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The Design of Smart Prototype Pet Feeder Using Passive InfaRed (PIR) Sensors

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ABSTRACT

Food is necessary to support daily life and in pets like cats. Pet feeders are usually carried out routinely by pet owners by taking the time to stay at home and feed the pets. With activities requiring animal owners to be outside the home for long periods, it is necessary to design a prototype that can automatically assist the process of providing food, especially dry food, to pets. So pet feeders can be carried out even though the owner is not at home and does not have spare time. The system was built using the C language related to the Code Vision tools that support the hex file compiler into the microcontroller. The research method used is the experimental method, namely conducting trials (trial and error) directly on the research object and the comparative testing method for testing the built system. The auto pet feeder prototype uses the ATMega8535 IC by utilizing a PIR (Passive InfraRed) sensor to detect movement around the animal bowl. The PIR sensor detects well as expected, and it has an effective detection range of up to 5 meters. Not only detects humans, but the PIR sensor can also detect other living things. The PIR sensor will send a signal to the microcontroller to open the valve from the food measuring station, which is driven by a DC motor based on the detected motion to drop food into the animal's bowl. PhotoDioda controls the amount of food falling into the animal's bowl. The test results of this tool show that at a distance of 0–6 meters, the PIR sensor can provide feedback or detect animal movements well.
Keywords: System; Smart prototype; pet feeder; sensor; PIR; IC ATMega8535;

1. INTRODUCTION

The rapid development of technology is evidence of human civilization's tendency to want everything sophisticated and practical. It is evidenced by the many electronic equipments that can make human work more efficient and practical, for example, control systems. The control system is the interconnection of components forming a configuration that provides the desired system feedback. The control system enables a stable, accurate and timely system (Fina Ayu Lestari & Cahyono, 2022).

The automatic control system functions to control the process without human intervention (automatic); the control system for automatic control consists of Open Loop and Close Loop (Rivaldo et al., 2020). An open loop is a system whose output value or number does not affect the result or input value of the control system. While a closed loop is a system whose output value or number affects the results and reference input values in the system. This closed-loop system has feedback on predetermined references (Putranto et al., 2023).

A microcontroller is a microprocessor system equipped with an electronic device in the form of an Integrated Circuit (IC) that can manipulate data based on a program sequence made by a programmer (Chaerah Gunadin et al., 2021). Microcontrollers such as control systems, automation, and others can be used in the industrial world. The microcontroller has a module which consists of two main components, namely the Avr ATMega8535 microcontroller IC and a microcontroller downloader to download programs on the IC.

ATMEGA8535 is an AVR type with 8 internal ADC channels with 10-bit fidelity. The ATMEGA8535 ADC in operating mode can be configured and has a very flexible noise filter capability so that it can be easily adapted to the needs of the ADC itself (Yasin et al., 2019).

Passive InfraRed (PIR) sensor is an electronic sensor device that measures infrared light emitted from surrounding objects. PIR sensors are very suitable for creating remote room monitoring systems that homeowners can use without fear of leaving the house (Toyib et al., 2019). The working principle of this smart system is that the PIR sensor will detect presence through body temperature and movement in one room which then the computer will give feedback on the presence to turn on and turn on the light like a switch (Yulisman et al., 2022). As the name implies, "Passive", the

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PIR sensor only gives feedback energy from passive infrared rays owned by every object it detects. The PIR sensor detects well as expected, but not only detects humans, but the PIR sensor can also detect other living things (Yulisman et al., 2022). The sensitivity of the PIR sensor sending observed data to the microcontroller (Toyib et al., 2019) has been measured with an average SMS delay of 15.1 seconds, and in general, the PIR sensor has an effective detection range of up to 5 meters and is very effective in being used as a human detector (Toyib et al., 2019).

A DC motor is an electric motor that converts direct current electrical energy into mechanical energy in a circular motion (Abrar et al., 2023). The advantage of DC motors is speed control, which does not affect the quality of the power supply (Sudaryoto & Zuhrie, 2019). While the photodiode sensor is a sensor that detects objects and light, if objects or light cover the photodiode sensor, the Sensor will have a value of 1 or On. If there are no objects or obstacles in front of the photodiode sensor, it will have a value of 0 or Off (Cahaya Ginting et al., 2021).

In this study, the system was built using C language as a programming language because it is easy to process in the compiler and made easier using simple functions (Lubis, 2022). The C language is related to the Code Vision tools, which support and can be changed and can directly load the results of the hex file compiler into the microcontroller. The software used in making the program is Code Vision AVR C Compiler, here in after referred to as cv AVR. This software is easier to use because it is available in C language. Besides, AVR cv makes it easy with a code wizard where users click to complete initialization or functions according to the properties that appear. The steps in using the AVR cv are selecting the Chip and Xtall frequency and initializing the I/O port.

2. LITERATURE REVIEW

Several related studies have been conducted before, including research conducted by (Kurnia & Widiasih, 2019) with the title Implementation of Nodemcu in Prototype Web-Based Automatic and Precision Chicken Feeding Systems. In this research, a prototype of a chicken feeding automation system was built to increase the efficiency and effectiveness of the work of farmers; the system uses an ATMega8535 or Arduino microcontroller combined with a fuzzy application and a smartphone. Another research was conducted by (Samsugi & Naufal Falikh Suprapto, 2021). In this study, a tool was created that can help feed cats in real-time with 2 modes of feeding, namely for the use of adult cats and for kittens. The controller application interface for the Intel Galileo-Based Cat Feed Tool is made with the MIT APP Inventor, Bluetooth for connection and the TCRT5000 Sensor to detect objects, namely cat food has come out or not

Related research was carried out by (Devitasari & Kartika, 2020) This research created a tool to monitor and provide food to pet cats that the user can access remotely. This tool uses the NodeMCU microcontroller, which is integrated with the internet network. This automation tool can provide feed in real-time by utilizing components. In addition, users will get notifications directly via fox push without opening a web page to determine whether the feed has been given. The average percentage of the success of the entire system obtained is 68%. Testing on the tool was carried out 10 times. If the feeding is carried out at a predetermined time, the tool works properly.

Another research was carried out by (Zulkarnain & Rosyada, 2019), building a prototype of an automatic cat feeder using Arduino Nano which works at a voltage level of 5V as a controller. Ultrasonic sensors are used to determine the cat's feed supply in the feed supply area, and a servo motor moves the bottom cover of the feed preparation area. The system built has the working principle of sending information in the form of SMS as a notification that the feed has succeeded or not at a predetermined time. If the set feeding time has been met, then the system will activate the buzzer as a sign that the feeding process will begin, and then the load cell will read the weight and whether the weight matches the profile. If appropriate, the GSM module will send an SMS as a sign that the feed was successful. If the feed that comes out and is read on the load cell is less than the profile, the system will calculate for 30 seconds. If there is no change, then initialized feeding fails.

Other related research using PIR sensors includes research conducted by (Toyib et al., 2019), integrating devices between microcontroller modules, PIR sensors and wireless modems made using the Code Vision AVR programming language. The Sensor is used to detect human body temperature; if there are other moving objects or other living things, such as animals, the Sensor does not detect it because of the PIR sensor.

Another research was conducted by (Kurniawati & Nova Trisetiyanto, 2021), designing and building a disinfectant sprayer that works automatically. The tool uses a PIR sensor as an object detector, and the Output uses a Relay module connected to a High-Pressure Water Pump, which sprays disinfectant liquid through a mist sprayer. This tool effectively detects objects in the disinfectant spray booth area up to 3.6 meters in front of the Sensor.

Research by (Sidik et al., 2022), made an Arduino-based automatic bird repellent using a PIR sensor. The tool is

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connected to an Arduino circuit that uses a PIR sensor as an input intermediary. The Sensor will send a signal to the servo if the Sensor detects an intruder entering the paddy field. Then the intruder in the form of a sparrow will be shocked or scared and then fly away from the rice plants because of the movement made by the servo.

Based on previous research that there are differences in the current research is the auto pet feeder prototype uses the ATMega8535 IC by utilizing a PIR (Passive InfraRed) sensor to detect movement around the animal bowl. The PIR sensor is used in this research because it is capable of detecting very effective, Not only detects humans, but the PIR sensor can also detect other living things, and it has an effective detection range of up to 5 meters.

3. METHOD

The research method used is an experimental method, namely a research method used to find the effect of certain treatments on others under controlled conditions. The experimental research method in this study can be seen in the following chart:

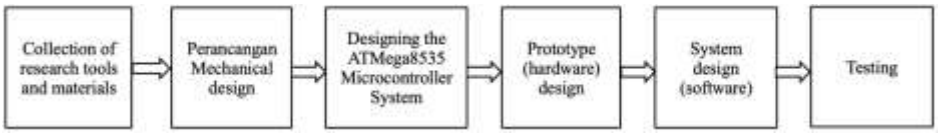

Figure 1. The Experimental Research Diagram (source: personal documentation)

The steps of this research method are as follows:

a. Collection of research tools and materials. This study required tools such as laptops, AVR downloaders, cutting pliers or clamping pliers, power supply, multitester, cutter blades, electric drills, grinders, solder, tin, lead suction, ruler and avometer. While the software needed is the DipTrace application program, Code Vision AVR Compiler. The research materials needed are PCB (Printing Circuit Board), Bolts and Nuts, ATMega8535 Minimum Microcontroller System, DC Motor, PIR (Passive InfraRed) Sensor, 5 Liter Gallon, Fiber Glass (Arcylic) Board, UTP Cable, Beams, Boards, Plywood and Nails. The components needed include Resistors, Capacitors, Transistors, PhotoDiodes, HDrip LEDs, 12000Mhz Crystals, Elco, IC Regulators, LDR, Trimpot, LM 324 + sockets, Pin Headers and Switch Buttons.
b. Mechanical design in the form of an overview of the automatic feeding system working process. The tool built uses 2 valves driven by a DC motor equipped with a Gear Box to drive (rotate) the valves. The first valve functions to open/close the food path from the holding container to the dosing container, while the second valve functions to open/close the food path from the dosing container to the pet's feeding bowl.
c. Designing the ATMega8535 Microcontroller System as the overall system controller, a microcontroller circuit consisting of four ports that can be used as data input or Output. This circuit consists of an 11.0592 MHz crystal oscillator that generates internal pulses, two 30 pF capacitors that stabilize the frequency, and a capacitor.
d. Prototype (hardware) design, as for the steps: First: make a Printed Circuit Board (PCB) with the correct short circuit for each driver to be made. The paths that are made can be drawn manually, and to make it more organized and tidy, you can also use the Diptrace application. Second: The prints on photo paper are glued to the PCB and then ironed so that the tracks adhere to the PCB. Then dissolve the PCB in Ferrite Chloride solution until the copper that is not drawn is separated from the PCB board. Third: Make holes in the PCB using a PCB drill. Fourth: Arrange the components on the PCB based on the appropriate design rules. And fifth: Pair the components on the PCB using solder and tin.
e. System design (software), the required software specifications include Windows operating system Windows 7 Ultimate 64 Bit in designing programs, AVRCodevision supporting software used to create programs that will be loaded on the microcontroller and C programming language. Selection of C language in the design of this software is due to the ease of the compiler process related to the Code VisionAVR tools, which support and can be changed and can directly fill the hex file compiler results into the microcontroller.
f. The hardware testing

The hardware testing method is carried out by measuring the input and output voltages on the circuit. This test is crucial to determine whether the circuit built can work optimally as expected. Besides that, it is also to find out whether one of the components is present or not. While software testing is done using black box testing to test system functionality.

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4. RESULT AND DISCUSSIONS

Based on the results of the analysis and experiments that have been carried out, a series of modules is made which is part of the smart prototype pet feeder as follows::

a. Power Supply Circuit

Figure 2. Power Supply Circiut (source: personal documentation)

The power supply in Figure 2 converts the high voltage into a low capacity voltage which will be supplied to another driver circuit.

b. Regulator Circuit

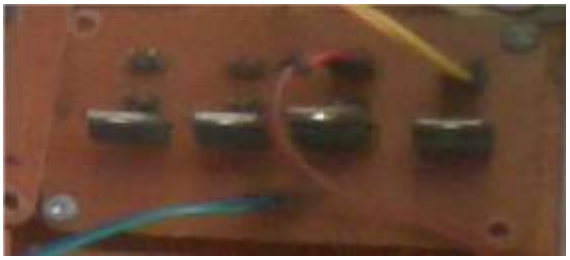

Figure 3. Regulator Circuit (source: personal documentation)

This circuit functions to change the voltage generated from the power supply driver to a low voltage according to the amount of voltage that will be another driver circuit will need

c. ATMega8535 Microcontroller Minimum System Circuit

Figure 4. ATMega8535 Microcontroller Minimum System Circuit (source: personal documentation)

The circuit in Figure 4 functions to manage data received from indicators. Then provide Output in accordance with the conditions of the incoming data with the program that has been created and filled in it.

d. PIR Sensor Circuit

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Figure 4. PIR Sensor Circuit (source: personal documentation)

The PIR sensor in Figure 4 provides energy feedback from passive infrared rays owned by every object it detects. The PIR sensor can detect up to a distance of 8 meters.

The results of hardware testing using the tools available on Code Vision AVR to detect the chip used can be seen in Figure 5 below:

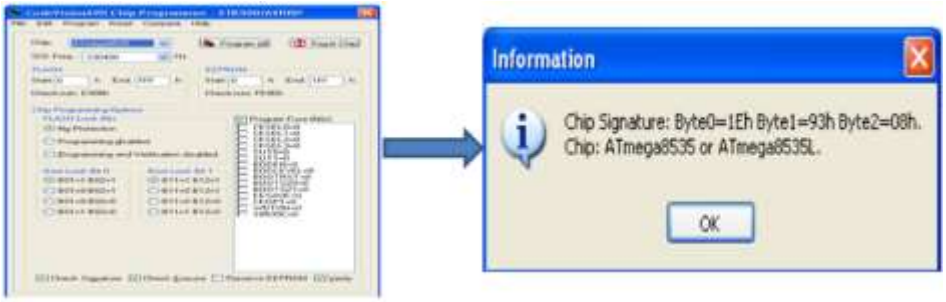

Figure 5. Hasil Uji Code Vision AVR (source: personal documentation)

In Figure 5 the chip programmer window enters the read chip signature menu, and the circuit and chip are detected as information on the type of chip used free from errors.

The results of testing the software built in this study using Code Vision AVR as a compiler can be seen in Figure 6 below:

Figure 6. Compile program (source: personal documentation)

In Figure 6 it is clear that there are errors and warnings, so the program is ready to use.

The results of functional testing of the smart prototype pet feeder using black box testing can be seen in Table 1 below:

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Table 1. PIR Sensor Testing Results

Attempt to:	Cat Position	Food Valve Status
1	Before approaching the sensor	Close
	Once at the location of the sensor	Open
	After passing the sensor	Open
2	Before approaching the sensor	Close
	Once at the location of the sensor	Open
	After passing the sensor	Open
3	Before approaching the sensor	Close
	Once at the location of the sensor	Open
	After passing the sensor	Open
4	Before approaching the sensor	Close
	Once at the location of the sensor	Open
	After passing the sensor	Open
5	Before approaching the sensor	Close
	Once at the location of the sensor	Open
	After passing the sensor	Open

The results of sensor response testing at a certain distance of 1 to 10 meters, the PIR sensor can respond well at a distance of 1 to 6 meters, as can be seen in table 2 below:

Table 2. Sensor Response Testing Results with a Certain Distance

Experimental	Distance (Meters)	Response Sensor PIR
1	1 – 2	Good
2	3 – 4	Good
3	5 – 6	Good
4	7 – 8	Not enough
5	9 – 10	No Response

Overall System Functional Testing Results with Testing Scenarios starting from testing the PIR sensor function to the Microcontroller Circuit function are successful because everything is in accordance with the expected results, can be seen in table 3 below:

Tabel 3. Overall System Testing Results

No	Functional	Test Skenario	Expected results	Results	Conclusion
1	PIR Sensors	Place an object in front of the sensor	Sensor Detects Cats	According to expectations	Success
2	Photodiode Sensors	Place an object in front of the sensor	The sensor detects an object	According to expectations	Success
3	Servos	Execute motion commands from the microcontroller	The servo moves according to the command given	According to expectations	Success
4	The food valve	Send orders to Servos to open the food velve	The food valve automatically open	According to expectations	Success
5	The food valve	Send orders to Servos to close the food velve	The food valve automatically close	According to expectations	Success
6	Mikrokontroler Circuit	Connecting with computer via	The program can be downloaded to the	According to expectations	Success

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No	Functional	Test Skenario	Expected results	Results	Conclusion
		downloader	microcontroller		

5. CONCLUSION

The design and manufacture of the Smart Prototype Pet Feeder using PIR (Passive InfraRed) went as expected. When pets, especially cats, approach the Sensor, the Sensor will send data to the microcontroller to give orders to the servo or DC motor to open the food valve. And the food valve will automatically close when the photodiode sensor mounted on the food section has reached a predetermined measuring limit. Basically, the researchers designed the movement of the food valve horizontally due to the construction where the food is made. The hardware and software testing results of this tool show that is no errors and warnings, so the program is ready to use, and also at a distance of 0–6 meters, the PIR sensor can provide feedback or detect animal movements well. The weakness that still needs to be fixed in this tool is in the sensor detection section; this Sensor also detects humans or living things that emit heat. So, if a human passes in front of the appliance, and right when the cat eats, the food closing valve will open by itself. Further research development can be carried out to maximize this prototype's performance with the ability to detect different objects.

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