Smart Bio-hazard Waste Bin
Project Proposal

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1. INTRODUCTION

a) Statement of Purpose

This project was chosen because we noticed that the waste bins which possibly contain bio-hazard waste in most hospitals and labs can be treated more efficiently and safely. Medical waste from hospital, if not processed properly, can bring huge damage to the environment and people around it. We have thought of many ways to make the waste bin more secure and more convenient to use. We believe that this will be a great help to the hospitals and the labs.

b) Objectives

i. Goals:

- The waste bin should open automatically when someone wants to deposit waste and kept closed when no one is around
- When the waste in the current garbage bag exceeds specific weight, the LED screen will display a warning information. The lid of the waste bin will always remain closed after that until trash bags are reset.
- When a bag is full, it should be properly sealed
- When a bag is sealed, the information of the bag should be recorded for future analysis
- Any liquid leak should be detected and displayed

ii. Functions:

- An infrared sensor will be installed around the lid to determine when to open the lid
- An electronic scale will be used to determine whether the current bag is full or overweight, and two metal clamps will be used to hold the bag in position
- Heat sealing technology will be used to seal the trash bag
- A microchip will be mounted inside the waste bin to record the information of the current trash bag at any time
- Liquid detection sensor will be installed at the bottom of the waste bin to detect any liquid leakage

iii. Benefits:

- No one has to touch the waste bin to open the lid or to change the bag, minimize the chance of infection through contact
- Weight limit of each bag prevent any bag from overflowing
- Proper seal of each bag also prevent the bacteria from spreading
- Data in microchip will provide information for future studies
- Liquid leak detection will provide one extra safety precaution

iv. Features:

- LED screen showing the current bag information
- Multiple safety precautions

2. DESIGN

a) Block Diagram

Seven modules are implemented in the design, which are sensors module, lid mechanics, metal rod mechanics, LED display, counter module and timer module. Above all, micro-controller module serves to control. The block diagram in Figure 1. clarifies the structure of our design. Each block stands for a module. Also, the directions of all the arrows among those blocks indicate the communications among all these modules.

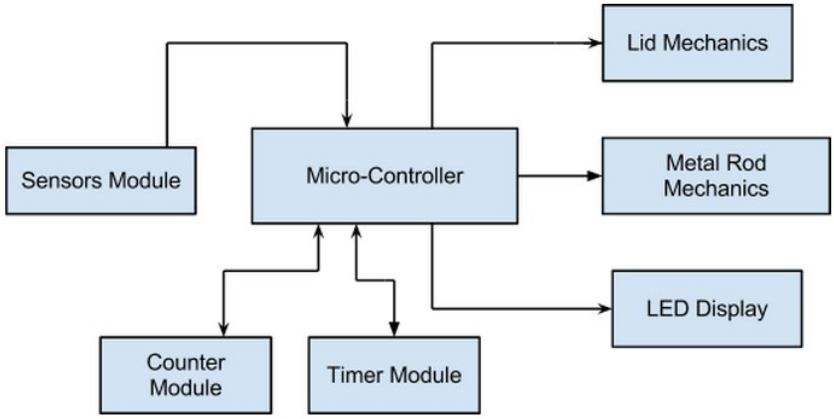

Figure 1. Top Level Schematic Layout

b) Block Description

i. Sensors Module:

In the design, sensors module, also known as detector module measures physical quantity and converts it into a signal which can be read by the micro-controller module. Three types of sensors are implemented, which are Passive Infrared Sensor, Load sensor and Liquid Leak Sensor. The signal generated by these sensors are implemented as inputs to the micro-controller module.

Passive Infrared Sensor: Passive infrared sensors, also known as PIR, detect if a human approaches. Strictly speaking, PIR do not detect human motions; rather, they detect abrupt changes in temperature at a given point. As a human body passes in front of the waste bin, the temperature at that point will rise from room temperature to body temperature, and then back again. This quick change triggers the detection. As RIP detects a user, it will send a signal to the controller module.

Load Cell: A load cell is a transducer which converts force into a measurable electrical output. In our design, the load cell is also connected to the micro-controller module. When the medical trash bag reaches 5 kilograms, the micro-controller module will pass a command to seal the current trash bag.

Liquid Leak Sensor: the liquid leak sensor is placed at the bottom of the waste bin. Hence, when swiftly, accurately and even small drip of the leakage is detected, the controller will pass a command to report the leakage on the LED display screen.

ii. Lid Mechanics:

The lid mechanics is such kind of device that will open or close the lid of the waste bin according to the signal given by the controller module.

iii. Metal Rod Mechanics:

The metal rod mechanics serve for one purpose, plastic bag sealing. The two metal rods are fixed on two sides at the entrance of the waste bin. Meanwhile a guide plate with high thermal conductivity is being used. The guide plate is designed to be able to move across the metal rods from one side to the other and driven by electronic sliders. As the controller module determines the bag of trash has achieved the certain weight (5 kilograms), it will pass a command to the sliders to move across the rods to the other side. As the guide plate reaches the destination, a current generated by the power supply will flow through the plate. With high thermal conductivity, the guide plate reaches 550 Kevin degrees easily. Plastic melts when temperature gets that high and the trash bag is sealed after cools down.

iv. Counter Module:

The counter counts the number of times that the lid opens or closes. Before a bag of trash is sealed, the counter will continue writing the information into the controller module.

v. Timer Module:

The timer keeps track of the current bag of trash until it is sealed. The timer will write information into the controller module.

vi. Controller Module:

The micro-controller module can be implemented by a chip and it will receive signals from the sensors module and send signals to lid mechanics, metal rod mechanics and LED display with certain programming.

vii. LED Display:

An LED display is a flat panel display, which uses light-emitting diodes as a video display. Here our LED panel will display weight, date and how many times the lid has been open or closed for current bag of trash. Also, the LED panel will tell if there is any liquid leakage or it is time to change trash bags.

viii. Power Supply

For the design, we decided to use an AC power supply. Considering the fact that the power supply needs to provide several voltages respect to each module. A 12 volt ATX power supply will be installed in this case.

3. REQUIREMENTS AND VERIFICATION

a) Requirements

i. sensors module:

infrared sensor: is able to detect an object approaching within 50 cm.

load sensor: is able to measure the weight of objects up to 10 kg.

liquid detection sensor: is able to detect if there is any liquid on the bottom of the waste bin.

ii. micro-controller module:

this module manage to receive signals from all sensors and transmit signals to other modules.

iii. lid mechanics:

- is able to drive the lid open for 3 seconds each time.
- is able to receive signals from the micro-controller.

iv. metal rod mechanics

- resistance wires on it can be heated to needed high temperature during a reasonable time.
- rods can move up and down, from left to right freely.
- is able to receive signal from the micro-controller.
- two rods can clamp the top of the trash bag tightly.
- motor is capable of supplying enough dynamic energy for the rods.

v. LED display

- is able to receive signals from the micro-controller.
- is able to display information clearly.

vi. timer and counter module

- timer is able to memorize the begin and stop time of the trash bag
- counter is able to record the number of times lid open
- is able to receiving and transmitting signals to the controller
- is able to be reset after the bag been sealed

b) Verification

i. sensor module:

Sensors will be tested separately and independently to make sure that each one functions properly. Infrared sensor will be tested to show the sensibility of detecting approaching human hands or body; load sensor will be tested to see if is sensitive to weight as small as 10 grams up to 10 kilograms; liquid detection sensor is tested to see the minimum amount of water it detects. All data should be noted down in tables.

ii. micro-controller module

first connect to a voltage source to see if all circuit is connected, giving particular values to each in ports and check the output value, make sure it's transmitted to appropriate terminals

iii. lid motor

Test if it can be driven by a power supply around 3 V (it's the expecting working voltage) and around this voltage, find a rotational speed of the motor that is more desirable, should be neither too quick nor too slow. Test how quick the motor respond to the signal transmitted from the controller by connecting its input terminal to a high signal. The frequency of the high signal given will be varied to justify the correspondence of the motor.

iv. metal rod mechanics

First check the setting of the rod, manually move them up and down, left to right, make sure their joints are securely connected to the waste bin. Next switch on the current, observe the raise of temperature of the resistive wires, use specific thermometer to test the temperature. Try them on trash bags, note down the time, temperature that successfully seal the bag as well as the tightness of the rod that push together the trash bag. Connect the input terminal of the rods to high signal, check the movements of the rod correspondingly. Check that motor, when connecting to a voltage source, provides enough power needed for rods.

v. LED display

connect the LED display to voltage source, check the screen visibility and response to various input signals.

vi. time and counter module

connect each of them to a voltage source, giving high signals to their inputs at random time, check the outputs count as expected

c) Tolerance

Most of the precise operations of the waste bin are depending on the infrared sensor, the readings of the electronic scale and the liquid leak detection sensor. The infrared sensor of the lid should be able to give a clear signal when anything is within 50cm of its range and give little or no signal when nothing is within range. We expect the maximum error to be within ±10 % (5cm), and the sensitivity of the infrared sensor can be modified by adding a voltage gate in the circuit.

The error in the electronic scale is expected to be no more than ±5 %. If the weight limit to drop the current bag is set to be 1000g, the bag should not be dropped before the scale reads 950g or later than it reads 1050g. Depending on what kind of electronic scale to use in the design, we will find the best way to minimize the error. The tolerance level of the liquid detection sensor can’t be easily quantified, since the unpredictability of the position is the nature of the leak, but the sensor is expected to show a clear reading no later than when 10mL of liquid has been dripped onto the sensor.

4. COST AND SCHEDULE

a) Cost Analysis

material	quantity	cost/$
load sensor	1	5
infrared sensor	1	5
liquid detection sensor	1	15
motor	2	60
PCB	1	35
metal rods	4	10
resistive wires	50cm	2
power supply cord	1	30
LED display	1	10
	material total	172

labor	hourly rate/$	total hours invested	salary/$
QIONG HU	30	150	11250
YANQIU YIN	30	150	11250
ZEKUN LIU	30	150	11250
total	90	450	33750

Grand total is 33750+175=33922$

b) Schedule

Before the end of	Content	Name
week4	hand in proposal; first TA meeting	all
week5	hand in profound and detailed review of the design; ordering all materials needed	all
week6	begin coding the micro-controller	ZEKUN LIU
week7	continue coding, debugging, testing	YANQIU YIN

week8	build the automatic open lid; test sensors	QIONG HU
week9	build the automatic sealing part; hand in individual progress reports	all
week10	spring break	all
week11	connect sealing rods to the waste bin	QIONG HU
week12	assemble the whole sealing part, debug	YANQIU YIN
week13	connect micro-controller with LEDs and everything	ZEKUN LIU
week14	final project test and improve	QIONG HU
week15	demos; preparation for final	ZEKU LIU
week16	presentation; hand in final paper; check out	YANQIU YIN