

Automatic Distance and Angle Measurement Tool using Atmega8535 Microcontroller based Ultrasonic Sensor for Conventional X-Ray Medical Device

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ABSTRACT

The aim of this research is to design an ultrasonic distance and angel detecting device by utilizes time delay of wave reflected. The ultrasonic echo waves were then converted into electrical echo pulses. This distance and angle detecting device can later be used on conventional X-ray modality. This distance and angle detecting device was designed based on ultrasonic sensor and an Atmega8535 microcontroller. Distance measurements was carried out vertically and horizontally with variations ranging from 90 cm to 130 cm with a 10 cm increment factor. While angle measurements were performed manually at angle variations of 10 ° to 30 ° with an increment factor of 5 °. The performance of the tool showed that the relative error value on vertical measurement was 0.10% with the greatest accuracy of 99.97%. While the horizontal measurement relative error was 0.10% and the highest relative accuracy recorded at 99.97%. Meanwhile, on the angle measurement, it was found that the relative error was 0.39% with the highest relative accuracy of 99.72%.

Key words: Atmega8535, measuring instrument, ultrasonic sensor, X-Ray.

1. INTRODUCTION

Measurement is important in the world of science and in life, including measuring distance from one place to another, measuring time from one event to another, measuring temperature, the temperature of one area to another, measuring the angle from a point. to a specific object point [1]–[4]. In general, to measure the distance from one point to another, a ruler or meter can be used. Along with the times and increasingly sophisticated technology, to measure distances and angles from one point to another, ultrasonic waves can be used [5]–[8]. By utilizing the ultrasonic waves that are emitted and received, the distance and angle measurements can be read automatically.

2. CONVENTIONAL X-RAY PLANE

A conventional X-ray machine is one type of X-ray machine used for radiography. The meaning of conventional here, shows the type of aircraft in terms of movement, where this conventional aircraft movement is limited to stationary and can only be used in a room that has been specially designed for this X-ray aircraft, it is different with mobile X-ray aircraft which can be placed in carry or move from one place to another, but all types of X-ray equipment have advantages and disadvantages. In the world of radiology, there are many kinds of tools that are used to carry out an examination, one of which is a conventional X-ray machine [9], [10].

3. SHOOTING DISTANCE

In the radiographic technique, the distance between the tube and the film is divided into 3 parts, namely FOD, FFD, OFD as shown in Figure 1 [11], [12].

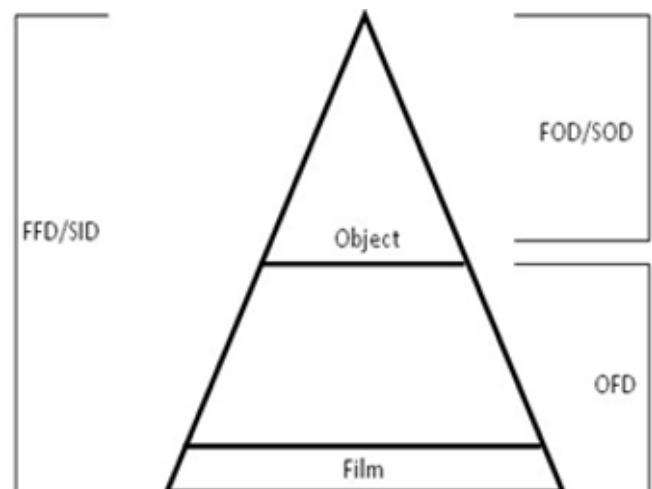


Figure 1: FDD, FOD, and OFD

Explanation of Figure 1 is below [13]–[16].

1. FFD (Film Focus Distance)/SID (Source Image Distance)
This term is given to the distance from the focus located on the window in the tube to the surface of the film.
2. FOD (Film Object Distance)/SOD (Source Object Distance)
This term is given to the distance from the focus that is on the window on the tube to the object point.
3. OFD (Object Film Distance)
This term is given to the distance from the object of interest to the surface of the film.

In addition to determining the distance when conducting an inspection, on the other hand, there is also an angle technique or determining the degree of inclination at the time of the inspection. This angle technique also plays an important role in radiology as a diagnostician. To determine the angle, there are several techniques, including being able to angle or position the patient directly according to the photo request in the form, it can also be by tilting the cassette by propping it with foam or the like so that the desired angle is formed, it can also be by angling the X-ray tube. by rotating the tube according to the desired angle. The following is an example of an examination technique using an angle which can be seen in Figure 2.

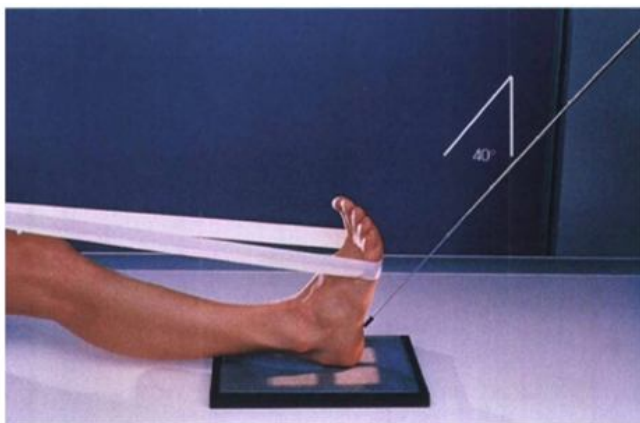


Figure 2: Cornering Technique

4. RESEARCH METHODOLOGY

The design of this research is a design to produce an automatic distance and angle measuring instrument with an ultrasonic sensor on a conventional X-ray aircraft. It is hoped that this examination tool will make it easier for the radiographer to carry out the examination. The assembly of tools was carried out in various places, namely at the Electronics Laboratory of the National University. The instrument testing will be carried out at the Radiology

Installation of Pondok Indah Hospital, Jakarta. Design of distance sensor on medical device shown at Figure 3.

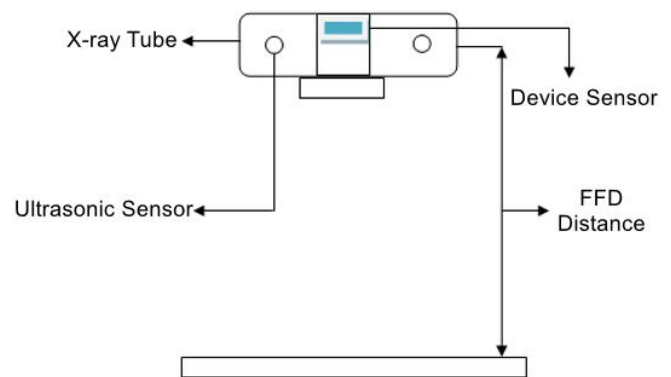


Figure 3: Proposed Device in Current Medical Device Design

Block Diagram Design

The following is a block diagram of a microcontroller-based distance measuring device consisting of an HC-SR04 sensor, a minimum circuit of an ATmega 8535 microcontroller, LCD (Liquid Crystal Display), keypad, LED, and buzzer. The block diagram design shown at Figure 4.

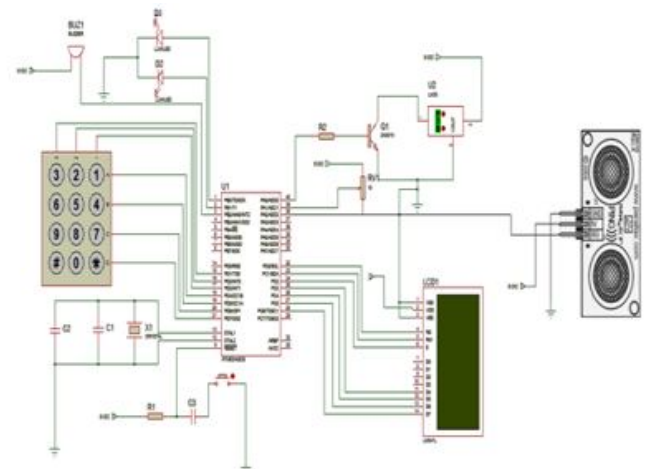


Figure 4: Design Schematic for Proposed Measuring Device

In general, according to Figure 4 above, the working principle of an automatic distance and angle measuring instrument using an ultrasonic sensor is initially an ultrasonic wave which is an ultrasonic signal with a frequency of approximately 40 kHz, which is sent from an ultrasonic transmitter, which is controlled by the ATmega8535 microcontroller. Then the ultrasonic signals sent (emitted) by this ultrasonic transmitter will go to the barrier or object, so that when the transfer of the ultrasonic sensor hits the barrier object, this ultrasonic wave will be reflected and received back by the receiver of the ultrasonic sensor for distance measurement, as well as also with the determination of the principle of the same angle with the measurement of distance. Once received and then processed in the microcontroller circuit then the results of the measurements will be used as

data to be displayed on the LCD and turn on the buzzer alarm indicator and LED lights. This circuit has an ultrasonic sensor consisting of a transmitter and a receiver placed on the X-ray tube, where to be able to reflect ultrasonic waves, the object of obstruction in this case is a cassette or bucky stand which is right in front of the X-ray tube. The research procedure as described above can be briefly described in Figure 5.

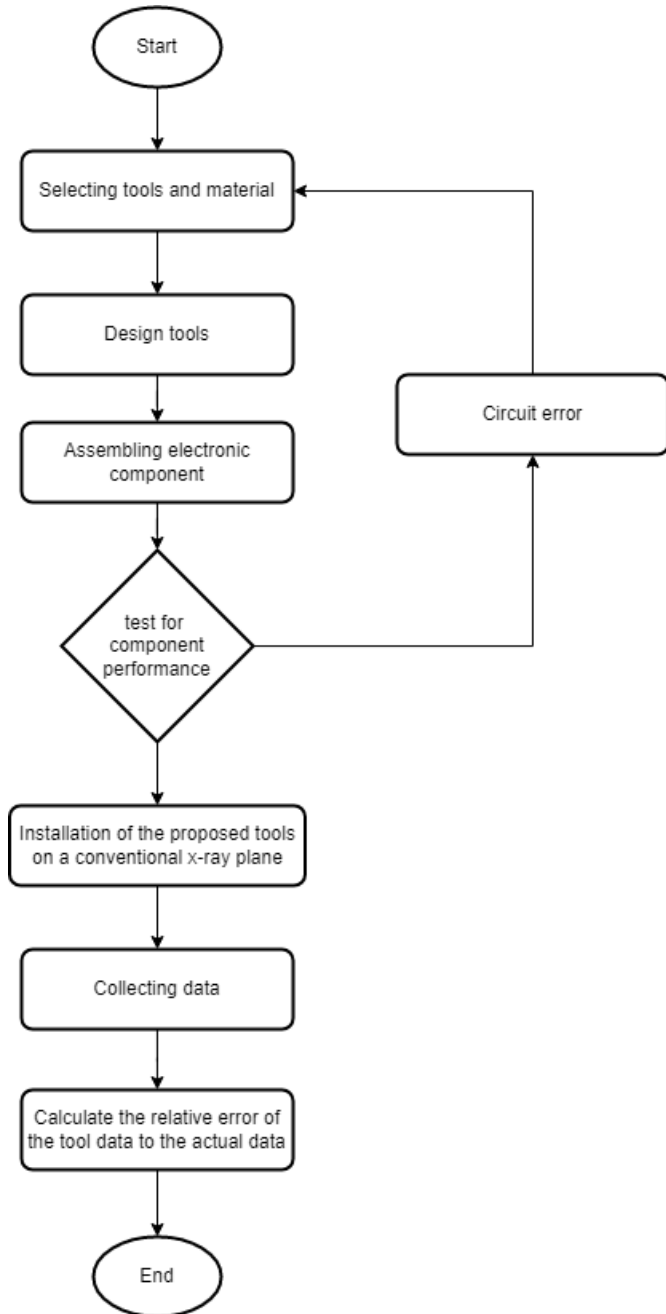


Figure 5: Research procedure flowchart

The following is a software on device workflow chart shown at Figure 6.

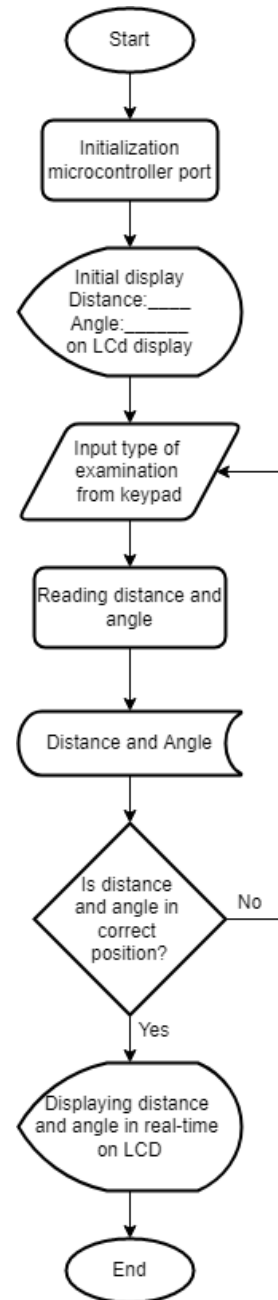


Figure 6: Software Flowchart of Proposed Device

5. RESULTS AND DISCUSSIONS

After carrying out the planning stage of making the instrument, collecting tools and materials that will be used to make an automatic distance and angle measuring instrument with an ultrasonic sensor, the tool can be seen in Figure 7. The function test of the tool will be carried out at the Radiology installation of Pondok Indah Hospital, Jakarta with actual distance data. For distance data collection, the author takes vertical and horizontal retrieval from a distance of 90 cm to 130 cm. This measurement is carried out sequentially with 10 cm increments for each measurement from 90 cm to

130 cm. For testing the automatic distance set as well as the LED, as well as the Buzzer, it is done by setting the automatic distance on the tool from 90 cm to 130 cm measurement with the addition of 10 cm for each test, while the angle data collection will be done manually.



Figure 7: Product of Proposed Device

This proximity and angle sensor device will be attached to the vicinity of the conventional X-ray tube. The following is a picture of the sensor device that has been attached to the X-ray machine, which can be seen in Figure 8.



Figure 8: Proposed Device Attached at Medical Device

Vertical Distance Measurement

The relative error in this distance measurement can be seen in Table 1.

Table 1: Results of Relative Error and Vertical Relative Accuracy

No.	Distance (cm)	Relative Error	Relative Accuracy
1	90	0.03%	99.97%
2	100	0.10%	99.90%
3	110	0.09%	99.91%
4	120	0.09%	99.91%
5	130	0.09%	99.91%

Horizontal Distance Measurement

The relative error in this distance measurement can be seen in Table 2.

Table 2: Results of Relative Error and Vertical Relative Accuracy

No.	Distance (cm)	Relative Error	Relative Accuracy
1	90	0.03%	99.97%
2	100	0.10%	99.90%
3	110	0.10%	99.90%
4	120	0.10%	99.90%
5	130	0.09%	99.91%

Angle Measurement

The relative error in manual angle measurement can be seen in Table 3.

Table 3: Results of Relative Error and Relative Accuracy of Angle

No.	Angle	Relative Error	Relative Accuracy
1	10°	0,39%	99,61%
2	15°	0,32%	99,68%

3	20°	0,33%	99,67%
4	25°	0,28%	99,72%
5	30°	0,39%	99,61%

Automatic Distance Set Test

Next test is testing with the distance set by pressing the number buttons listed on the tool. The data tested is from 90 cm to 130 cm with the addition of 10 cm each time the distance is set. After testing this distance set is in accordance with the distance set that has been pressed on the button, it can be seen in Table 4 below as follows.

Table 4: Results of Relative Error and Relative Accuracy of Angle

No	Distance (cm)	Buzzer	LED
1	90	on	on
2	100	on	on
3	110	on	on
4	120	on	on
5	130	on	on

Based on Table 1 we can see that the relative error value and relative accuracy obtained when the tool is installed vertically the largest relative error obtained is 0.10% with the best relative accuracy of 99.97% and in Table 2 when the tool is installed horizontally the largest relative error is 0.10% with the best relative accuracy is 99.97%. Meanwhile, the angle measurement based on Table 3 obtained the largest relative error of 0.39% with the highest relative accuracy of 99.72%.

6. CONCLUSION

From the research that has been done and seen from the processing results, it can be concluded, the relative error value and relative accuracy obtained when the tool is installed vertically the largest relative error is 0.10% with the largest relative accuracy 99.97% and when the tool is turned on pairs horizontally the relative error obtained is 0.10% with the greatest relative accuracy is 99.97%. Meanwhile, in the angle measurement, the largest relative error is 0.39% with the greatest relative accuracy of 99.72%.

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