Modeling and Implementation of Catastrophe Prediction of Cnaphalocrosis Medinalis Guenee in Intelligent Agriculture

Xiaopeng Dai[1], FeiYu[1], Huang Huang[1], Jiyao An[3], Miaoliang Zhu [2]
1. School of Computer &Information Engineering,
Hunan Agricultural University, Changsha 410128,China
{dxp_18, hunanyufei}@163.com, hh863@126.com
2. Institute of Artificial Intelligence, Zhejiang University, Hangzhou, 310027, China
zhum@zju.edu.cn
3. School of computer & communication, Hunan University, Changsha 410082,China
jt_anbob@hnu.cn

Abstract

The pest catastrophe prediction in ecology catastrophe is one of important part in expert system of intelligence agriculture for prevent and control pest catastrophe occurrence efficiently. The paper introduces the basic principles and methods of current catastrophe prediction in ecology. By modeling for the dynamic process of population, up-grown and amount of spawn, the paper finds out the trigger point and critical value, inducing the pest catastrophe and implements the catastrophe prediction of cnaphalocrosis medinalis guenee before catastrophe to prevent big population coming into being.

KEYWORDS **Ecology Catastrophe, Catastrophe Prediction Model, Expert System, Inference Machine**

I. Introduction

Most pests, which may invade crops in China, are characterized by the fact that they are migratory, eruptive and destructive. It is the paroxysm of a migratory pest that makes it very difficult to forecast a certain catastrophe precisely. Since “six. five”, the National Science Committee has been tackling the key problems in forecast of pests, and as a result, 80 percent of the pest catastrophes can be forecasted. However, it is the remainder 20 percent made by the eruptive increase of pest population which cannot be predicted by normal methods that are in great need of precise forecast. Catastrophes such as the outbursts of beet webworms in 1980s, the cotton bollworms in 1992 and the rice louses in 1997 etc, made people panic-stricken can only meet the emergencies passively, suffering the disastrous losing. We realize that the weak basic research and the deficient research methods have made our science and technology inadequate to tackle the difficult problems of biology catastrophe prediction.

The development and evolvement of biology catastrophe is a multi-scale ecology process in biosphere. At the same time, it is a result that material flow, energy flow and information flow in ecology system work with each other. The complex system, such as farm ecology system, has many internal variables with not simple linear relation. It makes the regular method (statistical forecast) in linear system cannot work well. The abrupt discontinuous change of population amount leads to catastrophe, which changes the way and quality of system development and makes the basic principle of prediction failure. The catastrophe outburst with multi-factor, non-linear, uncertainty etc characteristics, is a little probability event and its space-time transformation is unnecessary periodicity (some examples even just one), which lead to cannot be solved by traditional forecasting methods and theories based on analogy and continue principles. So, it is urgent to research on forecasting methods and theories and develop a new forecasting technology.

Catastrophe prediction aims at meeting the emergence in advance. That is, it must take some corresponding measures to prevent sudden increase of population before catastrophe by finding trigger points and critical values which initiate pest catastrophe as possible. Since the traditional forecasting theories and methods cannot work well, it is necessary to combine macrocosmic and microcosmic, cross multi-subject and research from multi-approach.

Expert system is a new subject in the middle of 60 ages, one of the applications to practice of artificial intelligence. It makes the computer have the “expert” effect in many fields. For example, expert system works like a famous doctor in medicine field, weather forecast specialist in weather field, plant guardian in plant field.

II. The Development of Catastrophe Prediction

The application of prediction model to entomology correlates closely with the research of insect bionomics. From logistic curve proposed by VerhuLst in 1838, competition model between populations proposed by Lotka and VoLterra separately in 1925 to fix quantify investigation on bionomics in 1960s, people had more and more knowledge about the principles of insect population changes. In the early 1960s, the nation combined the computer technology with dynamic model, multi-statistic model to predict the amount in a long time period of migratory locust in east Asia. From then on, it proposed some population dynamic models, population simulation model, changing dimension matrix model, analysis method of population life table and applied the gay system model, blur mathematics model, population mutation model etc to insect forecast. With the development of mathematics theory, the computer and other subjects, insect forecast goes through experience prediction phase, experiment prediction phase, statistic prediction phase and information prediction phase.

A. Experience Prediction

The experience prediction has been applied widely during a short time and important to agriculture production. The relation between the pest and its outside factors not being simple, the prediction made by experience method using a simple linear correlation coefficient cannot be precise enough. On the other hand, the experience method just works well in short term. Those are its deficiencies.

The pest workers summarize many effect experience methods, such as up-growth process and effect data algorithm, which have become popular.

B. Experiment Prediction

The experiment prediction includes two methods based in insect life table and effective accumulated temperature (EAT). It is the popular prediction model between 1960s and 1970s and has an extremely important effect on the development of insect bionomics and pest synthetic management. Now, it is seldom to use only the experiment method for prediction, and more often we look upon it as a useful instrument for comprehensive management. In addition, it is one of important submodules of information prediction.

C. Statistic Prediction

The statistic prediction is based on probability and multi-factor linear correlation principles and filtrate and module to forecasting factor in some extent using some mathematic ways. It includes a few prediction methods, such as, reversion analysis, stepwise reversion, stepwise distinguish, principal component analysis, multi-factor correlation analysis, second distinguish, calm random sequence, multi-dimension time sequence, Markov chain, blur mathematics, gay system analysis etc. It has become a main important forecast method. The statistic prediction has simple principle and can be mastered easily, but it has few defects. For example, (1) the result of forecast is instability, (2) some forecasting modules are based on the reconnaissance and thinks not or little pest ecology and physics regular, which leads to cannot combine the pest appearance regular and statistic theory well.

D. Information Prediction

The information prediction mainly includes database management system, time when the pest catastrophe happens forecasting system, information transfer system, information management system, decision-making supporting system, expert system and geography information system etc. With the development of kinds of subjects and the consummation of correlation information, information prediction research has become a hot point and has a very widely application. There are many succeed examples in and out country.

III. Catastrophe Prediction Module of Cnaphalocrosis Medinalis Guenee

Though there are the outside random factors, with the knowledge of pest catastrophe occurrence regular and outside factors physical process deepened little by little, it is possible to divide a part of outside random factors to make them predictable. Since the un-forecasting proportion decided by outside random factor is more and more little, it improve the forecasting right ratio to the long-term prediction. In essence, the possibility of long-term prediction depends on inherence random of system. The continuity in pest catastrophe occurrence process, dispersion of pest catastrophe occurrence data, un-dynamic evolvement characteristics in pest catastrophe occurrence system result in the complexity of pest catastrophe occurrence system. If the initial conditions or system parameters have little difference, the future state of pest catastrophe occurrence system will be different in essence. However, just uttermost sensitive to initial conditions, the pest catastrophe occurrence represents stability to abnormal. In principle, both the chaos behavior to dissipative nonlinear system and chaos behavior to HARMILTON nonlinear system all can have statistic description by the fix distributed function, which proves the pest catastrophe prediction is possible.

A. Foundation Of Prediction Modeling Theory

A great deal of research indicates that the complex characteristics of pest catastrophe occurrence are asymmetry, difference, diversity, outburst, random, predictable and periodicity etc.

1. Asymmetry and Difference

The asymmetry and difference of pest catastrophe occurrence is the nonlinear characteristic of pest catastrophe, exhibiting in distribution in space and time. For example, the degree of the same pest catastrophe happened differently in different year or month, even in the same time, happened differently in different place. Moreover, the changeable time of biology system parameter, the adapt of species and the process of evolvement are the important factors too which lead to the nonlinear characteristic of pest catastrophe occurrence. For example, the brown planthopper can restrict the size of population by their population density. With the density of population increasing, the brown planthopper compete in space and food resource, which results in the rising of the death rate and the proportion of long wing individuals of the offspring. The long wing imago spawns less than the short wing does, but they belong to migration type, which habit benefits to the future development of the population. At the same time, migration can reduce the press when the density of population enhances. Compared that the long wing individuals have the important significant to the future development of population, the short wing individuals are very critical to the amount of the population. Migration of brown planthopper is a advanced adaptive form of population, which increate and afford the space and environment for offspring, and get rid of a lot of factors that are not beneficial to the development of population, including density restriction, climate change periodically etc. According to the migration out and home, the population eliminates through selection or contest.

2. Diversity

For the big diversity of geographical environment in different area and plant mode of crops and the difference of the kinds of the natural conditions and society economy conditions inducing the pest catastrophe occurrence, so there exists diversity in pest catastrophe occurrence.

3. Random and Predictable

Random originates from the difference, diversity and asymmetry of the pest catastrophe. The random of atmosphere circulation, climate condition and nature environment lead to the uncertainty of the process and production of pest catastrophe. Predictable means that the process and development of pest catastrophe conform to some rules, which can be predicted. The relation between random and prediction is dialectic. Because it cannot master thoroughly the process and development pest catastrophe in any time and any place, which represents random characteristic to people. If the scientist technologies can reach special level, which can grasp the cause of formation, mechanism and process of the pest catastrophe, people can predict pest catastrophe exactly. It is necessary for people to take new ways to research on the cause of formation, mechanism and process of the pest catastrophe.

4. Outburst and Periodicity

The pest catastrophe occurrence is the result that kinds of factor restrict and work each other, which do not depend on one's will. The pest population can reproduce itself promptly in short term and bring disaster, which represents outburst in some extent and some time scale. On the other hand, long-term athletics rule of pest is periodic, such as four, eight, nigh, eleven, twelve etc periodicity alteration rules. The pest catastrophe occurrence is not only outburst but also periodicity.

B. Dynamic Modeling of Cnaphalocrosis Medinalis Guenee

The cnaphalocrosis medinalis guenee is a migration pest and its population is a aggregate of all kinds of ages. For the different ages, there is an unequal distance by ages. If taking the time as the partition unit, it can conquer basically the problem of unequal distance. But the up-growth temperature can have effect on the partition. So, it takes EAT as the unit to divide the ages group (take fourteen day as distance).

Set $Ni(t)$ is the amount of i age group in time t (described by day). $Ni(t)$ will changes when its part member go into next group (i+1) and pre-group (i-1) go into the group i. $\alpha i(T)$ is the maturity percent of the individuals of i group in unit time at temperate T. $Si(V,T)$ is the individual survival rate of i group in unit time (function of environment temperature T and management variable V). To a certainty unit time, the mature amount of i group is $Si(V,T)\cdot\alpha i(T)\cdot Ni(t)$ and the death amount of it is $[1-Si(V,T)]Ni(t)$. So, in the time (t+1), the amount of i group equal to un-mature individuals multiply survival rate [1-αi(T)]Ni(t) and plus the amount which (i-1) group enter into i group. That is,

$$N_i(t+1) = S_i(V,T)N_i(t)[1-\alpha_i(T)] + S_{i-1}(V,T)N_{i-1}(t)\alpha_{i-1}(T) \quad (1)$$

C. Up-Growth Modeling of Cnaphalocrosis Medinalis Guenee

In paper [10] indicates the up-growth speed of cnaphalocrosis medinalis guenee is the function of temperature. But the temperature is a function of time, so there is relation between up-growth and time like

$$S(t) = \int_0^t F(\delta)d\delta \quad (2)$$

$F(\delta)$ is a up-growth temperature function changing with time. Its value range likes as following,

$$F(\delta) = \begin{cases} T(\delta) - \beta & \mathrm{T}(\delta) \ge \beta \\ 0 & \mathrm{T}(\delta) < \beta \end{cases} \quad (3)$$

$T(\delta)$ indicates the temperature at time δ , β is the initial temperature of up-growth, S(t) is EAT。
The relationship of up-growth speed of cnaphalocrosis medinalis guenee and temperature can be described as followed equation.(R.E.Stinner.et al 1974)

$$R(T) = C/(1 + e^{a+bT}) \quad (4)$$

D. Spawn Production Modeling of Cnaphalocrosis Medinalis Guenee

The imago population amount of cnaphalocrosis medinalis guenee is N, sex rate is D, spawns of every trigamous imago in its life are Y, the whole spawn from eclosion time b to spawning period C is as follows:

$$F_C = N \bullet D \bullet Y \bullet P = N \bullet D \bullet Y \int_b^C \phi(t)dt \quad (5)$$

Thinking of the trigamous imago spawn not beginning from eclosion period, if the pre-spawn time is two days, $\phi(t)$ is zero at the first and second day.

$$\int_b^e \phi(t)dt = \int_b^{b+2} \phi(t)dt + \int_{b+2}^e \phi(t)dt = \int_{b+2}^e \phi(t)dt \quad (6)$$

Thinking of application, changing the module to the disperse module, as following,

$$\sum_{i=1}^{e} pi = 1, \quad F_C = \sum_{i=1}^{C} Pi \bullet D \bullet N \bullet Y \quad (7)$$

i is the imago year, Pi is spawn probability of i trigamous imago, FC is the amount of spawns from eclosion time to time C. Taking the temperature factor into account, FC is as following.

$$F_C = \sum_{i=1}^{C} PiDN(-740.533 + 69.8Xi - 1.429Xi^2) \quad (8)$$

Xi is the environment temperature at i day.
If e equals to 5(because of the lifetime of imago is 4.7 days), pre-spawn time is two days, spawn times is three times, spawn probability P1 is 0, P2 is 0, P3 is 0.38, P4 is 0.43, P5 is 0.19, the sex rate is 1:0.92, D=0.52.

IV. Design of Forecasting Guideline In Catastrophe Prediction

The catastrophe prediction guideline of agriculture pest is that can describe the current or latent result of a sort of or a type of agriculture pest directly, exactly, completely and quantizing. It can aggregate the results according to subjection relation and hierarchy principle. Moreover, it can describe the current state, estimate and guide the forecast in future development.
The catastrophe system of agriculture pest has the characteristic of multi-variable and complex. Some variables show the catastrophe risk. When taken as statistic guideline, they become indicators to predict catastrophe. It must conform to the following principles when designing.

A. Predictable Principle

The catastrophe risk in agriculture pest is an uncertainty factor, but this factor must be predictable guideline. In the design of guideline of catastrophe risk, it does not select too abstract or too widely factors.

B. Reliability Principle

In order to satisfy the need of monitoring the prediction, it must choice the data which can be collected in time.

C. Sufficiency Principle

The catastrophe risk in agriculture pest is a kind of sufficient phenomena, which is a special nature phenomena exist in cycles and effect the whole agriculture ecology system and has complex structure. The guideline must be maturity in order to represent the complex system. The basic characteristic and result in catastrophe risk correspond to an or a group of guideline.

D. Minimality Principle

The catastrophe risk in agriculture pest has all kinds of constitution factors and appearances and the corresponding guidelines are diversity. As a guideline system, the amount of guidelines must limit to least. So, the selected the guidelines are representative and un-substitutive, which constitute a least maturity guideline collection.
The paper lists the catastrophe risk guidelines by subjective experience, investigation and literature. The paper chooses the guidelines twice. The first roughing choice filtrates to many guidelines according to their reliability and predict. The second careful choice is to choose from guidelines selected from the first time according to the sufficiency and least. The weight of sour principles is described as table 1.
Table 1 Weights of selected principle in risk predict of agricultural harmful living disaster changes

Selected principle	Initial weight	well-chosen weight
mensurability	40%	10%
reliability	30%	20%
sufficient	20%	30%
minimality	10%	40%

Ⅴ. Implementation of Inference Machine of Catastrophe Prediction

The inference machine is one of important parts of expert system of ecology catastrophe prediction. It is a programmer to control and coordinate the whole system. For example, according to the input data (the real state of current pest) and rules of knowledge base, special inference policies, the inference machine simulates the thought and logic of human expert to work and get the answer to problem needed solved.

A. Rete Matching Algorithm

Produce system (PS) has been used widely in every field in artificial intelligence. Especially as a exploitation tool of expert system, it gets achievement. In order to improve the efficiency when the PS executes, Forgy proposes Rete algorithm, which is an efficiency algorithm comparing the multi-mode aggregate and multi-target aggregate. It can find all the targets matching every mode. Rete algorithm can be used in parse machine of PS and thought as one of high-speed algorithms of PS in public.

In Rete algorithms, PS can be compiled to generate Rete network. Rete network consists of root node, single input node , pair input node and terminate node. Rete network co-operates with working memory WM , conflict resolution etc. In the course of matching, data flow from top to end by way of triggering the node according to certain rules. So, the flow of the data and control is easier to master.

Typical OPS5 analyzer adopts Rete algorithm to finish its match. In OPS5 analyser, the output of match course and the input of conflict resolution are collection of conflict sets, conflict sets is a set of ordered data pair, for example:

(PS Element table that matched with the left part of PS)

The ordered data pair is also called sample sets, Rete match algorithm is an algorithm that calculate the conflict sets, which compare the left set of PS with the element set of WM and then find out all the examples. Rete algorithm has the following two important characteristics :

1.Replace time by space , dispel repeated match test in each operate cycle.

2.Avail of the structure similarity inside and between PS , share test result of matching.

In Rete algorithm, the form of WME is: (Class－name↑attribute1 Value1↑ attribut2 value2… attributen Valuen)，WEM is divided into several kinds according to class-name. Every CE described a kind of WME partly. The change of the content in WME expresses with the sign (token), toketl＝＜+WME＞ / ＜-VME＞，the function of mode network is to accept token activating relevant joint, carry on element characteristic test in token of WME. Finally ,find out all CE that succeed in matching with WME,send signal to the corresponding memory area of these CE, the Rete mode network tree expresses as “child chain form expression method”

B. The Optimization of Rete Algorithm

When one node has a new token emerging, Rete algorithm transmit it to the next node by using token stack, thus we have a token stack operation. Meanwhile, we must carry on a state stack operation at least because the control authority should give to the next node. (In fact, there are many status information enter the stack ,so we go on the stack operation more than once).Thus, when Rete network produces one token each time, we carry on not only a token stack operation but also a state stack operation at least, which has increased time expenses. Because a producing program will often generate a large amount of tokens while operating, the expenses of stack operation are quite large. In

order to get high match efficiency, Rete match algorithm improved as follows:
Attach the inclusive brother chain to the node in mode network.
Divide the connection node of the same producing system into equivalence class in the connection network according to the variable restriction.
Transform symbol knowledge into an integer form.
If we add an inclusive brother chain to the data construction of mode network, changing parts are:

```
nodesef=RECORD
    ……

  compati-sibling:nodeptr

          END
```

The corresponding algorithm is as follows:
{Suppose nBB$_{1BB}$，nBB$_{2BB}$，…nBB$_{BBB}$ as brother node, construct the inclusive brother chain of ni }
the set of candidate node:＝[nBB$_{i+2BB}$，nBB$_{i+2BB}$,…，nBB$_{BBB}$];
Comparing definition area of characteristic between every candidate node and ni, if inclusive relation established, enter brother chain of ni.
ENDP;

After the changing of mode network, the explain algorithm need only make the following change on the basis of original algorithm:

```
    ……

IF cn tests is successful
THEN [pn.child:=compati-sibling;
        If cn is leaf  THEN   ……
                       ELSE   ……
    ……
```

C. The Ingerence Machine Based On Frete Algorithm

The inference machine adopts FRete fast matching algorithms, in our system, the mission is to assemble Rete net and match the fact to consequence. The inference net consists of four kinds of nodes, among them, each node in the net represents an item in the mode of rules , one or many node connect to represent a mode, and at the end of the net to make a restraint node, so as to keep those facts which matched the mode. Rate net makes use of the comparability of PS architecture，let the same item or mode to share the same restraint node. The last half of Rete net built up link network by link node, they correspond the left of rule's mode one by one, make test between the variable of mode, save fact sets which fit for the condition of the test. All of rule's mode are connected to make rule node, where store some information, such as rule's name and priority level and so on.

The reasoning process is described briefly as follows with the algorithm:

1. System load the rule, and creat Rete net.
2. User input fact, matching. if matching succeed, do connecting test.
3. If fit the test condition, save and go on next transmission.
4. If the transmission reached the rule node, let the rule ignite.

The Rete net has conflict set, record all of the activation rules, and let the inference machine that based on a specific confliction resolution strategy to choose one of them to ignite. When the new fact has built, then repeat the process of matching-conflicting, and inference steps come into being one by one.

We transform symbol knowledge into an integer form（knowledge code）in assembling period，turning the match of symbol into comparison between integers in the process of reasoning, which has high and real time reasoning speed, every reasoning step keeps within one percent seconds equally, thus have improved the efficiency of reasoning. Moreover, also extend the method to obtain fact by setting interrupt function in inference machine .When new fact trigger interrupt, if inference machine is in leisure status, then start into the run of “recognition-operation” step。So new fact can be responded in time, exterior environment also can affect the working process of inference machine, let it stay in an available status，so as to meet the request of open and real time system.

States are the illuminations of the whole system state inferred by inference machine according to the information base and rules base. The paper defines states like OK, PRE_ATTACK, ATTACKING, ATTACKED.

Ⅵ. The Implemention Of Rules Base

According to the research results of cnaphalocrosis medinalis guenee in recent years and based on the test information of pest test-station of plant prevention in HUNAN farm science academy, the paper described the inference by expert knowledge rules.

The rules are divided to occurrence trend prediction, occurrence amount prediction, occurrence time prediction and loss rate prediction. The occurrence trend prediction is divided to the whole process of occurrence trend prediction, occurrence trend prediction of cnaphalocrosis medinalis guenee in the metaphase of paddy growing and anaphase of paddy growing. The occurrence amount prediction is divided to spawn density and three ages grubs prediction. The occurrence time prediction is divided to the initial period of chrysalis, the fastigium period of chrysalis, the beginning of imago, the fastigium period of imago, the initial period of incubation, the fastigium period of incubation, the initial period of three ages grub, the fastigium period of three ages grub. The least and simplest rule table is as follows.

Table 2 predict principle of occurrence period

Condition of Occurrence period	Condition of temperature	Result
the initial period of chrysalis	Larger or equal than 25 ºC	initial period of imago after 10-13 days
the initial period of chrysalis	Less than 25ºC	initial period of imago after 13-16 days
the fastigium period of chrysalis	Larger or equal than 25 ºC	fastigium period of imago after 10-13 days
the fastigium period of chrysalis	Less than 25ºC	fastigium period of imago after 13-16 days
the initial period of imago	Larger or equal than 25 ºC	initial period of incubation after 6-7 days
the initial period of imago	Less than 25ºC	initial period of incubation after 7-8 days
the fastigium period of imago	Larger or equal than 25 ºC	fastigium period of incubation after 6-7 days
the fastigium period of imago	Less than 25ºC	fastigium period of incubation after 7-8 days

Ⅶ. Conclusion

The biology technology and information technology are the mainly basic technologies in modern agriculture. With the geography information used widely in recent years, there are multi-subject intercrossing each other to develop. Compared to the traditional decision system of agriculture, the expert system of ecology catastrophe prediction proposed in paper is a single module, which has many deficiencies. The expert system is built based on the paddy plant information of HUNAN province and the experience of some experts. Our next research will be regarded as whether the system suits other area or not. Meanwhile, if the granularity of rules is too rough, it will effects the exactness of system, else add the overhead of communication between human and computer. How to find the most suitable granularity is the emphasis of next research.

References

[1] M.M.Aref, M. A. Tayyib. Lana-match algorithm: a parallel version of the Rete-match algorithm. Parallel Computing, 1998,24 (7) :763～775

[2] H. V. Jagadish, A. O. Mendelzon, I. S. Mumik. Managing conflicts between rules. Journal of Computer and System Science,1999, 58 (1):13-28

[3] FORGY C , SHEPARD S . Rete : a fast match algorithm. AI Expert, 1987(1) :34-40.

[4] AREF M , TAYYIB M. Lana-Match algorithm : a parallel version of the Rete-Match Algorithm. Parallel Comput ,1998 ,24 (7) :763-775.

[5] JU Bao-ping. Bio-disaster forecasting: challenges and strategies. Journal of Nanjing Agricultural University Journal Of China Agricultural University,2001(4):41-45

[6] Fei Yu, Renfa Li, Miaoliang Zhu, et al. An Intrusion Detection System Based on FRete Net Algorithm. Proceedings of the World Congress on Intelligent Control and Automation, IEEE ,2004:4362-4366

[7] Zhou Li-Yang,Zhang Xiao-Xi. Prediction Expert System of Rice Leaf Roller in Jianghuai Rice Region. Journal Of Nanjing Agricultural University Journal Of China Agricultural University,.1996,19(3):44-50

[8] Wang Si-Shui,Zhang Xiao-Xi. Long-time Prediction of Rice Leaf Roller based on Neural Network. Journal Of Plant Protect. 2000,27(4).-313-316

[9] Wang Si-Shui,Zhang Xiao-Xi. Predictive Warning System of Neural Network for Occurrence Level of Rice Leaf Roller (Cnaphalocrocis medinalis Guenée). Journal of Biomathematics,2003.18(1):93-97

[10] Huang Bao-Hong, Xia Ming-Hai. Prediction of Rice Leaf Roller in feng-yang county Rice Region. Anhui Agricultural Sciences,1997(2):151-152

Dai Xiaopeng is an Assistant Professor and is a Ph.D. candidate in the Institute of Computer & Information Engineering at Hunan Agricultural Unviersity,Changsha,China.His research interests are information security, intelligent agriculture and crop information science.

Yu Fei is a member of IEEE and is a Ph.D. candidate in the Institute of Artificial Intelligence at Zhejiang University, Hangzhou, China. He will be joining Hunan Agricultural University as an Assistant Professor in School of Computer &Information Engineering in August 2006. His research interests are Network Security and Intelligent agriculture.

Huang Huang is a fellow professor in the Institute of Agronomy at Hunan Agriculture University, Changsha, China. His current research area is intelligent agriculture, data mining and ecology.

An Jiyao is an Assistant Professor in the Institute of Computer and Communication at Hunan University, Changsha, China. His research interests are computer network security, information security and data programming

Zhu Miaoliang is a senior member of IEEE and a fellow professor in the Institute of Artificial Intelligence at Zhejiang University, Hangzhou, China. His current research area is computer vision and Artificial Intelligent.