

Intelligent Soybean Disease Tutor System

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ABSTRACT

Intelligent Soybean Disease Tutor System is developed using ASP.NET as a sub-system of Expert System of Soybean Diseases at Directorate of Soybean Research. The dynamic knowledge base is implemented using SQL server. This paper presents the development of Intelligent Tutor System for Soybean Diseases. The methodology used for development of the system is discussed. The importance of the system as an effective training tool for different clientele is described. The functionality of the system is explained with the help of user interface for better understanding of the system. This system can augment the conventional educational methodologies in specific courses in plant pathology. The current tutor system will pave a way to transfer the disease management technology in user-friendly manner.

Key words: Intelligent tutor, knowledgebase, knowledge acquisition, soybean disease and training tool

Soybean crop suffers from several diseases caused by bacteria, fungi, viruses, physiological disorders. Annual yield losses due to these diseases are in the tune of 12 per cent of total production (Gupta and Chauhan, 2005). Information on management of all the major diseases of soybean crop is needed by different clientele like students, research scholars, research workers, extension personnel, disease trainers, entrepreneurs and farmers. Therefore, Intelligent Soybean Disease Tutor System is developed to provide the information in different easy-to-understand ways.

Intelligent Soybean Disease Tutor System is a sub-system of Expert System of Soybean Diseases developed at Directorate of Soybean Research. It serves as an audio-visual soybean disease training tool. It provides information on useful disease

aspects like pathogen, geographic distribution, economic impact, favourable climatic conditions, detection methods and effective integrated management practices. It is a useful and interactive audio-visual training tool for providing pathological trainings with the help of multimedia effects, colour pictures, videos, texts, and graphics with capability of text-to-voice interface.

MATERIAL AND METHODS

Intelligent Soybean Disease Tutor System is developed using the system architecture (Fig. 1.) consists of i) disease knowledge base, ii) knowledge acquisition system, iii) audio-visual tools and iv) teaching parameters. It facilitates provision of pathological training services to different clientele. Knowledge engineers with the help

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of domain knowledge provided by disease experts and using knowledge acquisition system forms the disease knowledge base. This knowledge base provides all the

knowledge for giving training to the end users. Tutor can use audio, videos, disease photographs and text-to-speech conversion tools to provide training in attractive manner.

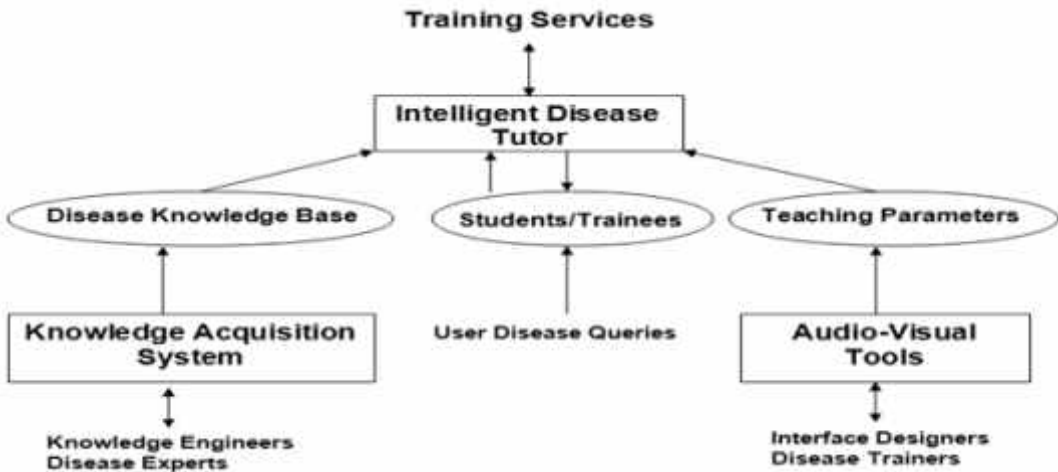


Fig.1. Intelligent disease tutor system architecture

Software development

The system contains the disease knowledge about twenty five soybean diseases. The development of multimedia intelligent interface was done as follows.

Software selection

The interface is developed using the ASP .NET and C# for development of the system (Harvey *et al.*, 2001; MacDonald, 2005) as the concepts of text-to-speech translation can be easily used with applications built using the Microsoft .NET framework using 3-tier web architecture.

The dynamic knowledge base is implemented using SQL server. Fig. 2 explains pictorially how our intelligent tutor system employs the three-tier web architecture using .Net technology (Active server pages) and SQL server. The .NET software development platform is based on virtual machine based architecture. The entire

.NET programs are independent of any particular operating system and physical hardware machine. They can run on any physical machine, running any operating system that contains the implementation of .NET Framework.

Database contains thirty-one database tables. The tables store facts and knowledge required for the knowledge base. A part of the database relationship diagram is shown in Fig. 3.

Software Modules

The tutor system contains different modules for - (i) disease detail, (ii) disease comparison, (iii) new user registration, (iv) disease picture gallery and (v) disease video gallery.

The Disease detail module helps the user to view detail information on different aspects of soybean diseases. The user can compare different soybean diseases on multiple aspects for in-depth comparison of

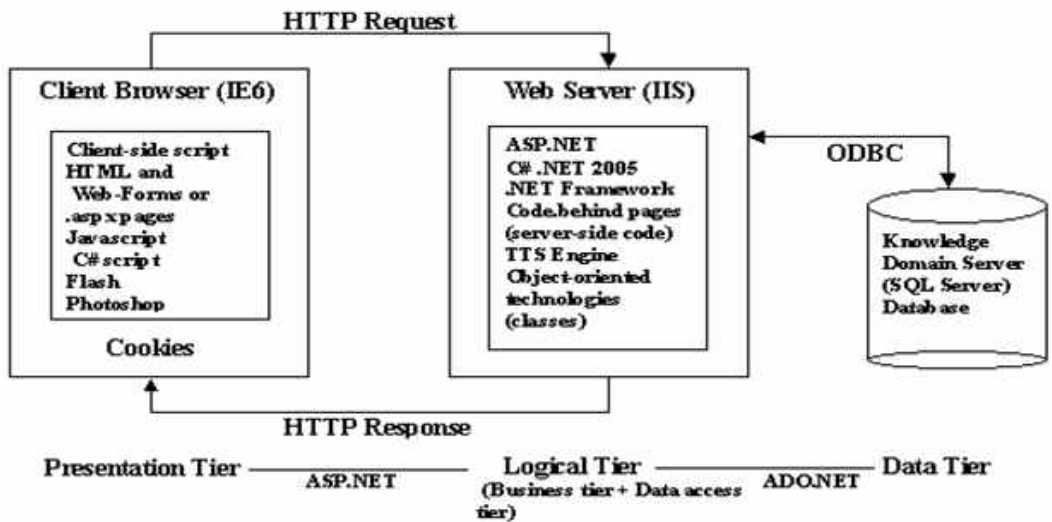


Fig. 2. Three-tier web architecture of the system (Savita *et al.*, 2011) Database Design

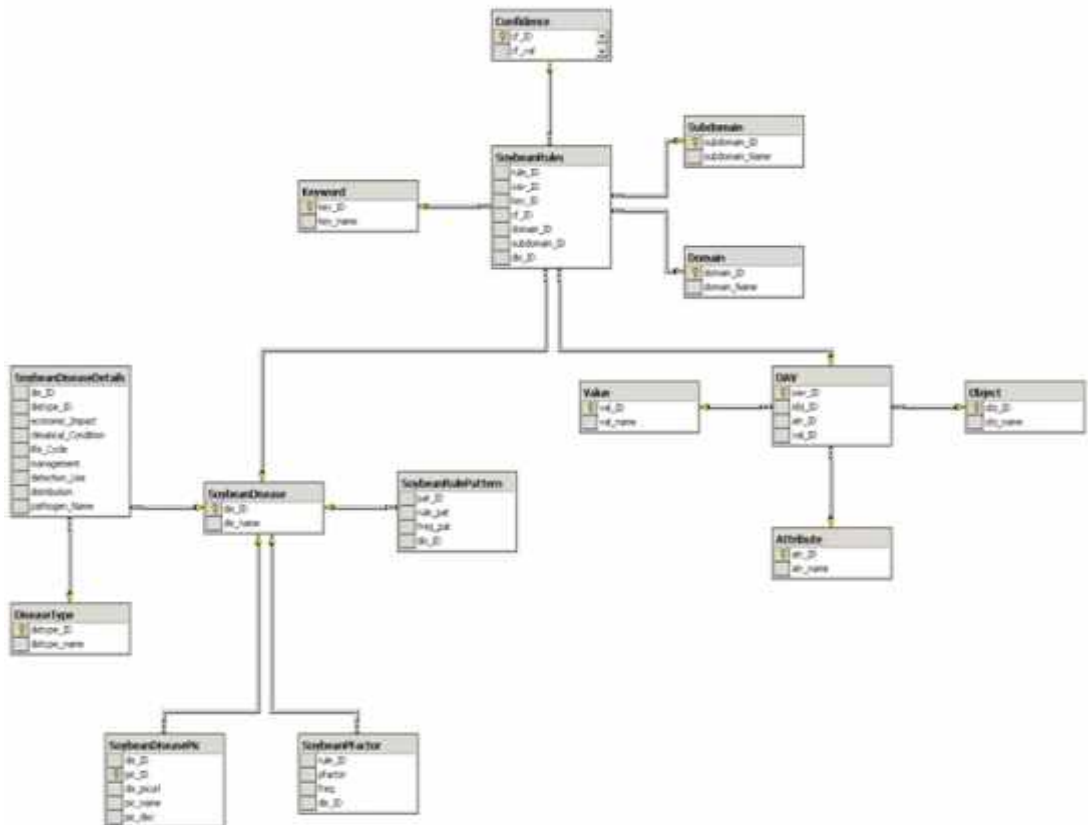


Fig. 3. A part of the database relationship diagram showing relationship between different database tables

different diseases by using disease comparison module. The new users can register for getting authorized access of the system by using new user registration module. The main users are students, research scholars, research workers, extension personnel, disease trainers, entrepreneurs and farmers. The registration is free for them for non-commercial, academic and research purpose. The users can view the pictures of different disease infection for giving correct disease symptom inputs by viewing disease picture gallery. The users can also view different disease videos by visiting disease video gallery.

Text to speech (TTS) translation

Automatic speech recognition (ASR) is commonly described as converting speech to text. The reverse process, in which text is converted to speech (TTS), is known as speech synthesis (Holmes, 2001). Speech synthesizers often produce results that are not very natural sounding. Speech synthesis is different from voice processing, which involves digitising, compressing (not always), recording, and then playing back snippets of speech. Voice processing results are very natural sounding, but the technology is limited in flexibility and is disk storage-space-intensive compared to speech synthesis.

Looking to this, our system includes the concepts of text-to-speech (TTS) translation and these features can be used comfortably with applications built using the Microsoft .NET framework.

The Microsoft Speech SDK is used to develop text to voice software applications [Microsoft speech API]. This SDK provides a collection of methods and data structures that integrate very well in the .NET 2005 framework.

Knowledge acquisition system

A web-based and interactive knowledge acquisition user interface is developed. It allows the expert to enter knowledge directly into the knowledge base, which means without an intermediary. This way of direct interaction of the expert increases the accuracy of the resulting application because errors of communication between knowledge engineers and experts are eliminated and as a result, we get a more reliable knowledge base.

The knowledge of different disease symptoms along with the knowledge on other disease related information like causal organisms, geographic distribution, economic impact, favorable climatic conditions, detection methods and effective integrated management of practices are entered using the web-based user interface of this subsystem. These are collected from literature, pathological experimental field trials, disease compendiums (Hartman *et al.*, 1999), books, scientific papers, disease bulletins (Bartaria *et al.*, 2001; Ghewande *et al.*, 2002; Gupta and Chouhan, 2005) and photographs of different diseases and interviews of plant pathologists.

RESULTS AND DISCUSSION

The interface is used by end-user by clicking menu-option "Intelligent Tutor" on the main user interface shown in fig. 4.

The user can use the system by doing login in the web form shown in fig. 5. The user gets the information in different ways by clicking menu buttons *viz.*, complete detail, disease comparison, image gallery and video gallery (Fig. 6). The user can get complete information of soybean diseases on different aspects like pathogen, geographic distribution, economic impact, favourable climatic conditions, detection methods and effective integrated management of practices



Fig. 4. Main web page of crop disease expert system



Fig. 5. Login page of intelligent disease tutor

by clicking complete detail menu button (Fig. 7). The user can compare different diseases on aforesaid aspects by clicking disease comparison menu button and by selecting desired options for comparison (Fig. 6). The disease knowledge is obtained in the form of comparison table as shown in Fig. 8. The user can view different videos and pictures to view disease expert knowledge on different

diseases according to their interest and choice (Fig. 9). This helps to visualize the disease symptoms and picture-based confirmation of the diagnosed diseases.

This intelligent disease tutor system would provide real time, context-appropriate and cost-effective training enabling learners to perform appropriate disease related tasks in the right manner and at the proper time. In doing so, such an intelligent tutor system would decrease the time required to migrate learners from novice to disease expert, while increasing the number of disease trained personnel successfully reaching a more knowledgeable level. It includes complete, comprehensive disease knowledge expressed to the user effectively with the help of multimedia effects, colour pictures, videos, texts, and graphics. The users could use the system comfortably and found the working with interface satisfactory. Thus, it is a useful and interactive audio-visual training tool for providing pathological trainings. It can augment the conventional



Welcome Savita Kulkarni in an ultimate Disease Tutor for ** Soybean Disease **

Intelligent Disease Tutor

Home	Complete Details	Complete Information	Image Gallery	Video Gallery	Log Out
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SELECT DISEASE

<input type="checkbox"/> Select Disease	<input type="checkbox"/> Collar Rot or Sclerotial Blight	<input type="checkbox"/> Phytophthora leaf spot
<input type="checkbox"/> Alternaria leaf spot or blight	<input checked="" type="checkbox"/> Frog eye leaf spot	<input type="checkbox"/> Powdery Mildew
<input checked="" type="checkbox"/> Anthracnose	<input type="checkbox"/> Fusarium blight or wilt	<input type="checkbox"/> Rhizoctonia Root and Stem Rot
<input type="checkbox"/> Bacterial blight	<input type="checkbox"/> Fusarium Root and Collar rot	<input type="checkbox"/> Rust
<input type="checkbox"/> Bacterial pustule	<input type="checkbox"/> Indian Bud blight	<input type="checkbox"/> Sclerotinia stem rot
<input type="checkbox"/> Brown spot	<input type="checkbox"/> Myrothecium leaf spot	<input type="checkbox"/> Target leaf spot
<input checked="" type="checkbox"/> Charcoal rot	<input type="checkbox"/> Phyllotry associated no padding syndrome	<input type="checkbox"/> Yellow Mosaic

SELECT PARAMETER

<input checked="" type="checkbox"/> ClimaticCondition
<input checked="" type="checkbox"/> LifeCycle
<input checked="" type="checkbox"/> Management
<input type="checkbox"/> DetectionUse
<input type="checkbox"/> Distribution
<input type="checkbox"/> PathogenName
<input type="checkbox"/> EconomicImpact

Show Detail

Fig. 6 Web page for taking inputs to get complete disease details



Welcome Savita Kulkarni in an ultimate Disease Tutor for ** Soybean Disease **

Intelligent Disease Tutor

Home	Complete Details	Complete Information	Image Gallery	Video Gallery	Log Out
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Complete information about the selected disease(s)

Select disease from this list => [Anthracnose] [3]

The disease details can be seen below :

Disease Name	Anthracnose
Economic Impact	It is economically important to soybean because this disease causes 1000 to 2000 crop loss up to 100% depending upon disease severity in severe cases. It is also mainly responsible for yield loss. It causes 10% to 20% loss in yield. It is also responsible for yield loss. It causes 10% to 20% loss in yield.
Climatic Condition	Warm weather (temperature 20-30°C) and high humidity are favorable for the development of this disease. It is also responsible for yield loss. It causes 10% to 20% loss in yield.
Life Cycle	Anthracnose is caused by the fungus Colletotrichum trifolii. It is a soil-borne pathogen. It enters the plant through wounds and natural openings. It causes 10% to 20% loss in yield. It is also responsible for yield loss. It causes 10% to 20% loss in yield.
Management	Use of resistant varieties, crop rotation, and fungicide application are the main management practices. It is also responsible for yield loss. It causes 10% to 20% loss in yield.
Detection Use	Visual inspection of leaves and stems for characteristic lesions is the primary method of detection. It is also responsible for yield loss. It causes 10% to 20% loss in yield.
Distribution	It is widespread in soybean-growing regions across the world. It is also responsible for yield loss. It causes 10% to 20% loss in yield.
Pathogen Name	Colletotrichum trifolii (Sacc.) G. & A. It is a soil-borne pathogen. It causes 10% to 20% loss in yield. It is also responsible for yield loss. It causes 10% to 20% loss in yield.

Fig. 7. Web page showing complete details of selected disease



Welcome Savita Kolhe in an ultimate Disease Tutor for ** Soybean Disease **

Intelligent Disease Tutor

Home	Compare Details	Disease Comparison	Image Gallery	Video Gallery	Log Out
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== Comparison of diseases on different disease aspects ==

Disease Name	Climatical Condition	Life Cycle	Management
Charred rot	Dry conditions, relatively low soil moisture and robustness and temperature ranging from 25°C to 35°C are favourable for the disease.	After germination of seed, microchrobia (colony) lying in the soil or with the seed germinate on root surface or in close proximity to root and penetrate transverse gum tubes. These later on penetrate leaf tissues through epidermal cells in natural openings. Consequently with time the mycelium reaches to epidermis, produces microcleridia that plug the vessels resulting in discoloration and wilting of host tissues.	Crop rotation or mixed cropping with cotton or cereals. Timely use of optimum dose of fungicides. Use of less susceptible varieties like MRC 2, MRC 27, IS 71-05, L26-1, MACS 12 etc. Maintenance of low plant population in the field where disease appear in order to have vigorous plants. Fencing of field 3-4 week before sowing or maintaining high soil moisture by irrigation, if possible, during crop growth. Seed treatment with captan or thiram @ 3 g/kg seed or use of Trichoderma hamatum or T. virens @ 4 to 5 g/kg seed.
Anthracnose	Warm weather (temperatures around 35°C) coupled with rain, dew or fog, which can provide free moisture for the periods of 12 hr. or more favours the infection of disease.	Inoculum, as mycelium from seed and debris may initiate the infection and causes pre and post emergence damping off of seedlings. Sometimes the infection from the conidia produced on stylobium gradually reaches to young stems which numerous small, deep seated cankers form and may kill the young plant. Alternatively, infection may also establish in infected seedlings without symptom development (latent infection) until plants begin to mature. Conidia produced in cankers (Fig. 29 & 30) on infected plant parts under favourable conditions may initiate secondary infection by producing spores even after germination.	Use of clean and healthy seeds. Burning of infected plant debris. Cultivation of moderately resistant varieties like Bragg, Hamo 1303, Hardee, PK 472, IS 30-21, Pusa 37, VLS 11, NRC 12 etc. Seed treatment with thiram + carbendazim (2:1) or captan @ 3g/kg seed and spray of carb. or mancozeb 0.2% on infected crop.
Frog eye leaf spot	Disease is favoured by warm and wet conditions and appears in severe proportions in seasons with frequent rainfall.	This pathogen survives on seeds and infected crop residues. Disease cycle of the disease starts with the primary infection from conidia produced either on infected crop residues or on cotyledons of infected seedlings sown from infected seeds, which are quickly dispersed by the wind. These conidia infect the soybean plants and produce lesions. Sporulation on these lesions again give rise crop of conidia (Fig. 33 & 34) which are carried out to short distances by an current and splashing rain and responsible for secondary spread of the disease through out the season. Infected seeds are a means of distant dissemination of the fungus.	Removal and burning of crop debris. Use of clean and certified seed and moderately resistant varieties like Bragg, IS 30-21, KRS 2, VLS 21 etc. Seed treatment with thiram + carbendazim (2:1) @ 4.2% spray of carbendazim or thiophanate methyl @ 0.05% or mancozeb @ 2% over the infected crop.

Fig. 8. Disease comparison on different aspects



Fig. 9. Web page displaying disease image of Anthracnose disease

educational methodologies in specific courses in plant pathology. It can prove to be a powerful means for transfer of technology of agriculture pathological technologies to practices.

Presently, the system generates knowledge in English, but in future it can be integrated with TTS engine of Hindi language also.

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