Identification of Stem Borer Attack in Rice Crop Using Fuzzy Inference System

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Abstract

Stem borer, bores into rice plant stems.This is any insect larva. Stem borers can destroy rice at any stage of the plant from seedling to maturity. Excessive boring through the sheath can destroy the crop. Its damage can reduce the number of reproductive tillers. At late infection, plants develop whiteheads. Visual inspection has been done in rice crop for deadhearts in the vegetative stages and whiteheads in reproductive stages to confirm stem borer damage.

In present day applications, visual inspection can be done by doing automation of the process to interprets and analyze the information by using various kinds of images and pictures as source of information. The fuzzy set theory is incorporated to handle uncertainties and fuzzy clustering is a powerful method of data mining. FIS is an expert system to approximate input- output mapping according to defined rules. In this proposed approach, whiteheads image of rice crop, caused by stem borer, captured by digital camera. In preprocessing steps, image cropping and image segmentation has been performed with captured images. After that, 24 features of normal and whiteheads rice crop images has been extracted. On the basis of this extracted feature, Mamdani fuzzy models has been implemented, to automate the process, to identify whiteheads caused by stemborer in mid of normal rice crop.

Keywords: Stem Borer, Whiteheads Rice Crop Image, Image Acquisition, Image Segmentation, Fuzzy Inference System

INTRODUCTION

Stem Borer

A stemborer (stem borer) is any insect larva, or arthropod, that bores into plant stems as shown in Fig. 1. Six species of stemborer attack rice. These are the yellow, white, striped, gold-fringed and pink stemborer.

Stem borers can destroy rice at any stage of the plant from seedling to maturity. They feed upon tillers and causes deadhearts or drying of the central tiller, during vegetative stage; and causes whiteheads at reproductive stage.

The stem borer larvae bore at the base of the plants during the vegetative stage. On older plants, they bore through the upper nodes and feed toward the base.High nitrogenous field favors population buildup of the stem borers.

Check the field for the following damage symptoms to identify stem borer:

- Deadhearts or dead tillers that can be easily pulled from the base during the vegetative stages
- Whiteheads during reproductive stage where the emerging panicles are whitish and unfilled or empty Tiny holes on the stems and tillers
- Frass or fecal matters inside the damaged stems[1].

Fig. 1 Stem Borers, Larvae and Whiteheads [1]

Fuzzy Inference System

The fuzzy inference system is a popular computing framework based on the concept of fuzzy set theory, fuzzy if- then rules, and fuzzy reasoning. The basic structure of a fuzzy inference system consists of three

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conceptual components: a rule base, which contains a selection of fuzzy rules; a database (or dictionary), which define the membership function used in fuzzy rules and a reasoning mechanism, which perform the inference procedure. FIS can be implemented by Mamdani approach or Takagi and Sugeno's approach [3].

MATERIALS AND METHODS

We choose whiteheads images of rice crop to identify damage done by Stem Borer. Steps to create fuzzy model is shown in Fig. 2. Total 70 images, of size 5152×3684 pixels, captured by digital camera as shown in Fig.3. Cropping operation has been performed on these original acquired images of size 1001× 801pixels as shown in Fig.4. Total 206 cropped images for both normal and whiteheads images have been taken for feature extraction [2]. Total features extracted for shape is 11, Texture is 4 and Color is 9. This extracted features are Area, Euler Number, Orientation, Extent, Perimeter, ConvexArea, FilledArea, Eccentricity, Major Axis Length, Equiv Diameter, Minor Axis Length, Contrast, Correlation, Energy, Homogeneity, max1R, max1G, max1B, stdDevR, MeanR, stdDevG, MeanG, stdDevB, MeanB. Sample of extracted feature is shown in TABLE 1.

Table I. Sample of Extracted Features

Feature Name	**Res1**	*Res2*
Area	-0.35357	0.34703
EulerNumber	-0.35924	0.346908
Orientation	-0.32022	0.347245
Extent	-0.07274	0.08366
Perimeter	0.073717	0.055195
ConvexArea	-0.34854	0.34573
FilledArea	-0.3533	0.346997
Eccentricity	0.346524	-0.32856
MajorAxisLength	-0.34681	0.356229
EquivDiameter	0.127031	-0.15537
MinorAxisLength	-0.36038	0.360104
Contrast	0.007703	0.007246
Correlation	0.888098	0.933342
Energy	0.923521	0.884113
Homogeneity	0.996149	0.996377
max1R	254	203
max1G	255	211
max1B	255	215
stdDevR	34.94922	34.47334
MeanR	6.880947	8.651909
stdDevG	36.09701	38.1659
MeanG	7.168281	9.707853
stdDevB	31.9976	34.45184
MeanB	6.260048	8.603863

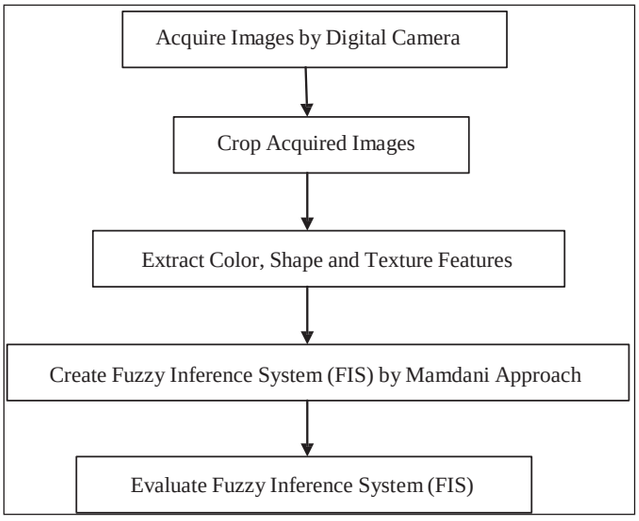

Fig.2. Steps to Create FIS [4]

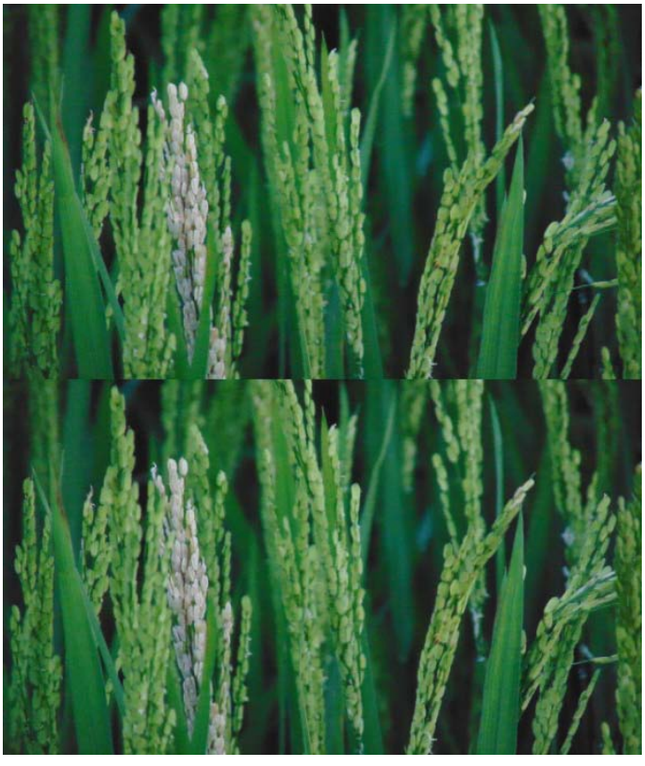

Fig.3. Original Captured Images

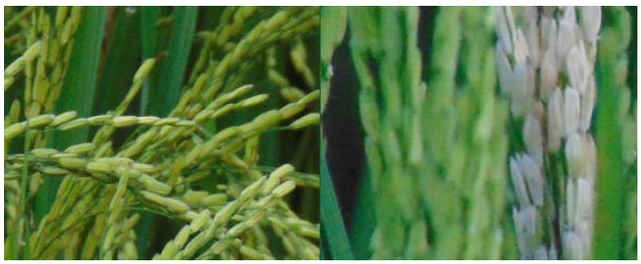

Fig.4. Cropped Images

With the help of these extracted features shown in Table 1, Fuzzy Inference System (FIS) has been created using substitution clustering.

RESULT AND DISCUSSION

Entire work has been implemented in MATLAB 7.9.0[5]. Fuzzy Inference System with 24 inputs and 1 output has been created. In this model, Substitution cluster technique creates total 20 clusters to map entire input-output. For this 20 cluster, there will be 20 cluster centers. Outline of the FIS model is shown in Fig.5.

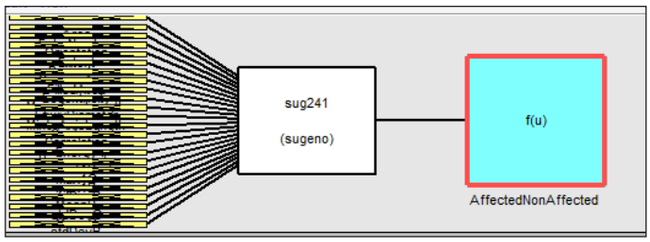

Fig.5. FIS Architecture

According to cluster center, each input require 20 membership function. Sample of one input "contrast" membership function is given in Fig.6. In the same way, 20 rule is defined in the rule base to evaluate the model as shown in Fig.7.

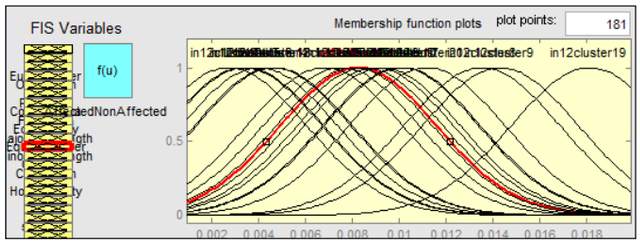

Fig.6. MF of Input Contrast

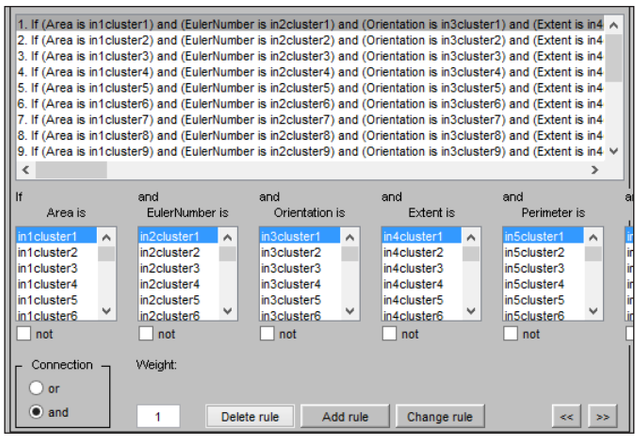

Fig.7. Rule Created for Identification

Surface view shown in following Fig.8. simulates the response of the fuzzy system for the entire range of inputs. In the plot below the surface viewer shows output surface for two inputs.

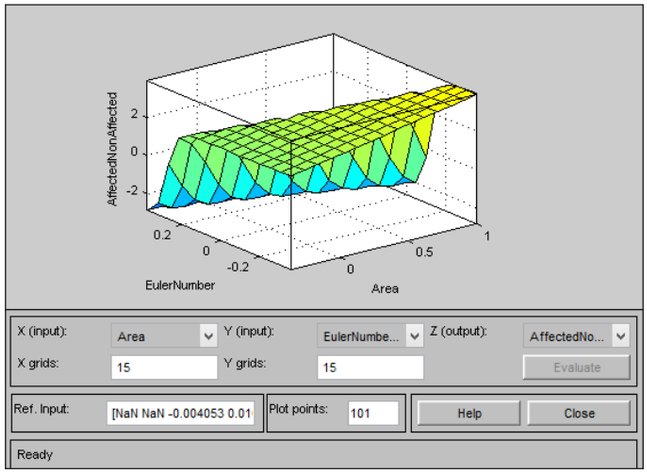

Fig.8. Surface View

Rule viewer is the graphical simulator for simulating the FIS response for specific values of the input variables as shown in Fig.9.

CONCLUSION AND FUTURE SCOPE

Fuzzy Inference System gives 100% accuracy, to identify Whiteheads Rice Crop, caused by stem borer attack. This is initial stage to automate the process to identify disease affectedness.

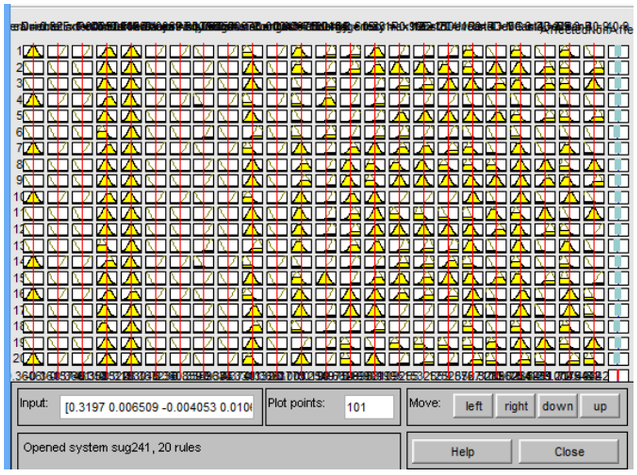

Fig. 9. Rule Viewer

In future, same concept can be implemented in other diseases in rice crop which can be identified by digital images for deeper analysis. There is another symptom also to identify stem borer. Methods can be implemented by considering all symptoms and that will be more reliable.

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