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Internet CAD System for Agricultural Machinery
—— CAD Program Applied to Rotary Blade Design

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Abstract

Japanese agricultural machinery for paddy rice field could be useful in Asian paddy agriculture. Especially, research and design for the agricultural machinery through agricultural mechanization after the world war II in Japan, are very important technology for Asian countries that intend to industrialize and to increase their agricultural products.

The Internet CAD (Computer Aided Design) system, which is proposed in this paper, will open and serve the technology of design for agricultural machinery and how to mechanized through the interactive communication on the Internet. In this research, an CAD program applied to rotary blade which is the rotary tillage equipment and widely used in the paddy rice field in Asia was constructed as an Internet CAD system. The system may contribute to mechanization of Asian countries with diffusing for infrastructure of the computer network.

Keyword: agricultural machinery, Asia, CAD, expert system. Internet, rotary blade, rotary tillage

Introduction

As economy grows, agricultural mechanization and its diffusion in developing countries lead to a decrease in the farming population and therefore an increase in the manufacturing population. Today, some developed countries help mechanization for developing countries. In Japan, as example, Tsukuba International Center of JICA plays a part of farm mechanization (Noguchi 1997). From the viewpoint of present situation of the developing countries in Asia, research and development for the first stage of the agricultural mechanization in Japan could be valuable for these developing countries. Mechanization must be carried out after considering the background of industrialization level and agricultural situation in own country.

In Japan, at present, farming is highly mechanized with diffusing the riding type machinery such as a tractor, rice transplanter, combine harvester, and so on. And the aim of some Japanese researches for agricultural machinery are studying more advanced machine to solve for labor shortage affected by decreasing farmer population or making easy operation for old farmers. On the other hand, the information of technology which has brought the successful mechanization in Japan and is indispensable to developing countries for mechanization, will be fading in the future.

Because the characteristics of agriculture is closely related to its climate, agricultural mechanization in Japan is deeply concerned to characteristics of paddy rice field. Agricultural mechanization and information technology in Japan is now ahead of the other Asian countries. Then, many information for agricultural mechanization in Japan after the world war II on machinery design should be arranged easy to use and systematically by using application software in order to dispatch the practical information to the all over the world based on the concept of globalization of agricultural engineering (Stout 1997). Therefore, after reconsidering the role of agricultural machinery, developing countries should assimilate the developed countries' proposal for the adjustable mechanization with considering environment and historical event by developing countries' effort to meet with success of mechanization

To solve these problems, the Internet CAD system was proposed in this paper as an application program operating on the WWW for hastening and optimizing agricultural mechanization for developing countries. Now, Internet is a keyword for new human activities. And the diffusion rate of it is growing very speedy. Taking the advantage of the Internet which has almost no strict regulations to use, several new technologies have been opened to us. In this paper, the structure of the Internet CAD system, and the rotary blade design as an application of CAD program were discussed.

Internet CAD System

Concept and Structure

The Internet CAD system (Fig. 1) makes agricultural design technology into electronic and systematic information via the Internet. Basically, concept of the Internet CAD system is similar to concept of the Expert CAD system (Chen 1991). The Internet CAD system is composed two main components that are CAD program and database working on TCP/IP protocol. Then user can

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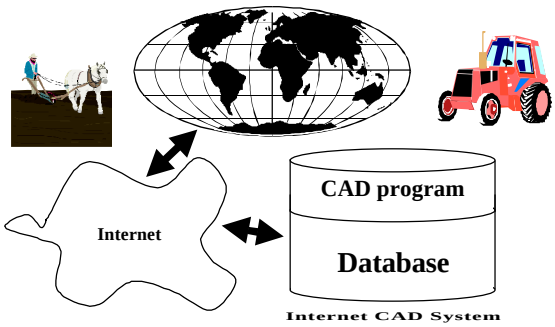

Fig.1 Concept of the Internet CAD system

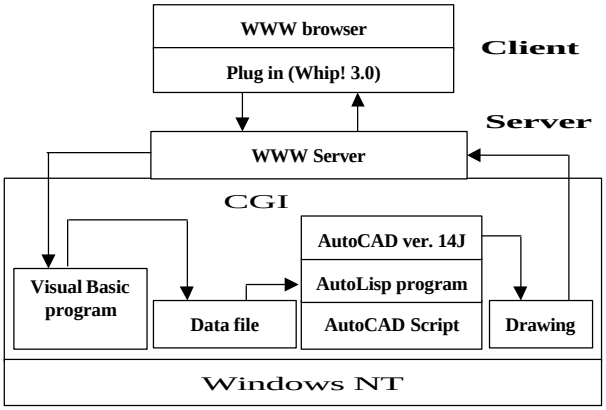

Fig.2 CAD program of the Internet CAD system

easily access to it by using WWW browser via the Internet. The Internet CAD system is open for the Internet user, especially agricultural machinery designer. One of the purpose of the system, the drawing calculation theory for drawing will be combined with the system by using the CAD program. Furthermore, the database of the system includes concept, know-how, method of calculation, and many drawings. The system should provide interactive communication of design data between the system and its user as designer by using the inference engine. Many aspect of machinery design condition which is changed according to the machine types or mechanization area can be discussed in the designing stage. So, the system will be able to make flexible in design for many condition and cases of mechanization. Adding the Internet in the system to some communication method should simplify a technology education.

CAD Program Applied for Rotary Blade Design

The structure of the CAD program of the Internet CAD system is as shown in Fig. 2. The CAD program is basically working by CAD software, AutoCAD* (http://www. autodesk.com/), on WindowsNT** operating system. Designer as a client of the system can access to the system by using WWW browser via the Internet. Server computer executes the following operation by CGI(Akimoto, 1997).

Table 1 Input parameters for rotary blade design on the CAD program(Hai 1989)

	Item	Symbol	Default Value
Holder portion	The distance between center of rotary shaft and a center of hole at blade-holder portion	E	45-50 mm
	The distance between center of hole at blade-holder portion and it's tip	F	20 mm
	The distance between center of hole at blade-holder portion to the bottom of holder	G	20 mm
	Allowable dimension for the possible insertion of blade-holder portion to the holder	BI	0-5 mm
	Width of blade-holder portion	A	25 $\pm$0.5mm
	Thickness of blade-holder portion	B	8-9 mm
	Diameter of hole at blade-holder portion	D	10.5 mm
	Radius for bending of blade-neck portion (inside radius)	Rs	40 mm
	Outside radius for bending of blade-neck portion	Rl	80 mm
Blade tip	Forward speed of operation machine	V	0.30-0.70 m/s
	Revolution speed of rotary shaft	N	150-400 rpm
	Maximum tillage depth	H_{max}	120 mm
	Maximum throwing distance of tilled clod-soil (R=250 then L_{max} =400mm)	L_{max}	400 mm
	Gravitation	g	9.81 m/sec
	Scoop angle	BD	80°
	Angle between the top and bottom of blade tip portion	KU	13°
	Radius for a bending blade portion	R10	30-50 mm
	Angle for a bending blade tip portion	GA	110-120°
	Distance between holder of rotary shaft	CH	45-50$\pm$0.5mm
	Thickness at a top of blade tip portion	t2	4-5 mm
Edge-curve	Edge-curve angle at the neck portion of blade	AN	65°
	Edge-curve angle at the top of lengthwise blade portion	AK	57.5°
	Edge-curve angle at blade tip portion	AT	4°
Life and beauty	High of a knife curve	LT	9-10 mm
	Dimension of bottom of knife curve	RB	1 mm
	Distance between a top of blade-tip and next holder	GH	5 mm
	Ratio of blade area for the determination of back edge curve	SI	1
	Angle for the cutting part of top of blade-tip portion	BC	1
	Maximum radius of revolution of blade	R	250 mm

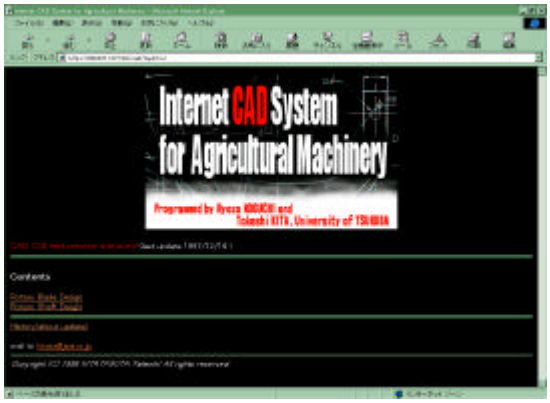

Fig.3 First screen of Internet CAD system

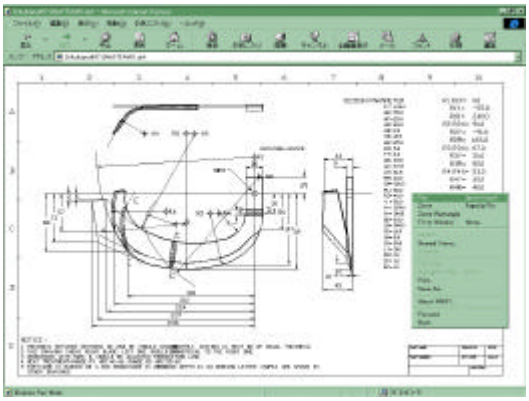

Fig.4 Rotary blade drawing on CAD program

Firstly, after WWW server accepting the design data from client and pass the data to executing program programmed by Visual Basic**, the program saves the calculated design data as text files. Secondly, AutoCAD script executes AutoCAD, and automatically makes drawing after reading text file data by AutoLisp* program. Finally, the drawing changes to the browsing type drawing on the WWW by using AutoCAD command, and client can get the drawing on the WWW browser by using Whip!3.0* plug in software.

Rotary blade which is widely used as tillage equipment in paddy field in Asia is designed according to specification of the tractor design, tillage condition, and Japanese Industrial Standard (JIS)(Hai, 1989) as shown in Table1. Because the shape of the rotary blade is widely changed by the design parameter, it is easier to design by the CAD program than by selecting from the database. Designer can get the rotary blade drawing on the WWW, after inputting the design parameters on the input screen on the WWW and calculating the optimum design parameter by Visual Basic program. Furthermore, adding the experimental data such as like a torque curve occurred on the rotary blade should make the database of the system more practical information database to make optimum design. Actually, if program source of Visual Basic and design theory for background of programming are opened, client can recognize the CAD program deeply.

*AutoCAD, AutoLisp, and Whip!3.0 are registered trademarks of Autodesk Ltd..
**WindowsNT and Visual Basic are registered trademarks of Microsoft Corporation.

Result and Discussion

The CAD program applied for rotary blade design may be used wide variety of design theory and problems. So far, there were some CAD programs for rotary blade(Hai, 1989), but operation of these programs was so dependent upon operating system or hardware that the programs have not been sufficiently opened and used. The CAD program makes not only automatically operation for calculation based on the design theory and drawing output, but also mutual communication on the WWW screen via the Internet. Then evaluation for contents and programs will be observed without dependence of operating system or hardware by clients as a designer.

Construction of the database in the Internet CAD system will be important matter for further discussion. And, design database and knowledge database should be needed to make high usability for the system. The Internet CAD system is able to serve the chance of communication to the designer. By accumulating information, the system will be one solution method for mechanization problems on the world.

To develop agricultural machinery, which is suitable to the specific area, many problems on field, agricultural products, and social environment must be solved. Therefore, the agricultural machinery for developing countries should have the diversity design. Then the Internet CAD system that offers data accumulation and searching by easy operation and mutual communication of design will be valuable system to diffuse agricultural machinery in developing countries. However, we must consider firstly putting the infrastructure of the communication with computer network in good order to make a successful Internet CAD system The growing of diffusion rate of the Internet user in the developed countries (see appendix) will be spread to developing countries in the near future. Anyway, the success of the Internet CAD system demands accumulation of many systematic information and the construction of effective utilization system with a user friendly interface.

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Appendix-Table 1 Number of host computer with domain name for the Internet in USA, Canada and the world (the beginning of 1997)

Number	World	USA + Canada (com, net, edu, mil, gov, org, us, ca)
Host Computer	16.15 million	10.70 million
Internet user	16.15 million × p	50.60 million

(http://www.dtinet.or.jp/~hagi/universe.html#anchor508277)

Appendix-Table 2 Two-letter domains host in the world (the beginning of 1997)

Number	Country
> 120,000	UK, Japan, Germany, Canada, USA-dom, Australia, Finland, Netherlands, France, Sweden, Norway, Italy, Switzerland,
50,000 – 110,000	Spain, Denmark, South Africa, New Zealand, Brazil, Korea, Belgium, Poland, Israel, Russian Fed. (RU)
20,000 – 50,000	Singapore, Hong Kong, Czech, Taiwan, Hungary, Mexico, Ireland, Portugal, Malaysia, China
9,000 – 20,000	Russia, Greece, Chile, Slovenia, Turkey, Argentina, Iceland, Indonesia, Thailand, Estonia
3,500 – 9,000	Colombia, Slovakia, Romania, Ukraine, Peru, Croatia, Bulgaria, Philippines, Luxembourg
900 – 3,500	Costa Rica, India, Kuwait, Venezuela, Dominican Republic, Uruguay, United Arab Emirates, Lithuania, Egypt, Cyprus, Bermuda, Bahrain,
300 – 900	Kazakhstan, Panama, Ecuador, Nicaragua, Pakistan, Morocco, San Marino, Bolivia, Honduras, Sri Lanka, Iran

(http://www.genmagic.com/Internet/Trends/)

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Appendix—Diffusion Rate of the Internet

Number of the Internet user is estimated by the number of domain name（http://www. dtinet.or.jp/）. Number of host computer that has a domain name is about 16.15 million as shown in Table 1.

If six persons (p) connect to one host computer with domain name, then about 100 million Internet users exist in the world. However, the Internet users don't have to connect to the host computer with domain name located in his country to enter the Internet. Therefore, the number of the Internet user must be estimated after due consideration of the case of connecting to overseas host computer by telephone line and so forth. On the other hand, difference of diffusion rate of the Internet connecting between developed countries and developing countries are large even now from the viewpoint of the number of two letter domains (Table 2).