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Report

Abstract

Overflowing garbage cans in public restrooms have decreased public sanitation. It is constantly found that garbage cans in restrooms are often full and janitors have trouble keeping up with the high traffic of the disposal systems. A SMART trash receptacle has been built with the capability to solve this problem by alerting custodians with their status. The SMART trash receptacle was designed and programmed using PBASIC to sense when the rubbish is full by determining the height and weight of the garbage. The SMART trash receptacle was tested and proved to be effective in the detection of waste. An ultrasonic sensor and emitter and a Flexiforce sensor were wired and programmed with PBASIC to accomplish this task. By creating a threshold value for both sensors, testing was completed by deliberately filling up the SMART trash receptacle which caused a control panel to alert the custodian using both an audible and visible alert. This solves the modern inconvenience of excess garbage in public facilities. The SMART trash receptacle has the potential to increase cleanliness and the health of people all over the world.

Introduction

Mechatronics is a combination field of electronics, mechanics, and computer science. Many modern day conveniences are created from this field. Mechatronics make our lives easier by simplifying tasks and increasing efficiency. In today's society, the role of a janitor is essential to society by increasing public cleanliness and reducing health issues. Unfortunately, it is not economically efficient to increase the number of janitors to ensure that the garbage can is never full. Instead, they have a scheduled time to empty the trash cans, usually twice a week. During the time that the trash can is full and overflowing, there is nobody to empty it. This poses not only a health risk but a fire hazard because of the large amount of paper. Mechatronics could

solve this problem by creating a device to signal a janitor to retrieve the rubbish when the trash can is full. By using specific sensors, different methods of the detection of trash could be utilized.

Two sensors are being proposed as a detection method for the SMART garbage can. The usage of an ultrasonic sensor and emitter and a Flexiforce sensor will determine when the trash is actually full. The ultrasonic sensor and emitter will use sound waves to determine the distance from the top of the rubbish and the top of the garbage can and the Flexiforce sensor will determine the weight of the garbage to meet the weight capacity of a trash bag. These sensors will relay a signal to the control board in real time and the BASIC script will check to see if threshold values have been met. If threshold values have been met, an audible and visible alert will indicate to the custodians attention is required. This system would allow an entire network of garbage cans to be monitored in real time.

Methodology

Plexiglas was used for the construction of the trash receptacle. To create one receptacle, the materials were: two 6″ x 11″ x .125″ Plexiglas panels, two 6″ x 10½″ x .125″ Plexiglas panels, two 6″ x 6″ x .125″ Plexiglas panels, one hinge, one ultrasonic sensor and emitter, one Flexiforce sensor, one 5.5″ x 5.5″ x .0625″ panel with rounded corners, and a .0625″ thick cylindrical Plexiglas 2″ in diameter. Three receptacles are needed for this experiment. The panels are glued together using methylene chloride to form a rectangular prism with a hinged top. Figure 1 shows the completed trash receptacle. The cylindrical piece was glued to the center of the rounded panel, creating a stand (see Figure 2). A small hole was drilled one inch from the bottom of the rear 6″ x 11″ Plexiglas panel to allow for the insertion of wires. Using a dremel, a

gap about 2″ wide and .1″ thick was created between the bottom panel and the rear panel approximately centered to allow for the insertion of a Flexiforce sensor (See figure 2). These steps were repeated until three receptacles were completed.

Figure 1

The ultrasonic sensor and emitter was affixed to the inside of the hinged top of the receptacle using a screw and nut (see Figure 2). The Flexiforce sensor was centered on the bottom of the receptacle and attached using electrical tape (see Figure 3). Contacts on the ultrasonic sensor and emitter were soldered to allow for an electrical wire extension. However, the sensor was not grounded because of a product design flaw. Grounding would lead to inaccurate readings. The Flexiforce sensors' contacts were also soldered.

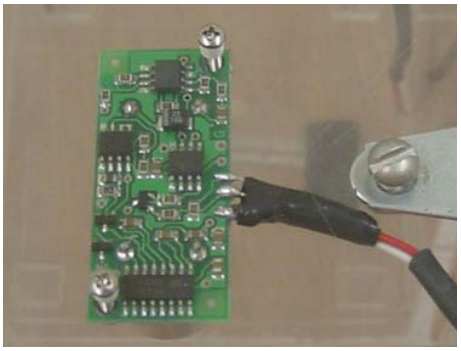


Figure 2

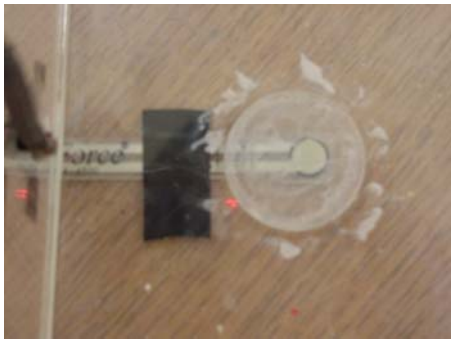
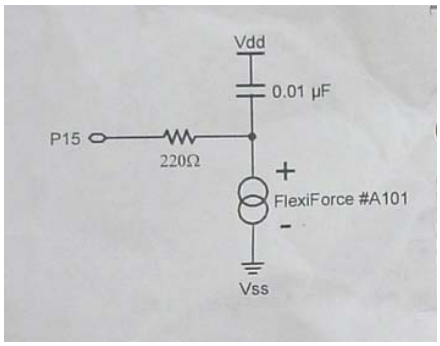


Figure 3

A control panel for displaying the status of the receptacles was made from a type of plastic. It is approximately 4″ by 6″ with rounded corners (see Figure 4). 4 legs were created out

of Plexiglas that was approximately 2.5″ high. Six holes in a 3″ x 2″ rectangle were then drilled. The drill bit diameter matched the diameter of an LED.

The BS2 was connected to a breadboard with a serial wire. Every I/O pin, a VSS, and a VDD were soldered to an extension wire and connected to a serial port. This port was then soldered into the breadboard. Each Flexiforce sensor was connected to one I/O pin and a 0.01μF capacitor that lead to the VDD (see diagram 1). Each ultrasonic sensor and emitter was connected to two I/O pin and a VSS (see diagram 2). Six more I/O pins attached to a LED were soldered with a 270Ω resistor. The six LEDs were inserted into the openings of the control panel.



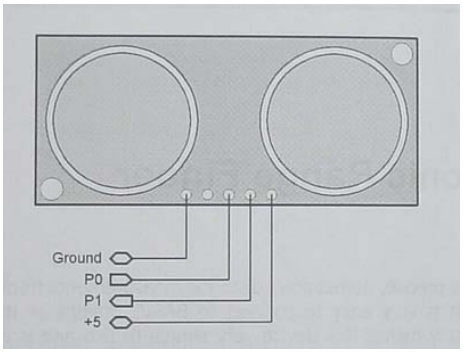


Diagram 1 **Diagram 2**

The PBASIC script consisted of many repeated commands to check the status of each receptacle and output a signal to the LEDs. Each disposal center is checked sequentially for garbage height and garbage weight. The ultrasonic sensor first measures the distance to the top of the rubbish checking with the rest of the script to determine if it has reached its maximum height. When maximum height has been reached, LED #1 turns on. The Flexiforce sensor detects weight and also checks for any triggering events. If maximum weight has been reached, LED #2 turns on. This procedure is repeated for each of the garbage cans for a total of six LEDs. The final command checks to see if there are any LEDs on. If so, a speaker is turned on to warn the custodian that there is a problem that needs to be checked.

Data / Program

```
' {$STAMP BS2}
' {$PBASIC 2.5}

' Can 1-------------------------------------------------------------------------------

Trigger   PIN 0
Echo      PIN 1

Trig10 CON 5
ToCm   CON 30

samples   VAR Nib
pWidth    VAR Word
rawDist   VAR Word

rawForce  VAR Word
sensorPin CON 2

' Can 2-------------------------------------------------------------------------------

Trigger2   PIN 3
Echo2      PIN 4

Trig102 CON 5
ToCm2   CON 30

samples2   VAR Nib
pWidth2    VAR Word
rawDist2   VAR Word

rawForce2  VAR Word
sensorPin2 CON 5

' Can 3-------------------------------------------------------------------------------

Trigger3   PIN 6
Echo3      PIN 7

Trig103 CON 5
ToCm3   CON 30

samples3   VAR Nib
pWidth3    VAR Word
rawDist3   VAR Word

rawForce3  VAR Word
sensorPin3 CON 8

'================================================================================
```

```
=========='

' Can 1---------------------------------------------------------------------------------

Can1:

Setup:
  LOW Trigger
  DEBUG CLS,
        "Can 1", CR,
        "-----", CR,
        "Raw 1.....      ", CR


Main:
  DO
   GOSUB Get_Sonar
   DEBUG CRSRXY, 15, 2, DEC rawDist, CLREOL

   GOSUB Measure
   GOSUB LED
   GOSUB SOUND
   GOSUB Can2
   PAUSE 100
 LOOP

END



Get_Sonar:
  rawDist = 0
  FOR samples = 1 TO 5
    PULSOUT trigger, Trig10
    RCTIME Echo, 1, pWidth
    rawDist = rawDist + (pWidth / 5)
    PAUSE 10
  NEXT
  RETURN


Measure:
  HIGH sensorPin
  PAUSE 2
  RCTIME sensorPin,1,rawForce
  DEBUG HOME, "Flexiforce raw output 1= ", DEC rawForce, CR
  IF rawForce < 32500 AND rawForce > 0 THEN HIGH 14
  IF rawForce > 32500 OR rawForce = 0 THEN LOW 14

RETURN

LED:
  IF rawDist < 250 THEN HIGH 13
  IF rawDist > 250 THEN LOW 13
```

```
RETURN

SOUND:

  IF rawDist < 250 THEN FREQOUT 15, 500, 3300
  IF rawForce < 32500 AND rawForce > 0 THEN  FREQOUT 15, 500, 3300

RETURN


' Can 2-------------------------------------------------------------------------------

Can2:

Setup2:
  LOW Trigger2
  DEBUG CLS,
        "Can 2", CR,
        "-----", CR,
        "Raw 2.....      ", CR


Main2:
  DO
   GOSUB Get_Sonar2
   DEBUG CRSRXY, 15, 2, DEC rawDist2, CLREOL

   GOSUB Measure2
   GOSUB LED2
   GOSUB SOUND2
   PAUSE 100
 LOOP

END



Get_Sonar2:
  rawDist2 = 0
  FOR samples2 = 1 TO 5
    PULSOUT trigger2, Trig102
    RCTIME Echo2, 1, pWidth2
    rawDist2 = rawDist2 + (pWidth2 / 5)
    PAUSE 10
  NEXT
  RETURN


Measure2:
  HIGH sensorPin2
  PAUSE 2
  RCTIME sensorPin2,1,rawForce2
  DEBUG HOME, "Flexiforce raw output 2 = ", DEC rawForce2, CR
  IF rawForce2 < 5000 AND rawForce2 > 0 THEN HIGH 12
  IF rawForce2 > 5000 OR rawForce2 = 0 THEN LOW 12
```

```
RETURN

LED2:
  IF rawDist2 < 250 THEN HIGH 11
  IF rawDist2 > 250 THEN LOW 11


RETURN

SOUND2:

  IF rawDist2 < 250 THEN FREQOUT 15, 500, 3300
  IF rawForce2 < 5000 AND rawForce2 > 0 THEN  FREQOUT 15, 500, 3300

GOTO Can3


' Can 3-------------------------------------------------------------------------------


Can3:

Setup3:
  LOW Trigger3
  DEBUG CLS,
        "Can 3", CR,
        "-----", CR,
        "Raw 3.....      ", CR


Main3:
  DO
   GOSUB Get_Sonar3
   DEBUG CRSRXY, 15, 2, DEC rawDist, CLREOL

   GOSUB Measure3
   GOSUB LED3
   GOSUB SOUND3
   PAUSE 100
 LOOP

END



Get_Sonar3:
  rawDist3 = 0
  FOR samples3 = 1 TO 5
    PULSOUT trigger3, Trig103
    RCTIME Echo3, 1, pWidth3
    rawDist3 = rawDist3 + (pWidth3 / 5)
    PAUSE 10
  NEXT
  RETURN
```

```
Measure3:
  HIGH sensorPin3
  PAUSE 2
  RCTIME sensorPin3,1,rawForce3
  DEBUG HOME, "Flexiforce raw output 3= ", DEC rawForce3, CR
  IF rawForce3 < 32500 AND rawForce3 > 0 THEN HIGH 10
  IF rawForce3 > 32500 OR rawForce3 = 0 THEN LOW 10

RETURN

LED3:
  IF rawDist3 < 250 THEN HIGH 9
  IF rawDist3 > 250 THEN LOW 9


RETURN

SOUND3:

  IF rawDist3 < 250 THEN FREQOUT 15, 500, 3300
  IF rawForce3 < 32500 AND rawForce3 > 0 THEN  FREQOUT 15, 500, 3300

GOTO Can1
```

Results

The PBASIC script works as expected. The processor does not work as fast as expected but it accomplishes the task of alerting the custodian. The garbage disposal system detected the thresholds of trash height and weight and sends a signal to produce an audible and visible alert. Figure 1 shows the control panel when the receptacle is not full. Figure 2 shows the control panel when the ultrasonic sensor is activated. Figure 3 shows the control panel when the Flexiforce sensor is activated. Figure 4 shows the control board and the three receptacles.

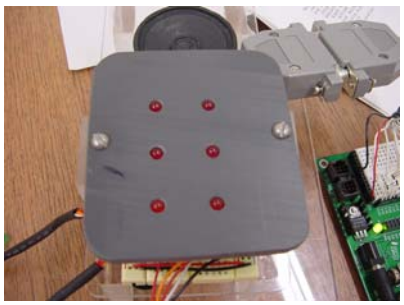


Figure 4

Figure 5

Figure 6

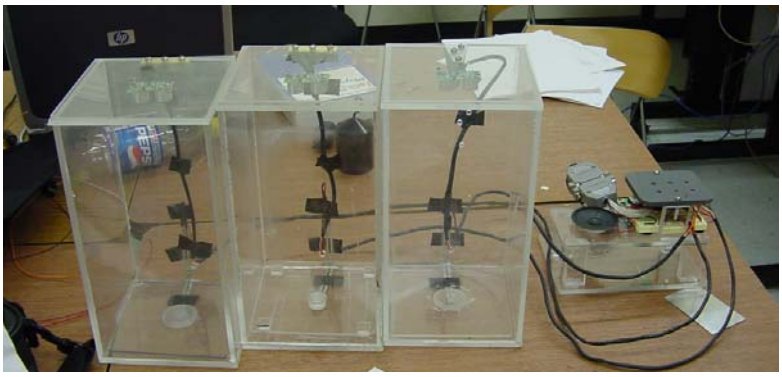


Figure 7

Discussion/Conclusion

The original proposal for the intelligent receptacle was to replace the existing trash cans in the bathrooms of Polytechnic University, because of the numerous complaints of overflowing trash. This poses not only a safety issue, but also a health risk and a fire hazard. The trash receptacle system built is a solution for these problems.

The prototype trash receptacles that we built were not large enough to accurately mimic the large activity of a more commonly used bathroom receptacle. This experiment showed that mechatronics could be used to relay a signal to custodians when the trash is full, alerting the custodians to proceed with the retrieval of garbage. There was an issue when installing the ultrasonic sensor and emitter. The directions which came with the packet specifically instructed us to ground the sensor as shown in diagram 2. All electronic devices have to be grounded or else it would create a short circuit. Unreliable values appeared when installed properly. Fortunately, the ground wire was left unattached incidentally and the readings became much more accurate. Through this, it is concluded that the ultrasonic sensors had a design flaw and therefore the use of a ground is unnecessary.

At first, only the ultrasonic sensor was to be used, but we encountered another problem. What if the garbage was exceedingly heavy? The solution was to use a Flexiforce sensor, which measures weight. However, it has a large threshold value before any signal would be transmitted. Through experimentation, we found that we could increase the resistance to create a smaller threshold. We do not have an answer to why this works though.

Although this prototype does not have markers which accurately detect a specific height or value, it has been decided that a SMART rubbish receptacle does not have to be so accurate. The trash is generally considered full when it is nearly overflowing. There is no predefined measurement to indicate whether or not a receptacle is full. This prototype creates a safer and cleaner environment by alerting the custodians to empty the trash cans. It has satisfactorily completed its task of sending a signal to a user-friendly control panel to indicate the status of the garbage cans.