ECE 445 – SENIOR PROJECT (TEAM 31)

Smart automatic recycling trash basket

<The Project Proposal>

Suwon Shin

Scott Matthews

Kaiyuan Fan

Intro

Our project is to design a smart automatic recycling trash basket. We selected this project because it is an interesting solution to an everyday inconvenience, and we are looking forward to its completion because of its practical uses. We hope that the convenience of a recycling trash basket that helps its user sort materials will encourage more people to recycle.

The goal of this project is to essentially create a recycling bin that is just as convenient to use as the small desk-side trash cans that students and office workers use. We hope to promote recycling by making it as easy to recycle something, as it is to simply throw it away. In addition to this, we will make our product as affordable as possible to achieve widespread use.

The trash basket must be convenient as it is intended for practical use in everyday life. Some of these conveniences include:

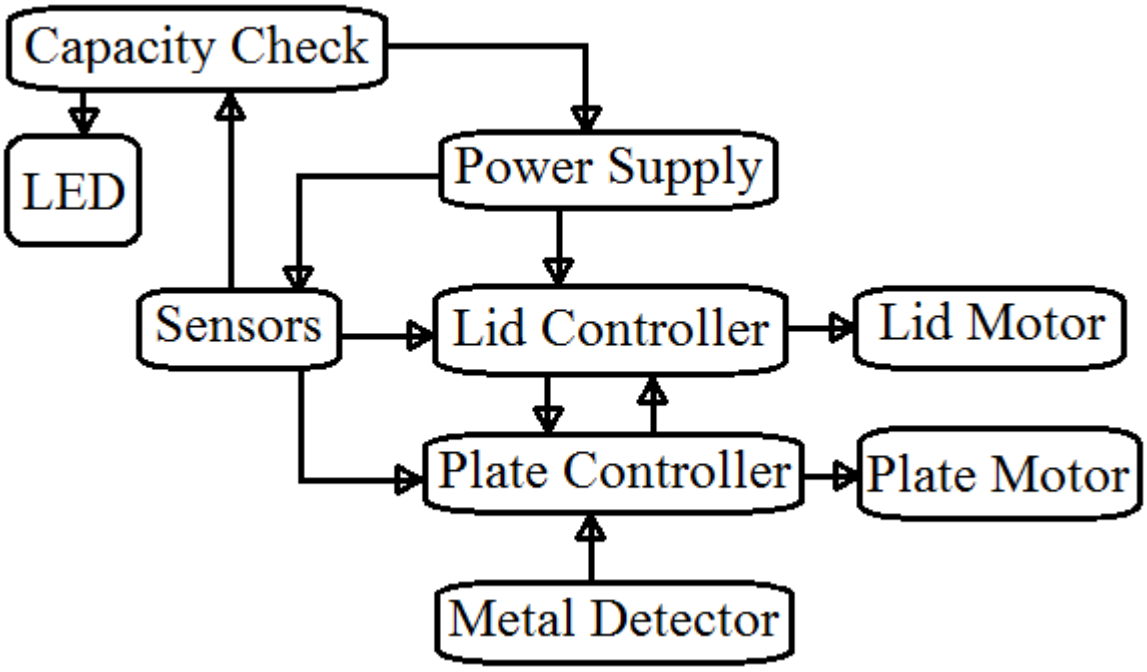
- Being able to sort recyclables automatically
- Automatic lid for ease of use
- Warning light indicating when a basket is nearly full

These will be accomplished through the use of the following features:

- Motor-operated lid that opens when it detects a nearby object
- Motor-operated tilting plate that closes off one bin to ensure proper disposal
- Internal infrared sensors that detect when either bin is getting too full
- Lid-mounted LED display that indicates when one or both baskets are full

Design

The block diagram on the following page describes the various components of the automatic recycling trash basket and their relationships to each other. Three separate sensors detect if an object is present, the type of object to be recycled, and whether or not the basket is full. The capacity check circuitry will activate the LED display when full. As for the functionality of the basket itself, the basket lid and the tilting plate are operated by motors, and as such are only activated when their control circuitry indicates to do so. The interaction between the two control circuits allows for a set amount of time that the basket lid is open.



Requirements and Verification

Block	Requirement	Verification
Microcontroller Unit		
Lid Controller	1. Receive the sensor signal by programmable chip and transfer command signal to Motor to start mechanical motion(Open) 2. Stop proceed action signal to motor for certain seconds 3. Send second command to motor to achieve the CLOSE action 4. Proceed another signal to active Detection Controller 5. Wait until receive feedback signal from detection controller to start new cycle again. 6. If there is a signal from capacity monitor, turn to STOP status and let the lid closing until the signal is disappears	Test the coded chip with standard inputs(1/0) to different pins and measure the corresponding out pins result by oscillator equipment in school lab Use stop watch to check the waiting periods Set opening time to 3s That T(open) = Tm+Tw = 3s; Tm = time motor takes to complete the action on lid, set Tm ≤ 0.75s by control the speed of motor Tw = time the controller wait for the trash to be thrown in. While T(close) = Tm
Detection Controller	1. Start a operation cycle after the signal from Lid controller	Test the chip with 1/0 inputs to pins to simulate all the state situations

	2. Actions depends on the sensor inside the basket, if nothing has detected, call END signal back to Lid controller; if anything detected, active metal detector. 3. Detector find metal, proceed to motor to open metal bin(tilt the plate to metal side) 4. Detector didn't find, proceed to motor to open paper bin(tilt the plate to paper side) 5. Wait certain seconds(T[open]) to let OPEN action done 6. Call motor to close the bin, and send END signal back to Lid controller when the bin closed.	and check the correctness of responded outputs. Check certain waiting period between two states with stopwatch. T(open) = Tm T(close) = Tm Set Tm ≤ 0.75s by control the speed of motor Plate is fixed in horizontal before motor start by controller. It need to be strong enough to hold heavy metal trash. Test with maximum load of 5kg to decide the materials & structure of the plate and its holder. Plate should tilts over 60^0 to open big enough and let larger pieces drop in bins
Motor		
Plate motor	1. Able to receive two different signals from controller and response in opposite movement 2. Need to be drive by DC source like batteries.	Motor Condition synchronous servo motor Vdc = 1.5-4.5V(drived by 1-3 batteries) Higher Efficiency: Higher speed to reduce Tm with less power consumed
Lid motor	1. Able to receive two different signals from controller and response in opposite movement 2. Need to be drive by DC source like batteries.	Motor Condition synchronous servo motor Vdc = 1.5-4.5V(drived by 1-3 batteries) Higher Efficiency: Higher speed to reduce Tm with less power consumed
Sensor		
Lid Sensor	1. It needs to detect presence of objects in front of the wastebasket within 50 cm. 2. Need few ones to placed on the top of lid to increase the detective angle.	Sensor Condition: RF/Infrared Stable operation and lower failure rate, tests form in different testing distance and content sizes Less Reaction time: T ≤ 0.5s

		Detectable Angle > 60^0 Use less than 3 sensors to enlarge to the angle.
Inner Sensor	1. Need higher sensitivity then others in this project to detect mini size of trash	Sensor: Higher detect resolution: test the sensor with min objects at $0.25cm^3$, paper at $0.25cm^2$
Capacity Sensors	1. 2 detectors should focus on the available capacity in each sub-basket, and give a signal back to the circuit if they are full.	Use one like lid sensor but has less detection distance within 5cm Place the sensor on top of the bins and detect anything pile up to the top
Metal Detector		
Oscillator	1. Be able to generate alternating current into coil from dc current supply by DC power supply	Current need to be operates in a certain level that the magnetic field would be affected by any existing metal inside the bin at the bottom
Coils	1. One coil used to generate magnetic field with oscillating current 2. One coil for measuring the electric field as a magnetometer, the change in the magnetic field due to the metallic object can be detected	Fixed the coil size to keep the measuring range around the area above the tilt able plate
Power Supply	1. Aim on one supply to support the entire electrical device in this project with different needs of voltage and current values.	Using a series of voltage dividers to approach multi operation voltages on each device

Tolerance Analysis

Sensor

All the precise performances in project are quite rely on the sensors with high accuracy and long-term stability. The lid sensor should assure its measurement within 50cm and give slight or no reaction for anything stays 50cm away from the lid. However the V-I characteristic of the sensor

may perform in a peak curve, it can be improved by adding a voltage gate like diode to trigger the signal to controller:

I_{50cm} * R > V_{gate} , The maximum Distance Error within±10%(5cm) will considered into the detection result to controller. The inner sensor used for plate aims more on detectable objects size than distance, sensors in PIR may works better to reacted on smaller objects within 20-25cm; Bin sensors need a narrow detection range in 10(±0.5) cm with less error to ensure that the bin is really full, only 5% of distance error would be tolerate.

Cost and Schedule

1. Cost Analysis

1) Labor:

Suwon Shin ($15/hour) x 2.5 x 160hours=$6000
Scott Matthews ($15/hour) x 2.5 x 160hours=$6000
Kaiyuan Fan ($15/hour) x 2.5 x 160hours=$6000

2) Parts:

Microcontroller Unit:
Lid controller ($30) + Detection Controller ($40)= ($70)
Motor: ($120)
2 Sensors: (Each $40 = $80)
Metal Detector: ($50)
Power Supply: ($30)
Miscellaneous: ($30)

3) Grand Total:

Labor + Parts = $18,000 (Labor) + $380 (Parts) = $18380 Estimated

2. Schedule

Week 5: Buying materials for this project / Starting body lid part connecting motor and sensor

Week 6: Continuing Body lid part connecting the motor and distance sensor

Week 7: Starting the inner lid part and inner sensor to detect whether it is metal or not

Week 8: The inner lid part and inner sensor to detect whether it is metal or not

Week 9: Assemble the whole parts and Debugging / Preparation for the individual progress report

Week 10: Debugging / Preparation for Mock-up Demos / Test integrated system

Week 11: Setting the LED part to give a caution for the full trash basket

Week 12: Setting the LED part to give a caution for the full trash basket

Week 13: Thanksgiving Break / Preparation for the Final Paper

Week 14: Debugging for Demos / Making power point slides / Final Paper

Week 15: Preparation for presentation and Debugging / Final Paper

Week 16: Preparation for presentation and Final Paper / Checkout