Smart Closet

Project Proposal

ECE445

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Table of Contents

1 introduction

1.1 Statement of Purpose

Selecting clothes in closet become an inconvenient behavior for most of people. People cannot directly see the outlook of each clothes and even do not know how many times the clothes have been worn. We try to design a smart closet which can sort different types of clothes, highlight the clothes that people select, take picture for clothes and record the use time. People can easily manage their closet via their smart phone, and they can see the picture and status of their clothes on app.

Compare to transporting rack system in dry cleaning room, our design has some unique function. First of all, this smart closet link every clothes with phone app, and our database will record picture, status, worn time as information. Second, smart closet is based on personal use unlike the commercial purpose. And last but not least, there are rarely similar solution as smart closet on the market, except some customized closet and some pure digital smart closet app on phone.

1.2 Objectives

1.2.1 Goals & Benefits:

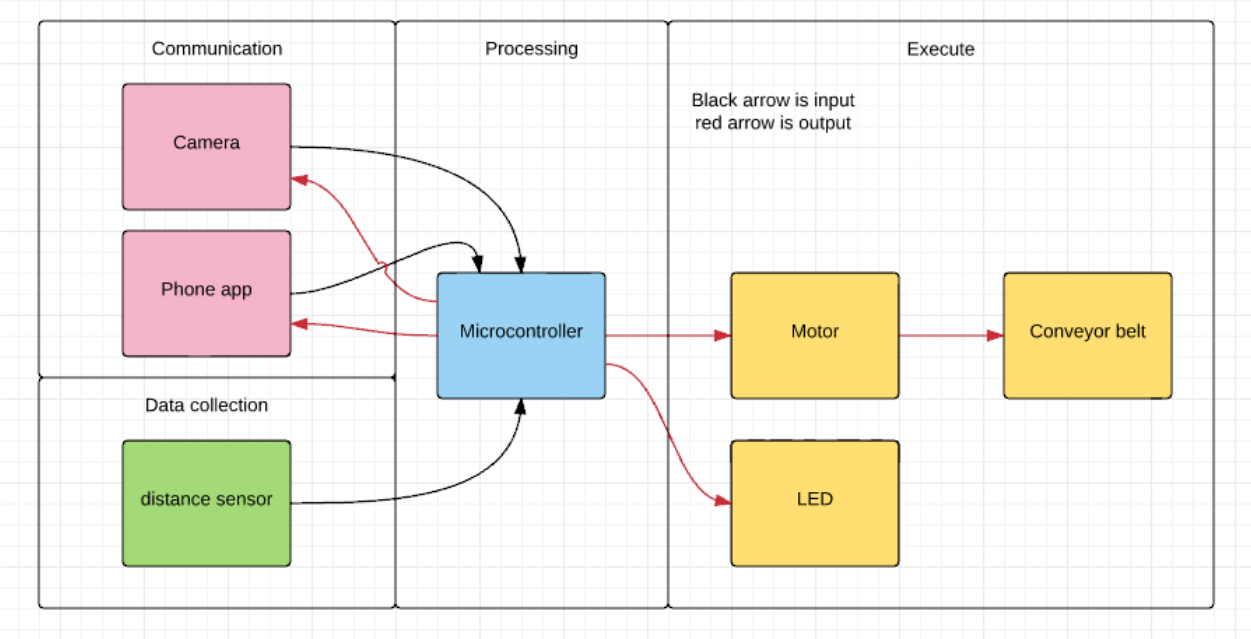
- Reduce time to find clothes
- Help people better sort clothes
- Manage clothes when outside home

1.2.1 Functions & features:

- Record clothes' use time
- Take picture for each clothes
- Use LED to help people locate clothes
- Distance sensor to detect clothes
- Use Knex chain to transmit clothes on hanger
- Remote operation via WIFI mode
- Database of clothes on phone app
- Pick up clothes at center of rack

2 Design

2.1 block diagram



2.2 Block Descriptions

2.2.1 Data collection Module

This module is collecting data to inform microcontroller whether or not to stop the motor.

2.2.1.1 Distance Sensor

This kind of distance sensor is small and can output a high voltage (2.8V) signal when there's something in front of sensor (around 15 cm), otherwise it can output a low voltage. And microcontroller can halt the motor if distance sensor output a high voltage signal. Can be bought online easily.

2.2.1.2 Computer vision

When people want to pick up the clothes they want, the LED will become green on the hanger. We will use a camera to capture the LED light on the hanger, and when a Green light passing through the center of the camera, we will stop the motor and people can take off the cloth they want.

2.2.2 Communication Module

This module is communicating between separate modules and microcontroller, sending information to microcontroller and receiving as well.

2.2.2.1 Camera

When distance sensor output a high signal and motor is halted, then microcontroller will output a high voltage signal to camera to let it photo. After getting a photo camera will upload the image to microcontroller, and send a signal to tell microcontroller it is ready to take next photo. This camera module should link to the controller by wire, like some Raspberry Pi camera kit.

2.2.2.2 Phone App

When microcontroller get a photo, it will update this information into phone app's database. And link a hook number to the photo. So every time microcontroller get some new information, that information will sync to the phone app. App and microcontroller have a same type of database structure, including clothing type, picture, hook number, worn days, location status(in or outside of closet). When user request a clothes through app, phone will send hook number information to microcontroller, and microcontroller can lit the LED over that specific hook number. Phone app planned to be in android system.

2.2.3 Processing Module

Process all the data and control motor and LED system. Storing a database.

2.2.3.1 Microcontroller

Receiving signal from distance sensor to control the on and off of motor. Receiving photo information from camera, and direct camera when to take photo. Also sync a database with phone app. Use the database information and request from phone app to control LED system. We plan to use Raspberry pi with a touch screen.

2.2.4 Execute Module

Microcontroller will control all modules here.

2.2.4.1 Motor

Controlled by microcontroller, must respond quickly to the signal. This motor powers Knex chain. Buy it from store or online.

2.2.4.2 LED System

Controlled by microcontroller. Each clothes hook have two LED, one is red and one is green for example. Red indicates this clothes should be pick, green indicates this clothes wear too many times.

2.2.4.3 Knex chain

Powered by motor, will stop if motor stop. It should be a thin belt that can hang a hook on it. Planning to build this belt on our own, since the price is too expensive outside.

3 Requirements and Verification

Requirement	Verification
Data Collection Module\ Distance sensor 1. $V_{out1} = 2.8\,V \pm 0.1$ V $V_{out2} = 0.4\,V \pm 0.1$ V	1. Verification Process for Item 2.2.1.1: (a) Provide the supply voltage between 4.5 and 5.5VDC (b) Put a reflective object at distance 15cm from the infrared proximity sensor, measure the output voltage V_{out1} (c) Put a reflective object at distance 15cm from the infrared proximity sensor, measure the output voltage V_{out2}

Computer vision 1. output 1 when detect output 0 when not detect	2.Verification Process for Item 2.2.1.2: (a) Let cloth pass through rack (b) Measure distance from cloth to center when motor stopped. (c) Ensure that the distance not exceed ±5cm
Communication Module 1. An jpeg format image is stored in the memory of Raspberry Pi 2. Message and picture are received on both devices without timing out. Timeout should be 5s ±2s.	1. Verification Process for Item 2.2.2.1: (a) Open up Raspberry Pi Camera module (b) Install the Raspberry Pi Camera module by inserting the cable into the Raspberry Pi (c) Boot up your Raspberry Pi (d) Run “sudo raspi-config”, the “camera” option should apear (e) Navigate to the “camera” option and enable it. Select “Finish” and reboot Raspberry Pi (f) Type “raspistill” –o image.jpg at the prompt to capture an image 2. Verification Process for Item 2.2.2.2: (a) Install the program on mobile phone, send a plain text message to other designated mobile phone under good network connection (b) Send back a picture if the other phone receives the message and the internet connection remains stable (c) Send acknowledge message if the first phone receives the picture and the internet connection remains stable

Processing Module 1. After the boot process, a login prompt will appear. After user log-in, raspberry pi will appear at command line prompt.	1. Verification Process for Item 2.2.3.1: (a) Slot SD card into the SD card slot on the Raspberry Pi (b) Plug in USB keyboard and Mouse into the USB slots (c) Connect HDMI cable from monitor to Raspberry Pi (d) Plug in an Ethernet cable into the Ethernet port (e) Plug in the micro USB power supply. This will turn it on and boot. (f) Select an operating system and configure
Execute Module 1. The motor should take around 64 steps per revolution and has a 64:1 gear ratio. 2. The corresponding light should be on when the LED is powered. 3. The chain is stable. The cycle is not broken in the middle. Maximum support weight 30kg ± 5kg.	1. Verification Process for Item 2.2.4.1: (a) Supply the motor with 9v battery (b) Measure the revolution speed 2. Verification Process for Item 2.2.4.2: (a) Supply each LED bulb with VCC = 5v (b) Observe the behavior of the bulb 3. Verification Process for Item 2.2.4.3: (a) Connect the chain into a circle (b) Use it to hold maximum clothes along with hangers

4 Tolerance Analysis

The respond time for the motor to stop when it get the signal from the microcontroller is a hard task for our project. When distance sensor detect the clothes 15 cm in front of it, it will output a 2.8 V voltage. Microcontroller will notice this change, and cut off the power for motor. But this process may have some delay that let cloth out of the vision of camera. We think a ± 5 cm difference is acceptable, because the vision of the camera can capture a whole image for cloth around ± 5 cm from center.

5 Cast & Schedule

5.1 Cost analysis

5.1.1 Labor

Name	Hourly rate	Total hours	Total= hourly Rate *2.5 *total hours
Luchuan zhang	$30	250	$18750
Guannan guo	$30	250	$18750
Yiwei li	$30	250	$18750
		750	$56250

5.1.2 Parts

Item	Quantity	Cost
Distance sensor(infrared Proximity by sharp)	1	$12.5
Raspberry pi	1	$39.95
LED bulbs	30	$10
Raspberry pi Miniature WIFI	1	$11.95
Raspberry pi camera Board	1	$29.95
RioRand Stepper motor	1	$24.95
Knex chain	20 feet	$20
Whitmor Rack	1	$20.65
Grand Total		$169.95

5.1.3 Totals

	Labor	**Parts**	**Total**
Paid Engineering	$56250	$169.95	$56419.95
Volunteer Engineering	$0	$169.95	$169.95

5.2 Schedule

Week	**Task**	**Delegation**
2/8/2016	Prepare project proposal Research Raspberry pi	Luchuan zhang Yiwei li Guannan guo
2/15/2016	Research camera and wifi mode	Yiwei li
	Purchase Raspberry pi and other mode	Luchuan zhang
	Prepare mock design review	Guannan guo
2/22/2016	Begin build up mechanical(motor and chain)	Luchuan zhang
	Install microcontroller	Yiwei li
	Prepare design review	Guannan guo
2/29/2016	Write control logic	Yiwei li
	Set up camera and distance sensor	Guannan guo
	mechanical part debugging	Luchuan zhang

3/7/2016	Finishing logic build up	Yiwei li
	test motor and camera	Luchuan zhang
	Begin write code for app in phone	Guannan guo
3/14/2016	Link phone app with Raspberry pi	Yiwei li
	Run test on output of microcontroller	Guannan guo Luchuan zhang
3/21/2016	Install LED system	Luchuan zhang
	Test communication between phone and Raspberry pi	Guannan guo Yiwei li
3/28/2016	Communication system: debugging	Guannan guo Yiwei li
	Test LED system with different signal	Luchuan zhang
4/4/2016	Prepare Mock demo	Luchuan zhang Guannan guo Yiwei li
	Testing/debugging system	
4/11/2016	Testing/debugging system	Luchuan zhang Guannan guo Yiwei li
	Prepare final demonstration	
4/25/2016	Optimization/remain issues	Luchuan zhang Guannan guo Yiwei li
	Prepare final report	
5/2/2016	Final Presentation and Final Demos	Luchuan zhang Guannan guo Yiwei li