

Development Of Ultrasonic Testing Based On Delphi Program As A Learning Media In The Welding Material Study Of Detection And Welding Disables In The Environment Of Vocational Education

Bagus Dwi Cahyono*, Chandra Ainur

Graduate Program, Universitas Negeri Surabaya

*baguscahyono16070895013@mhs.unesa.ac.id

Abstract: The development of science and technology has a direct impact on the preparation of qualified workers, including the preparation of vocational high school graduates. Law Number 20 the Year 2003 on National Education System explains that the purpose of vocational education is to prepare learners to be ready to work in certain fields. One of the learning materials in Vocational High School is welding and detecting welding defects. Introduction of welding and detecting welding defects, one way that can be done is by ultrasonic testing will be very difficult if only capitalize the book only. Therefore this study aims to adopt ultrasonic testing in a computer system. This system is called Delphi Program-based Ultrasonic Testing Expert System. This system is used to determine the classification and type of welding defects of the welded defect indicator knew. In addition to the system, there is a brief explanation of the notion of ultrasonic testing, calibration procedures and inspection procedures ultrasonic testing. In this system, ultrasonic input data testing that shows defects entered into the computer manually. This system is built using Delphi 7 software and Into Set Up Compiler as an installer. The method used in this research is Research and Development (R & D), with the following stages: (1) preliminary research; (2) manufacture of software design; (3) materials collection; (4) early product development; (5) validation of instructional media experts; (6) product analysis and revision; (8) media trials in learning; And (9) result of end product of instructional media. The result of the research shows that: (1) the result of feasibility test according to ultrasonic material testing expert that the system is feasible to be used as instructional media in welding material subject and welding defect detection in vocational education environment, because it contains an explanation about detection method of welding defect using method Ultrasonic testing in detail; (2) feasibility test results according to media experts, that this system has a very attractive visual, user friendly, compatible with windows and Linux and media size that is not too large; And (3) result of test by using data of indication of welding defect in PT PAL Surabaya, obtained classification data of welding defect in accordance with calculation of welding defect classification.

Keywords: Expert System, Ultrasonic Testing, Classification of Welded Disability, Delphi

1. Introduction

Currently, the development of science and technology has grown very rapidly. The rapid development of science and technology requires the preparation of qualified workers, including the preparation of vocational school graduates. Based on Law Number 20 the Year 2003 regarding National Education System explains that the purpose of vocational education is to prepare learners to be ready to work in certain fields. One of the learning materials in Vocational High School is welding and detecting welding defects. Introduction of welding and detecting welding defects, one way that can be done is by ultrasonic testing will be very difficult if only capitalize the book only. Because learning just by using a book will be bored and difficult to understand. Therefore this study aims to adopt ultrasonic testing in a computer system. This system is called Delphi Program-based Ultrasonic Testing Expert System. This system is used to determine the classification and type of welding defects of the welded



defect indicator knew. In addition to the system, there is a brief explanation of the notion of ultrasonic testing, calibration procedures and inspection procedures ultrasonic testing. In this system, ultrasonic input data testing that shows defects entered into the computer manually. This system is built using Delphi 7 software and Inno Set Up Compiler as the installer. To limit this research to more focus on the formulation of the problem, several restrictions are required as follows:

1. Experts system is only used for the evaluation of the ultrasonic testing of welded specimens (carbon steel and iron ingots);
2. The process of entering data into the ultrasonic flaw testing computer is done manually;
3. Ultrasonic techniques and standard procedures in accordance with the standards of ASME Sec. V Non-Destructive Examination;
4. Criteria for acceptance of defect types by standard AWS D1.1 in Cyclically loaded no tubular connection and Statically loaded no tubular connection;
5. The calibration procedure used in accordance with the calibration procedure UT Flaw Detector with brand SIUI CTS-9005;
6. Provide appropriate solutions of the type of defects found, and efforts to overcome the defect appears.

1.1. Expert System

Expert systems are a computer-based application that is used to resolve problems in accordance with the thinking of experts. Experts are people who have special expertise that can solve problems that can not be solved by people in general⁶.

The architecture of a typical expert system is shown in Figure 1¹⁰.

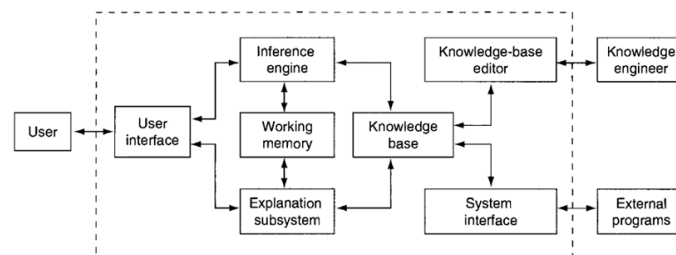


Figure 1. Architecture of Expert System

2. Method of Reasoning

The reasoning is also called inference method is the process to generate information from the facts that are known or assumed. In general, there are two methods of reasoning, trace-forward (forward chaining and backward chaining)¹⁰.

Forward Chaining begins by placing the initial data in the form of symptoms as a premise in working memory. In the working memory, inference engine to match the initial data with the facts contained in the knowledge base, choose one rule and determine a conclusion.

2.1. Ultrasonic

The basic principle of this test is to transmit ultrasonic waves into the material being examined. The ultrasonic wave will propagate into the material and will be reflected when the direction of propagation found an air cavity. The reflected wave will be welcomed back by the probe (transducer) in the form of a pulse on the CRT screen which is a pulse or pulses disabled Backwall².

3. Experimental details

The method used in this research is Research and Development (R & D), with the following stages: (1) preliminary research; (2) manufacture of software design; (3) materials collection; (4) early product

development; (5) validation of instructional media experts; (6) product analysis and revision; (8) media trials in learning; And (9) result of end product of instructional media.

3.1. Input Requirement

There are two kinds of input requirements. The first material data form of materials, welding technique and material dimensions (thick material). The second data indicative of a form of ultrasonic defect, the location indication defect, a flaw in the screen display pulse UT flaw detector, the zero reference level, the level indication, sound path value, value and visual indication rating disabilities.

3.2. Process Requirement

3.2.1. Inference engines

To the needs of the input data as output data as input into output using the technique of reasoning trace Forward (Forward Chaining), the input is processed through three stages:

Phase I Design Creating a Program Flowchart In making the flowchart authors limit the materials to be used as a display as well as information that can be accepted by users. At the design, stage is also the input (data ultrasonic material and data) and output (the presence and type of weld defects, material acceptance, the solution to the existing defects) were collected and grouped according to the criteria. Phase II Development the criteria that have been grouped, made into a database which is then processed into a program. Phase III Testing At the last stage is a program that will process the input is matched to the output according to the criteria.

3.2.2. Output Requirement

To the requirement of output data showing the conclusion of the classification and type of defects in the welds are obtained, the cause of the disability and appropriate solutions. These conclusions were obtained through the execution of the program by entering the inputs that have been stored in the database.

3.3. Requirement of Software and Hardware

The software used in developing an expert system program is the Embarcadero Delphi 7 AlphaLite its components and software Inno compiler set up. The hardware needs to follow the requirements of the software.

3.4. Formulation Knowledge Base and Inference Machines

Material Data and Ultrasonic Data are grouped, arranged into a decision table and decision trees.

3.5. The design of the Main Window Interface

The design of the main window interface including: interface design of database page, interface design of evaluation defect classification page, interface design of evaluation defect classification page, and the design of the interface type of disability evaluation page

4. Program Algorithm

Algorithm program classification expert system for evaluation of weld defects and defect type is shown in the following figure2.

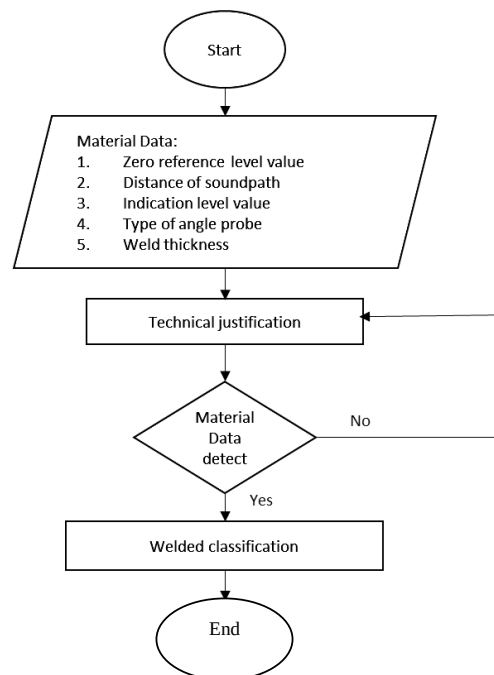


Figure 2. Flowchart of classification defect evaluation

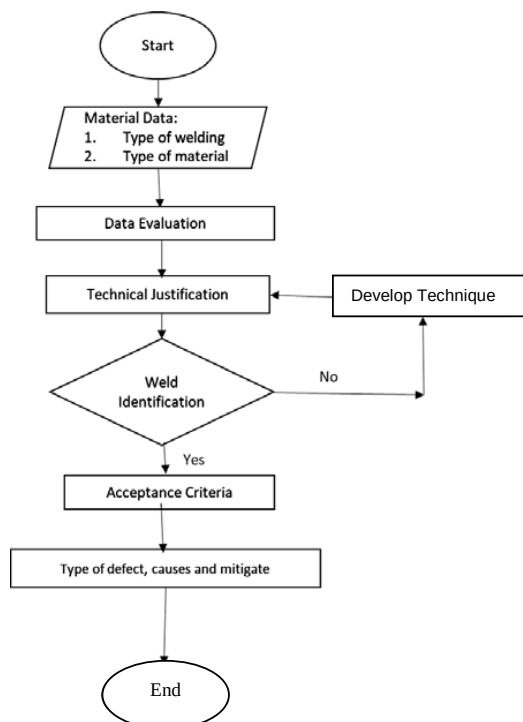


Figure 3. Flowchart of defect type evaluation

5. Results And Discussion

5.1. Implementation Program

Implementation is the stage where the program is ready to operate on a real stage, so it will be known whether the programme can actually produce the desired goal. This stage is done by running the program.

5.1.1. Testing of UT Basic Principles

In this test testing the form view of login in this form, the user is prompted to enter a username (User Name) and password to get into the expert system program detecting weld defects using ultrasonic methods with certain username and password.

After entering the username and password correctly then the user will go to the home page of an expert system program. On the home page form when we press the menu there will be several sub-menus are:

1. Choice: Useful for the next program option to choose.
2. Basis Data Cacat: the page is useful to go into an explanation disabled
3. Exit: To exit from the program expert systems.

On the basic principles UT group box, there are two buttons that are the database that serves to get to the database. A page where users can retrieve data associated with the UT in the form of a word (format. RTF). The data is already available in the Database folder, which folder should be placed in My Documents that can be opened directly. When the user presses the Open a File button, the user will go to the My Documents, then we select the Database folder and then the user must select the folder description of the UT is cool. As at this time the author took the test database on the basic principles of UT.

On this page there are several buttons which are:

1. Open: allows you to open a database in the form of a word (format. RTF).
2. Save: allows you to save the database in the form of a word (format. RTF) if there is a change.
3. Edit Font: allow you to edit the font size and type of letters used.
4. Pages setting: begun used to set the page before printing.
5. Printer setting: allows you to choose a printer that is used.
6. Print: allows you to print (print) database.

To return to the home page then the user must press the Return to Menu Submenu. As for the exit of the program, the user must press the Exit submenu on the Menu. To get help with this program the user must press the Help menu. At the main page the user selects the Start button on the Basic Principles UT group box then the user will go to the options page explanation of the UT. At the time, the selected menu shows the submenu option and the Return to Menu. Submenu option serves to select a group of UT explanation that users want. These options are About UT, Device UT and Couplant, Calibration Device, and Discontinuity. Furthermore, the user can just choose which one ultrasonic explanation required by him by pressing the related explanation.

At the time the user selects the option of Basic Principal Ultrasonic on the dialog box about UT, it will be displayed page explanation of the basic principles of ultrasonic. On this page, there are buttons to go up to a further explanation. And there is a menu that contains submenu Return to return to the options and sub-menu Return to Menu to return to the homepage. On this page, there is also an example of the calculations used to calculate the wave of thick material based on the formula contained in the explanation.

The next time the user will perform ultrasonic inspections in the field, need to perform calibration of UT equipment. In this program, there has been a description of the calibration procedure UT

equipment Sec.V. ASME standards Where the calibration procedure is divided into 2 kinds of probe normal calibration procedures and calibration of the probe angle. Apart from these two calibrations prior to the inspection of the calibration procedure needs to be done DAC (Distance Amplitude Correction), so that when the implementation of the inspection data obtained sound path proper distance. Normal probe calibration using the normal probe and reference blocks V1. While the calibration of the probe angle is divided into four steps:

1. Examination of the index point
2. Examination angle
3. Calibration mileage
4. Angle probe calibration using reference blocks V2

After performing the calibration procedure the user can perform an ultrasonic inspection. Ultrasonic inspection procedures contained in this expert system is based on the implementation of ultrasonic inspection procedures made by PT Multi Spec Sinergindo used in the implementation of UT inspection by PT PAL Indonesia.

5.1.2. Testing of the Weld Defect Evaluation

Testing of the weld defect evaluation is divided into two, namely the evaluation of the weld defect classification to determine whether these defects can be accepted or rejected. the second evaluation is the weld defect types.

In the test below is a test to determine the classification of weld defects:

In the testing of the weld defect classification is the user entering the data material, data and data of ultrasonic flaw indications are:

1. Material data:

The data included material is thick welds (mm)

2. Indicative of defects data:

Data included indications of defects is the indication level, zero level reference, distance sound path

3. Ultrasonic data:

Data is entered ultrasonic probe angle used during the implementation of inspection.

By entering the zero reference level, the level and range indication will be obtained sound path attenuation value and indication rating. The results obtained using the formula.

$$c = ((sp/25) - 1) \times 2$$

$$d = a - b - c$$

With :

d = Indication rating, a = Indication level, b = Zero reference level, c = Attenuation factor, sp= Sound path distance

The rating indication should be round to the nearest number.

After knowing the value of the indication rating by looking at Table 1 for statically Loaded Non-Tubular Connection and Table 2 for Cyclically Loaded Non tubular Connection, it will be known to the classification of weld defects. Classification will be known whether the defective weld is accepted or rejected. To test this UT inspection test data used in PT PAL when I do the Job Training (KP) in PT PAL.

Oyong Extension Platform Inspection

Date: July 27th, 2011

Criteria : AWS D 1.1

Drawing No.: 9810-90-02-201

Material Type: Carbon Steel (CS)

Place: Plat Construction workshop II (Oyong Project)

Surface Condition: smooth

Surface preparation: As-Welded

Flaw Detector: SIUI CTS-9005

Calibration Block: IIW Block V1, V2

DB Reff (b) : 81,5

Couplant : CMC + Air

Probe : CB MWS 700 4MHz 8x9

Test results on the platform on July 27th, 2011 as shown at Table 1.

Table 1. Data Observations On Platform 1

No	JOINT NO	T (mm)	L (mm)	Acceptance Criteria			Sound Path (mm)	Length of discontinuity (mm)	Depth (mm)	Result	Error Type
				Indication Level(a)	Attenuation factor (c)	Indication Rating (d)					
1	J.100	8+10	190	87.5	0	6	23	15	5-7	Acc	-
2	J.122	8	150	82.5	0	-1	20	120	5-7	Rep	PJ
3	J.128	8	120	82.5	0	-1	20	120	5-7	Rep	PJ
4	J.129	8	120	82.5	0	-1	20	120	5-7	Rep	PJ
5	J.130	8+20	120	82.5	0	-1	20	130	5-7	Rep	PJ
6	J.130A	8+20	120	80.5	0	-1	20	130	5-7	Rep	PJ

After knowing the data is the data is entered into the expert system program to determine the indication rating and classification of weld defects. By entering the data obtained from ultrasonic inspection into the defect classification evaluation form, the obtained results of the comparison between the indication rating is calculated using a formula and a calculation program as in the table below.

A.1 Date: July 27th,2011

Criteria: AWS D 1.1

Drawing No. : 9810-90-02-201

Material Type: Carbon Steel (CS)

Place: Plat Construction workshop II (Oyong Project)

DB Reff (b) : 81,5

Probe: probe: CB MWS 700 4MHz 8x9

Differences in the indication rating are calculated using formulas and programs as in Table 2.

Table 2. Difference indication rating value from formula and program

No	JOINT NO	T (mm)	Acceptance Criteria					Error presentation (mm)	Length of discontinuity (mm)	Depth (mm)	Classification	Result	Error Type
			Indication Level(a)	Attenuation factor (c)	Sound Path (mm)	Indication Rating (formula)	Indication Rating (Program)						
1	J.100	8+10	87.5	0	23	6	6	0	15	5-7	B	Acc	-
2	J.122	8	80.5	0	20	-1	-1	0	120	5-7	A	Rep	PJ
3	J.128	8	80.5	0	20	-1	-1	0	120	5-7	A	Rep	PJ
4	J.129	8	80.5	0	20	-1	-1	0	120	6-7	A	Rep	PJ
5	J.130	8+10	80.5	0	20	-1	-1	0	130	5-7	A	Rep	PJ
6	J.130 A	8+10	50.5	0	20	-1	-1	0	130	5-7	A	Rep	PJ

From table 2 can be known differences in the indication rating formulas and calculations in the program did not experience the difference (error percentage = 0%). Thus it can be said to be an expert system program has been successful in calculating the value of the rating and classification indication correctly. By knowing the value indication, it will be known classification rating. So that the classification will be known whether these defects can be accepted (Acc) or rejected (Rep). UT inspection on the implementation of Table 2 is used to statically Loaded No tubular Connection. This is because of the welded joints on Platform Extension Oyong a static connection. This evaluation can only be known the classification of weld defects that would be useful to know the acceptance of weld defects. As for knowing the type of welded defects then the user can go into the form of defects that

contain the question dialog box. The question dialog box contains questions relating to the indication of welded defects that users must answer for welded defects. After knowing the type of welded defects then the user can know the explanation about the type of defect in the form explanation type welded defects. In this form, we find it difficult to obtain data related to indication of welded defects that can be identified using ultrasonic methods. Because during this ultrasonic inspection is only used to determine the depth of defects and classification in the determination of acceptance of welded defects. So the question in this dialog box only contains the indication data of welded defects that can be identified using ultrasonic method in the form of ultrasonic display, the effect of changing the position of the transducer to the height of amplitude and visual appearance.

5.2. Validation

From Media Expert: according to experts in the Expert system using Delphi said it expects the results of testing on Friday the 13th July 2012 This system has a very attractive visual, user friendly, compatible with windows and linux and media size is small. But, the database type weld defects remains to be stored in My Documents that can be opened by an expert system that will be a little troublesome users.

From Material Expert of Ultrasonic: According to experts in the field of NDT said it expects the results of testing on Friday the 13th July 2012, an expert system for evaluation of weld defects using ultrasonic method to function properly. The existence of defect classification evaluation can help to determine the classification of weld defects acceptance. In addition, this expert system contains an explanation of its procedures and calibration of ultrasonic inspection ultrasonic. With it will be helpful for the implementation of inspections in the field. But, this expert system database contains twenty-eight types of disabilities and limited to the welding area, so the expert system cannot be used to identify and evaluate other defects in the weld which is a representation of material outside the weld area.

6. Conclusions

The result of the research shows that: (1) the result of feasibility test according to ultrasonic material testing expert that the system is feasible to be used as instructional media in welding material subject and welding defect detection in vocational education environment, because it contains an explanation about detection method of welding defect using method Ultrasonic testing in detail; (2) feasibility test results according to media experts, that this system has a very attractive visual, user friendly, compatible with windows and linux and media size that is not too large; And (3) result of test by using data of indication of welding defect in PT PAL Surabaya, obtained classification data of welding defect in accordance with calculation of welding defect classification.

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