>
<td>![Image]</td>
<td>Sterile</td>
</tr>
<tr>
<td>Stained round sterile (SRS)</td>
<td>Round and small, lightly or incompletely stained, rough surface</td>
<td>![Image]</td>
<td>Sterile</td>
</tr>
<tr>
<td>Stained round fertile (SRF)</td>
<td>Round and large, darkly stained, smooth surface</td>
<td>![Image]</td>
<td>Fertile</td>
</tr>
</tbody>
</table>
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Current pain areas

Unavailability of an end to end solution from image acquisition to report generation

Huge effort & time involved during manual inspection

No automated solution for classification and count data for fertile, partially fertile and sterile pollen

Manual inspection prone to human error

Pollen

- Fertile
- Semi fertile
- Sterile

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Rice Pollen Analyzer Overview

- **Trinocular Microscope**
- **USB/Ethernet Image acquisition**
- **User Feedback through marker tools provided by pollen analyzer**
- **Reports**
Rice Pollen Analyzer

Rice Pollen Analyzer Features

❖ Image processing
  - Identify agglomeration (overlapping) and gives intelligent suggestions to the user with probable pollen overlay (dotted) on actual image so that segmentation can be achieved with the help of human intervention, resulting in high accuracy and recall
  - Marking tools for user to mark undetected regions/pollen grains

❖ Intelligence
  - Provision for initial batch machine learning and online machine learning
  - Classification of pollen grain into fertile, partially fertile and sterile pollen
  - Count data for three categories
  - User defined threshold limits for classification
  - In-The-Run intelligent checks and expert guidelines
  - Provision for giving feedback to system in case of misclassification

❖ Reports
  - Flexible and customizable reports
Rice Pollen Analyzer Architecture

- **Image Acquisition Engine**
  - Pre-processing
  - Segmentation
  - Feature Extraction
  - Smart Image overlay

- **Image processing engine**
  - Clustering
  - Classification

- **Pattern recognition engine**
  - User defined threshold
  - Segmentation
  - Feature Extraction

- **User Interface**
  - Smart marker tools
  - User defined threshold
  - Image panel
  - Reports

- **Database**
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Work flow of batch learning

Batch learning is a method of learning in which the entire dataset is used for training the classifier.

MATLAB Image Processing Toolbox, Computer Vision System Toolbox, Statistics and Machine Learning Toolbox, Neural Network Toolbox

Preprocessing → Segmentation and feature extraction → Clustering → Labelling of clusters by user and corrections → Classifier training → Trained model

Rice pollen grain Images
Rice Pollen analyzer

Work flow of Pollen grain analysis and online learning

Online machine learning is a method of learning in which data becomes available in a sequential order and at each step we use the new data to update our best predictor/classifier for future data.

- Preprocessing
- Segmentation and feature extraction
- Identification of agglomeration and in-the-run intelligent checks and suggestions
- Machine Classification/ User defined threshold
- Feedback by user for segmentation
- Re-tune classifier based on user decision

MATLAB Image Processing Toolbox, Computer Vision System Toolbox, Statistics and Machine Learning Toolbox, Neural Network Toolbox

Trinocular Microscope
Image file
Stained Rice Pollen Grain Image
MATLAB Image Acquisition Toolbox
Report
Why MATLAB?

- Provides all basic tools needed for development of scientific computing application
- Supports image acquisition from wide range of cameras with different protocols
- Database integration tools and Deployment tools which are vital for Application development
- Efficient off the shelf algorithms for Image Processing and Machine Learning
- Features Apps that can be used for quick analysis by developers
# Rice Pollen analyzer - Infrastructure

<table>
<thead>
<tr>
<th></th>
<th>Toolbox Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MATLAB 2015b</td>
</tr>
<tr>
<td>2</td>
<td>Image Processing Toolbox</td>
</tr>
<tr>
<td>3</td>
<td>Computer Vision System Toolbox</td>
</tr>
<tr>
<td>4</td>
<td>MATLAB Compiler</td>
</tr>
<tr>
<td>5</td>
<td>Database Toolbox</td>
</tr>
<tr>
<td>6</td>
<td>Parallel Computing Toolbox</td>
</tr>
<tr>
<td>7</td>
<td>Statistics and Machine Learning Toolbox</td>
</tr>
<tr>
<td>8</td>
<td>Neural Network Toolbox</td>
</tr>
<tr>
<td>9</td>
<td>Image Acquisition Toolbox</td>
</tr>
</tbody>
</table>
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Benefits

- **High accuracy** results >99% as user feedback is considered for re-tuning the classifier
- **Reduces dependency** on human expertise and error due to human negligence
- **Time efficient**, processing speed is <2sec
- Provision for **user defined threshold limits** to define Fertile/Partially Fertile/Sterile pollen
- **Marker tools** to give feedback to the system
- User friendly and **easy** to operate
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Future Scope of Work

- Extending the application to analyze other crops pollen with similar characteristics
- Rice pollen analyzer to be adapted to similar applications in medical domain
- Interfacing with database & managing data
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