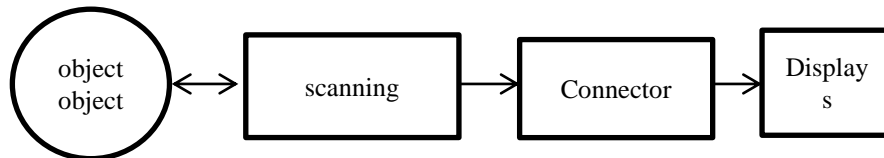


ultrasonic waves, can be converted into an image or image visualization display so that it can be analyzed.

2. RESEARCH METHOD

The outline of the system design is shown in Figure 3.1 below:



Objects in the form of objects will be retrieved data. The data is the reflection time of the ultrasonic waves to be converted into gray levels which are then displayed as images that can be seen on a computer monitor screen. The initial process in the block diagram is scanning. Data retrieval is done by scanning the objects. Scanning is the process of addressing a specific location on an object. The address determines the location of the pixels which will then be displayed on the computer. The second part of the process is programming. Programming is divided into two, namely programming on the microcontroller and programming for the visualization display so that the end result of the process, namely the image, can be displayed on a display, namely the computer monitor screen.

2.1 Hardware Design

The hardware used in this research is

- a. Ultrasonic transmitter and receiver.
- b. MC68HC908GP32 microcontroller.
- c. MC74HC595A.
- d. PPI 8255.
- e. One computer unit with a 333 MHz Pentium II processor equipped with Borland C++ Builder software version 4

2.2 Software Design

The operation of the hardware is very dependent on the software. There are two kinds of software used, namely WinIDE_GP32 with assembly programming language for microcontroller programming and Borland C++ Builder 4 with C programming language for activating PPI 8255 and displaying image visualization on a computer.

- a. MC68HC908GP32 Microcontroller Programming
MC68HC908GP32 microcontroller programming uses WinIDE_GP32 software with assembly programming language. The MC68HC908GP32 microcontroller is a tool that functions to manage the system and process data before it is sent to the computer. The functions of the microcontroller include activating and deactivating the ultrasonic transmitter, calculating the ultrasonic reflection time, activating the buzzer and sending the process results to the computer.
- b. C++ programming
The software used is Borland C++ Builder version 4. Programming is divided into two main parts. The first part is the PPI 8255 activation program in the ISA slot and the second part is the 2D image display program on the computer monitor screen.
- c. PPI 8255 programming
PPI 8255 programming is carried out as a process of initializing the connecting ports between the hardware and the computer. There are 3 main things that need to be considered, namely determining the port address, mode, and control word address. For the PPI 8255 module, four addresses are needed. In this design the addresses used are:

Port A = base address 280h = 1010000000

Port B = base address +1 281h = 1010000001

Port C = base address +2 282h = 1010000010

Control Word = base address +3 283h = 1010000011

The determination of the communication mode / protocol is chosen using mode 0 (simple protocol / basic input - output) because the hardware connection is only as input or output on each port.

d. Image Appearance Programming

The final stage of programming is the appearance of the image so that the image can be analyzed. Image display is made on a canvas measuring 10 x 10 pixels. Each pixel is 200 dots. The arrangement of the pixels.

3. RESULTS AND DISCUSSIONS

3.1 Transmitter Waveform

The waveform of the transmitter is a square wave. This is because the transmitter circuit uses the MCI 455 timer IC as a frequency generator. The waveform is shown in the figure:

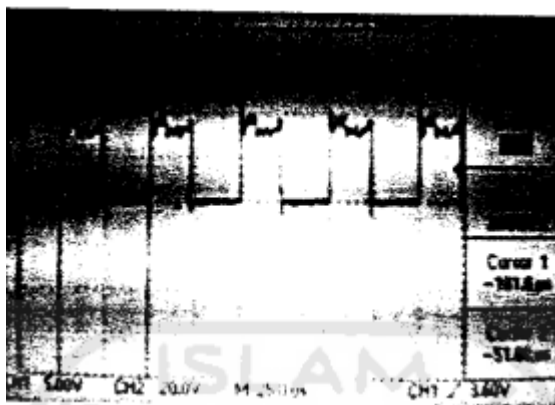


Figure 1. Display of an ultrasonic transmitter oscilloscope.

From the picture above, the resulting wave is a square wave with a frequency of 20 kHz and a period of 50 μ s. The peak-to-peak voltage (V_{pp}) is 11 V.

3.2 Receiving Waveform

In the ultrasonic receiver circuit, the receiving sensor will receive reflected ultrasonic waves to be converted into voltage. In this circuit the voltage is amplified. The resulting voltage is an AC wave with a frequency of 35.71 kHz. A rectifier is needed to convert the received AC voltage into DC voltage as the comparator input. The waveform is shown in figure 4.2. In this ultrasonic receiver the waves formed before being rectified are square waves with a frequency of 35.71 kHz and a period of 28 μ s. The peak-to-peak voltage (V_{pp}) for this waveform is 6.4 V

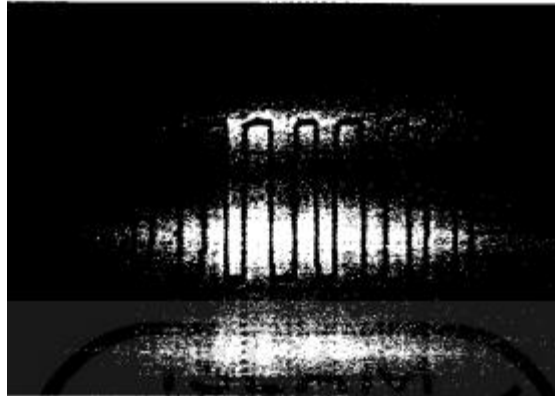


Figure 2. Ultrasonic receiver oscilloscope display.

3.3 comparator

The comparator used in this study is the LM 311 with an input voltage range of ± 15 V. The comparator is used to determine the value of the reference voltage for the comparison. The reference voltage must be below the maximum output voltage of the ultrasonic receiver circuit. The comparator will produce a high voltage when it gets a smaller voltage than the ultrasonic receiver circuit, and will produce a low voltage if the input voltage is higher than the reference voltage. This higher input voltage will give a signal to the microcontroller to stop the counter.

Table 1. Results of comparator voltage measurements.

Measurement Point	Transmitter Inactive	Active transmitter
Reference voltage	5.82V	5.82V
Comparator inputs	2.28V	5.76-5.88V
comparator output	4.94V	4.76-0.11V

3.4 Counter Time

Counter is a variable. The data sent to the computer is the value of the counter variable. (The counter represents a grayscale color from 0-255. The counter decreases according to the length of time it bounces. The decrease in value starts from 255 to 0. For each reduction of one counter value, there is a time that depends on the number of cycles in the program. Cycle is the time needed to each program instruction. The time for one cycle in program instructions depends on the value of the crystal used in the microcontroller. The crystal used in the microcontroller is 8 MHz. The unique calculation for getting one cycle time is as follows:

$$\begin{aligned} \text{Operating frequency!} &= \text{crystals} / 4 \\ &= 8 \text{ Mhz} / 4 \\ &= 2\text{MHz} \end{aligned}$$

$$\begin{aligned} \text{One cycle - } 1/ \text{ operating frequency} \\ &= 1/2\text{MHz} \\ &= 0.5\mu\text{s} \end{aligned}$$

The time required to reduce one counter is 2538 cycles. This value is obtained from the cycle calculation in the microcontroller program (appendix 1), starting from filling in the X (LDX) register with a value of 2 to reducing the Counter value (DEC Counter). So the time between counters.

3.5 Testing Reflected Waves

This test is carried out to find out at what distance the sensor begins to respond to objects in front of it. The test was carried out with one type of object, namely a toy candle with a block shape and a flat surface.

- a. Speed Based on Reflection Distance

This experiment was carried out with a toy candle barrier that has a flat surface area with a size of 9 x 6 cm and a variety of distances as shown in the picture

Table 2. Measurement results with wall reflecting media

Distance(cm)	Counter Value	Tool readable distance (cm)
<50	0	>33,595
48	1	322,326
46	3	319788
42	3	319,788
40	10	310,905
38	15	304.56
36	26	290,601
34	26	290,601
32	40	272835
30	43	269,028
28	46	265,221
26	50	260,145
24	52	257,607
22	55	253.8
20	55	235.8
18	60	249,993
16	62	247,455
14	63	244,917
12	80	243,648
10	84	222,075
8	70	16,999
6	68	234,765
4	40	237,303
2	60	272,835
0	5	247,455

From experiments conducted with several lengths of distance in cm, the fast reflection time is at a distance of 8 - 12 cm. At this distance, the reflected wave is received faster by the receiving sensor, which is around 216 — 234 ms. At a distance above 50 cm the receiving sensor is considered unable to receive the reflected wave. This is due to the limitation of the bounce time by the program, that is, after taking 323,595 ms, the bounce time is considered complete. If there is no time limit, the receiving sensor will be too sensitive and will always receive reflected waves.

3.6 Image Final Results

This experiment was carried out as the end result of the research, namely creating an image of an object with the C-r program. The material used in this research is toy wax. There are 4 kinds of objects: balls, cubes, blocks and prisms. While the object distance is selected with a distance of 2 cm. 5cm. and 9 cm.

4. CONCLUSION

Based on the design and testing of the circuit system that has been carried out, the following conclusions can be drawn: Ultrasonic sensors in detecting objects are influenced by several factors, namely: the shape of the object, the distance of the object and the position of the object. Based on the experiment, the reflected distance is above 50 cm with a toy candle object with a flat surface, considered to be 0 or the receiving sensor is considered not to receive the reflected wave due to the reflection time limitation in the microcontroller program, namely after a time of 323.595 ms, the reflection time is considered complete. Based on the reflection speed test, the location and position of the sensor can affect the speed of reflection and reflection can be received perfectly if the transmitter and receiver sensors get a barrier to the object as a whole.

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