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Smart Trash Can Using Ultrasonic Infrared Sensor and Touch Sensor Based on Arduino Mega

Rahmat Tullah[1], Fiqih Hana Saputri[2], Alvi Syahrin[3]

[1,2,3] Institut Teknologi dan Bisnis Bina Sarana Global, Tangerang, Indonesia, 15113
E-mail: [1]kanjeng.ratoe@gmail.com, [2]fiqihhana@gmail.com, [3]alvisyahrin05899@gmail.com

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ABSTRACT

Most of the trash bins at school are conventional models. When you want to dispose of trash you have to open or push the lid on the trash can, sometimes the lid is dirty with garbage piling up because the cleaners rarely check the condition of the trash can, this makes students' interest and awareness low to throw garbage in place. The purpose of this research is to design a tool that can facilitate and attract students' interest in disposing garbage in its place and making it easier for janitors to check and control the contents of the waste. This research make the environment at SMK Yaspih Rajeg cleaner because most students are no longer lazy and hesitant to throw garbage in its place, supported by the performance of cleaners who are more optimal in checking and controlling the contents of the trash. This study uses several methods such as data collection and analytical methods (Structured Analysis and Design) with flowcharts. The result, smart trash can that uses Arduino Mega as a microcontroller combined with several sensors and modules such as ultrasonic sensors, infrared sensors, touch sensors, servo motors, and SIM800l V2 which presents various features in smart trash cans.

1. Introduction

Disposing of rubbish in its place may be an easy task for every student, but in reality there are still many students who do not throw rubbish in its place so that rubbish is thrown everywhere. Due to the lack of awareness about throwing away rubbish in its place, this happens because most of the existing rubbish bins are conventional models so that when students want to throw rubbish they have to open or push the lid of the rubbish bin first, and sometimes the lid of the rubbish bin is dirty even without a lid so The smell coming from the rubbish spreads and is smelled by students which makes them lazy to throw away the rubbish, plus the rubbish often piles up due to the lack of cleaning staff checking the condition of the rubbish bins.

Therefore, it is necessary to innovate technology-based tools for trash cans to make it easier for students to throw away rubbish, so that they do not hesitate to throw rubbish in the right place and also make it easier for cleaning staff to check and control the contents of the rubbish bin. One of them is a trash can that can open and close automatically by adding an infrared sensor [5] combined with a servo motor [6] thus minimizing direct contact with the waste bin and being able to measure the contents of the bin by adding an ultrasonic sensor connected to an LCD [7] so that the results of the measurements can be displayed directly on an LCD screen which makes it easier for students and cleaning staff to know the remaining capacity of the trash can, plus a touch sensor[8] which is connected to the SIM800L V2 module[9] to call officers when the trash can is full, making it easier to control the contents of the trash with the help of students.

2. Method

2.1 Data Collection Methods

1. Observation Method

The author collects data by directly observing the research object to obtain relevant data and obtain solutions to existing problems.

2. Interview Method

To obtain data and information, the author conducted questions and answers directly with related parties so that the data obtained was more accurate.

3. Literature Study

The author collects data by studying theory and data from books, articles, journals and other reading materials sourced from the internet.

2.2 Research Design

The Object Oriented Technology (OOT) design method applied in this research goes through 5 (five) stages as follows:

1. Planning Stage

The initial stage defines estimates of resource requirements, such as physical equipment, methods and budgets which are still general in nature. In this stage, steps are also taken in the form of defining the problem, determining system objectives, identifying system constraints and making a feasibility study.

2. Analysis Stage

The analysis stage is the research stage of the running system with the aim of designing a new system using flowcharts.

3. Design Stage

The Design Stage is the stage in determining the required data processing with the aim of meeting user needs.

4. Implementation Stage

The stage where the system design is formed into a code (program) that is ready to be operated. The steps are to prepare physical facilities and personnel, and carry out simulations.

5. Maintenance Stage

After implementing the new system, the next stages that need to be carried out are use, system audit, maintenance, repair and system development.

2.3 Problems Faced

Some of the problems faced in the design of smart trash cans using ultrasonic sensors, infrared sensors and touch sensors based on Arduino Mega which arise from the running system are as follows:

1. There are no trash cans that have smart features such as automatic opening and closing and most of the available trash cans only have conventional features so we have to make direct contact with the trash can.
2. Lack of interest and awareness among students to dispose of rubbish in its proper place.
3. Cleaning staff only check the condition of the trash can when it is full and sometimes don't know how much is in the trash can.

2.4 Problem Solving

To deal with the above problems, the author provides the following solutions:

1. Smart features in the trash can can be designed using an Arduino Mega as a microcontroller combined with several sensors and other electronic devices that can provide various features.
2. To attract interest and awareness of disposing of rubbish in its place, the rubbish bin is designed with various features such as automatic opening and closing, measuring the contents of the rubbish bin and warning when the rubbish is full as well as calling cleaning staff.
3. The load measuring feature with an ultrasonic sensor connected to an LCD makes it easier for students and cleaning staff to know the capacity of available trash cans, because the results of the ultrasonic sensor measurements will be directly displayed on the LCD screen.

2.5 Identify Needs

1. Hardware, including:

Arduino Mega2560[12], *Stepdown lm2596, Breadboard, Servo motor, Ultrasonic sensor, Touch sensor, Infrared sensor, LED, LCD 16x2, SIM800L V2, Dfplayer mini*[13], *Speaker*, *Dfplayer* mini[14], Jumper cables.

2. Software, including:

Arduino IDE software[15] and Arduino library.

3. Results and Discussion

3.1 Proposed New Procedure

After conducting interviews with several sources who threw rubbish into conventional rubbish bins, the author was able to find problems that were encountered when students and other school residents wanted to throw rubbish, most of them were reluctant to throw rubbish into the rubbish bin because the bins were dirty and sometimes full because cleaning staff who rarely check the condition of the rubbish bin plus conventional models of rubbish bins which require direct contact with the rubbish bin when throwing away rubbish, such as pushing and lifting the lid of the rubbish bin,

By having the development analysis become an input in a proposed system carried out by the author, this development is expected to have a good impact, especially for students and other school residents. The system design being carried out by the author aims to make it easier and increase awareness of students and other school residents to dispose of waste in the right place. By using an Arduino Mega 2560 as a microcontroller combined with various sensors and other devices, this tool can open and close automatically by directing the waste to the infrared sensor, then a feature for measuring the waste load with an ultrasonic sensor which is directly displayed on the LCD so that officers can easily check it. Trash can loading is coupled with a text and voice notification alarm feature which will be active when the bin is full, and students can call the cleaning officer by touching the touch sensor connected to the SIM800L V2 module via telephone call.

3.2 Circuit Design

After conducting a needs analysis, the author tries to provide an overview of the design of tools or circuit schemes used in the design of smart trash cans using ultrasonic sensors, infrared sensors and touch sensors based on Arduino Mega. The following is a schematic overview of the tool design circuit.

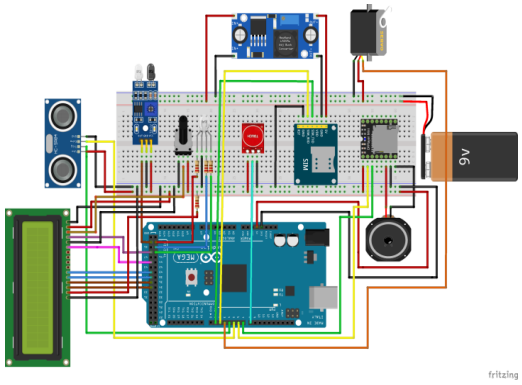

Figure 1. Smart Trash Can Circuit

Based on Figure 1. The Smart Trash Can Circuit can be explained as follows:

1. Arduino Mega 2560

   This tool functions as a microcontroller and as a connector for a series of other tools.

2. Step down lm2596

   This component is used to reduce the electric current voltage from the battery, which was initially reduced to 9 volts to 6 specifically for the SIM800L V2 module.

3. Breadboards

   This component functions as a connector for electric current and connecting pins from the Arduino Mega board to other components.

4. Servo motors

   In this tool the author uses 1 servo motor to open and close the trash can lid, pada motor servo terdapat 3 pin yaitu pin VCC, pin GND dan serial pin.

5. Ultrasonic sensors

   This sensor functions to measure the capacity and load of the trash can using ultrasonic waves in centimeters. The results of this measurement will be immediately displayed on the I2C 16x2 LCD so that students and officers can easily find out the remaining capacity of the smart trash can.

6. Infrared sensors

   The infrared sensor functions to detect waste with infrared waves within a certain distance. If detected, the sensor will provide input which will be processed into a command to move the servo motor to open the lid of the smart trash can.

7. Touch sensor

   The touch sensor functions to detect touch or hand pressure. If detected, the sensor will provide input which will be processed into a command to activate the telephone feature of the SIM800L V2 Module to call a cleaning officer.

8. SIM800L V2

   SIM800L V2 is a GSM/GPRS modem that works in four frequency bands, namely 850, 900, 1800 and 1900 MHZ. Which functions to connect cleaning workers with smart trash cans via telephone calls.

9. I2C 16x2 LCD

   The I2C LCD functions as a medium for displaying all text-based smart trash can information such as the results of measuring the load of the trash can, and text notifications from each active feature on the smart trash can. This component has 4 pins including the GND pin, VCC pin, SDA and SCL pins.

10. LEDs

    The LED functions as an indicator and notification light for each active feature in the smart trash can. The author uses 3 LED colors, namely red LED, yellow LED and green LED.

11. Dfplayer mini

    Dfplayer mini functions to play or play songs and sounds in mp3 format that have previously been inserted into the memory card, this tool will play notification sounds according to the currently active feature.

12. Speakers

    The speaker functions as a medium for sound notifications from each active smart trash can feature.

13. 9 volt battery

    The battery functions as a dedicated power source for the SIM800L V2 and servo motor.

3.3 Tool Design Flowchart

In making this tool the author added a flowchart to describe the workflow of the system that has been created so that it is easy to study and evaluate.

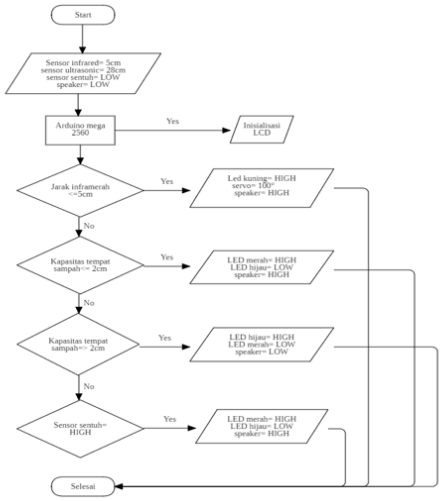

Figure 2. Smart Trash Can Flowchart

Based on Figure 2, the flowchart flow for designing a smart trash can can be explained as follows:

1. Start

   The first step to operate the tool is to provide power to the system or circuit and in this part the program starts to run.

2. Initialize All Sensors

   At this stage the system activates all sensors and several other parts according to the functions that have been set in the program, and the results of the input will then be processed by the microcontroller.

3. Processing Incoming Input

   The Arduino Mega will process all input and functions which will then be displayed via the LCD in the form of text and sound via the speaker.

4. Initialize LCD

   Before displaying the results of data processing, Arduino will match the LCD address with the address in the program. If it matches, the data will immediately appear on the LCD screen, otherwise the data will not appear.

5. Infrared distance <=5cm (Less than 5cm)

   If an object approaches less than 5cm, the yellow LED light will light up, the servo will move to open the trash can lid and a sound notification will appear from the speaker.

6. Trash Can Capacity <=2cm (Less Than 2cm)

   When the trash can is full, the red LED light turns on and the green light turns off, then a text and sound notification appears via the LCD and speaker.

7. Trash Can Capacity =>2cm (empty/more than 2cm)

   When the trash can is empty or the capacity is above 2cm the green LED light is on and the red light is off and without text and sound notifications.

8. Touch Sensor (HIGH/On)

   When the touch sensor is touched, the sensor will go HIGH/light up, the red LED will turn on and the LED will turn off then activate the calling feature of the sim800l V2 to call the waste officer.

3.4 Tool Design Prototype

After the author carried out system analysis and design, the author got the results of designing a smart trash can using an ultrasonic sensor, an infrared sensor and a touch sensor based on Arduino Mega.

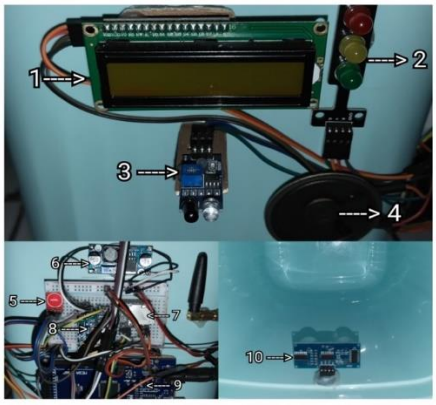

Figure 3. Design and construction of the tool

In the design above, all components have been assembled in such a way. Component descriptions in the image above include:

Table 1. Tool Design Components

No	*Tools*
1	LCD I2C 16x2
2	3 Color LED: Red, Yellow, Green
3	*Infrared* Sensor
4	*Speaker*
5	*Touch* Sensor
6	*Stepdown* LM2596
7	*Dfplayer* Mini
8	SIM800L V2
9	Arduino Mega 2560
10	*Ultrasonic* Sensor

3.5 System and Tool Testing

After the author has carried out system analysis and design on a series of tools, the author will test the tools to determine the performance and results of the design and evaluate if there are errors in the system and tools.

The tests and experiments on the series of tools are as follows:

1. Infrared Sensor Testing

   The automatic opening and closing feature of the infrared sensor functions to detect trash or other objects within a certain distance and send input which will be processed into a command to move the servo motor at a predetermined angle and duration followed by a yellow LED light that lights up. The following is a picture of the infrared sensor test:

Figure 4. Infrared sensor testing

The following is a table of results from testing waste detection on the infrared sensor

Table 2. Infrared sensor test results

No	*Detection Distance*	*Result*
1	7cm	Not Detected
2	6cm	Not Detected
3	5cm	Detected
4	4cm	Detected

From the table above it can be seen that the maximum detection distance from the infrared sensor is 5cm.

2. Ultrasonic Sensor Testing

   In the load measuring and trash full warning features, the ultrasonic sensor functions to measure the load on the smart trash bin using ultrasonic waves which are converted into centimeters, and the results of these measurements will be displayed on the I2C LCD and if the load is within the specified maximum limit then The sensor will send input to activate text and sound warning notifications followed by a red LED light that lights up. The capacity of the smart trash can is 26cm. The following is a picture of the ultrasonic sensor test:

Figure 5. Ultrasonic sensor testing

Table 3. Ultrasonic sensor test results

No	*Remaining Capacity*	*Result*
1	26cm	Notifications Off
2	15cm	Notifications Off
3	5cm	Notifications Off
4	2cm	Notifications On

From the table above you can see that the notification is not active if the remaining waste capacity is more than 2cm, but when the waste load is around or less than 2cm the notification will be active.

3. Touch sensor testing

   In the feature of calling a janitor, the touch sensor functions to detect touch or pressure by utilizing electricity in the human body, especially on the fingers. If the sensor detects a touch, the sensor will send input to activate the telephone call feature from the SIM800L V2 module followed by a red LED light that lights up when calling. janitor. The following is a picture of the touch sensor test:

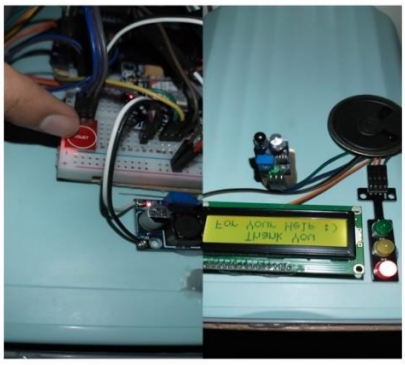

Figure 6. Touch sensor testing

The following are the results of touch testing on the touch sensor which can be seen in the following table:

Table 4. Touch sensor test results

No	*Circumstances*	*Result*

1	Any Touch	Active call
2	No Touch	Call Off

From the table above, it can be seen that the telephone call feature will be active when the touch sensor detects touch or pressure from a finger, but the telephone call feature will not be active when the sensor does not detect touch or pressure from a finger.

4. Conclusions and Suggestions

4.1 Conclusions

Based on the results of the research that has been carried out, the following conclusions can be drawn:

1. Smart features in the trash can can be designed using an Arduino Mega combined with several sensors and other electronic devices, then designed and controlled via an Arduino Mega which has been programmed via the Arduino IDE software.
2. To attract interest and awareness about throwing rubbish in its place, this rubbish bin is designed with various features such as automatic opening and closing with an infrared sensor and a servo motor which makes it easier for students to throw rubbish.
3. The trash can is designed with a trash load measuring feature with an ultrasonic sensor connected to an LCD so that the results of the ultrasonic sensor measurement are directly displayed on the LCD screen so that students and cleaning staff can find out the remaining capacity of the available trash can.
4. The infrared sensor acts as a detector of trash or other objects in the automatic opening and closing feature. When the infrared sensor detects an object, the sensor will send input which is processed into a command to open the lid of the trash can within a certain time and will close it again when the time is up.
5. The touch sensor acts as a touch detector from the finger in the janitor calling feature. When the touch sensor detects a touch, the sensor will send input which will be processed into a command to activate the telephone call feature on the SIM800L V2 module to call the janitor.

4.1 Suggestions

Suggestions that the author can give based on the results of this research for further research are:

1. For further research development, you can add a charger module or battery charger feature.
2. To overcome assembly problems, you can use an Arduino or other better type of microcontroller.
3. Can use other, better sensors to increase data accuracy.
4. This tool should be developed by adding features that can sort organic and non-organic waste.

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