Automatic Pet Feeder Project
Project Proposal

TA: Henry Duwe

Project Contributions:

Zhuokai Zhao   zzhao33
Ziyun He        ziyunhe2
Fan Ling        fanling2

February 10, 2016
# Table of Contents

1. Introduction .................................................................................................................. 2  
   1.1. Motivation ................................................................................................. 2  
   1.2. Objectives ................................................................................................. 2  

2. Design ..................................................................................................................... 3  
   2.1. Block Diagrams ......................................................................................... 3  
   2.2. Block Description ....................................................................................... 4  
      2.2.1. Microcontroller .............................................................................. 4  
      2.2.2. RFID module ............................................................................... 5  
      2.2.3. Sensors Measuring Food Containers ........................................... 5  
      2.2.4. Sensors Measuring Food Plates .................................................... 5  
      2.2.5. Bluetooth Module ....................................................................... 5  
      2.2.6. Servomotor Controlling Food Gate ............................................ 5  
      2.2.7. Servomotor Controlling Food Plates ......................................... 6  
      2.2.8. Phone application ....................................................................... 6  

3. Requirement and verification ................................................................................. 6  

4. Tolerance and analysis ......................................................................................... 8  

5. Cost and schedule ............................................................................................... 8  
   5.1. Cost ........................................................................................................ 8  
   5.2. Schedule ................................................................................................ 9
1. **Introduction**

We chose this project because pet keeping is a time consuming responsibility and we want to provide convenience to owners by helping them feed their pets easily and smartly.

### 1.1. Motivation

Keeping pets takes many commitments. This includes keeping them company, showing your concerns and of course, feeding them on time and in the correct way. However, not everyone is a pet expert, taking care of your pet’s diet can be hard and time consuming. One of the top health concerns of pets are overeating and obesity. Especially at younger age, they are usually satisfied with however much is given to them. Many adult pets are fed unscientifically that later may cause short lifespan. Another problem of feeding pets is that owners might not always be home regularly. Being occupied by personal plans knowing that they still have a starving little fellow at home to be taken care of is always a concern that bothers owners. The third concern that we want to deal with is the fact that there hasn’t been any product on the market right now that is able to dispense different foods for different kinds of pets. However, pets themselves might not necessarily recognize the potential health problems of eating the wrong food. Therefore, we want to take care of owners’ concern of feeding by building a phone-controlled automatic pet feeder that can dispense the correct amount of food on time, based on the type of animal that’s demanding it.

### 1.2. Objectives

Our project is designed to help all the pet owners to feed their pets remotely and smartly.

**Benefits to customer:**

- Owners will be able to feed the correct amount of food to their pets by setting it on the phone app. The information will be transferred to the PCB via Bluetooth, which will send signals to food dispensing gates.
- Owners will be able to monitor their pet’s health condition via their daily consumption of food recorded by the app. Sensors will be embedded on the food plate, which measures the difference of weights by the end of each day. Information will be processed by PCB and sent to the phone app.
- Owners with two different types of pets will be able to feed them separately with corresponding food. In particular, a household can have dogs of different ages that need different food; or if the owner owns both dog and cat and does not want them to eat the wrong food by accident. Each pet will have a RFID tag. When the RFID receiver identifies the type of animal, the correct angle of food plate will be spinned so that the corresponding food will be exposed.

**Product feature:**

- The phone app could set the correct amount of food to drop at the correct time.
• The phone app could save a pet profile (name, age, birthday, weights, etc) for owners to keep track.
• The app could keep track of how much food the pets have consumed in a long run graphically.
• The machine could be sustained by both power cords.
• RFID will be embedded into pets’ tags to differentiate types of pets for different food needs.

2. Design
   2.1. Block Diagrams

![Block Diagram Image]

Figure 1: General block diagram of the hardware design
2.2. Block Descriptions

2.2.1. Microcontroller

We choose to use AVR 8-bit microcontroller because it provides a nice compatibility with any of the other modules on the market. 8-bit is also sufficient for our purposes. The microcontroller is the central control unit of the whole system. It will be collecting many inputs. This includes: measurement from sensors, which will be transferred to phone devices via Bluetooth; RFID activation signal from the reader, which will be processed in the microcontroller; data acquisition signal from the Bluetooth, which asks the daily food consumption data stored inside of the microcontroller. The microcontroller also generates several outputs. First, after receiving triggered signal of RFID, it will look up the angle to spin for the round food plate if current exposed region is not for the particular animal. Second, when the weight sensor on the food plates measures insufficient amount of food, the microcontroller will signal to rotate the gate by the precalculated angle and dispense 100 grams of food for the animals. We chose to dispense 100 grams of food at once to make sure that the dispensing process is in a range that we can control and it also helps minimize collateral damage in case the pet trips the machine over and spills all the food. Once the total amount dispensed has reached the upper limit that the owner has set, no more food will be able to dispense. This feature helps prevent overeating problem of
pets. The microcontroller will be storing the weight of remaining food in the containers only when there is an action of food dispense, while storing the food weight on the food plates at regular time to keep track of animals’ food consumption. In addition, the microcontroller also stores the consumption data which will be transferred to the phone upon Bluetooth request.

2.2.2. RFID Module
Passive RFID module will be used to recognize different pets and dispense food correspondingly. We chose passive RFID for two reasons. First, it minimizes the consumption of electricity and potential danger of the pets by having no on-tag power supply. Secondly, passive RFID grants small read range for the receiver. Having a small read range minimizes the possibility that the receiver misrecognizes a pet for eating when it’s only hanging out around the machine to prevent unnecessary mechanical movements and electrical consumption. When the animal has come to the range of the reader (50 cm), microcontroller will be notified by the receiver. The microcontroller will signal the round food plate to spin at the precalculated angle and expose the correct section of food for the animal to have.

2.2.3. Sensors Measuring Food Containers
Two identical cylindrical containers will be assembled at the top of the machine, with a weight sensor attached to the bottom of each container. The sensors will be taking measurements constantly and sending their data to the microcontroller, while microcontroller stores data only when an action of food dispense has occurred.

2.2.4. Sensors Measuring Food Plates
There will be two separate food plates in the shape of half-circles. Two weight sensors, one for each half of the food plate, will be attached to the bottom of the plates. The sensors will keep track of the amount of food the pets have consumed. The sensors will be taking measurements constantly and sending their data to the microcontroller, while microcontroller stores data on specified time of the day.

2.2.5. Bluetooth Module
Bluetooth module will be implemented by HC-06 Wireless Bluetooth Transceiver Module. HC-06 module is a widely used bluetooth module which supports Bluetooth 4.0 technology and can provide a significant small latency (approximately 3ms). It can be connected directly to the 5V AVR 8-bit Microcontroller. The effective distance of this device is 10m, which would satisfy an easy connection and pairing.

2.2.6. Servomotor Controlling Food Gate
There will be a 120° pie shape opening on the bottom of each food container, which corresponds to the same 120° pie shape on the gate plate. The gate plate is a smaller circular shape plate
attached in the middle of the two containers. With the 120° opening on the gate plate, it allows the food to be dispensed when the two pie shapes overlap with each other. Servomotor, controlled by microcontroller, will be spinning the gate plate to desired location.

### 2.2.7. Servomotor Controlling Food Plates

The food plate will be a half closed structure where only one side of the food plate would be exposed at a time. Once RFID reader signal is triggered, microcontroller will be sending spin information to the motor. The servomotor will spin the plate by the specified angle and direction to expose the corresponding half of the plate for the particular pet.

### 2.2.8. Phone application

Figure 2 is a state diagram that shows a complete execution logic of the phone application. The edges represent inputs from the user. The ones without any illustration are assumed to be “of all inputs”. The application will send and receive information to/from the feeder via Bluetooth connection. Bluetooth 4.0 will be preferred but 3.0 will also be accepted.
The first page of the interface will be the Home page. Three tabs will be displayed: “Set”, “Profile”, and “Data”. When user clicks on either “Set” or “Profile”, they will be prompted to select either Pet 1 or Pet 2 first. The user will then have the option to enter the food information for the selected animal. If the entered amount is invalid (negative or exceeds our maximum capacity), a warning will be prompted and it will go back to the previous state and ask user to enter the numbers again. After completing the “Set” information, the software will go back to its initial Home state.

If the user chooses to enter the bio-information of the pet by pressing “Profile”, a form which contains questions including the age, weight, and gender will be given to the user. Then the user will again go back to the Home screen.

In addition, the third tab “Data” enables the users to collect information of pets’ food consumption. When the tab is pressed, the phone will be sending a data request signal to the microcontroller. When the data is acquired, it will ask the user to choose between “Graph” and “Today”, which will generate either a graph of pets’ weekly consumption or more detailed information of today’s consumption.

### 3. Requirement and Verification

<table>
<thead>
<tr>
<th>Module</th>
<th>Requirement</th>
<th>Verification</th>
<th>Points</th>
</tr>
</thead>
</table>
| RFID Module     | a. Be able to recognize the pets correctly in the range of 50 cm +/- 15 cm | a) 1. Connect the receiver to a computer through an Arduino  
2. Test the RFID tag from 40 cm to 80 cm away from the receiver | 15 points |
| Sensors Measuring Food Plates and Food Containers | a. Be able to measure the correct data at 15 grams tolerance  
b. Be able to respond to the changes of weights in food containers accurately | 3. Check the data sent to the computer and monitor the range when the receiver stops recognizing the tag |
| --- | --- | --- |
| | a)  
1. Connect the sensor to a computer through an Arduino  
2. Fill the food container with a known amount of pet food (i.e., 200g)  
3. Check the data generated by the weight sensor and see if it’s within the tolerance  
b)  
1. Gradually pour food into the container  
2. Observe the data change via computer to see if there is any discontinuity or unusual |
| Bluetooth Module | a. Be able to connect with the phone app  
b. Has at most 5 ms latency for signal transferring | 20 points |
| | a)  
1. Connect the phone with the Bluetooth Module  
2. Check the connectivity status on the phone  
b)  
1. Write a code to check the speed of response signal on Arduino  
2. Connect the Bluetooth module to computer through the Arduino  
3. Send a signal from the Bluetooth module  
4. Check the result responding time |
| Servomotor Controlling the Food Gate and Food Plates | a. Be able to rotate the food gate for specified degree in a given direction  
b. Steady performance | 20 points |
| | a)  
1. Connect the motor to the computer through an Arduino  
2. Send specified degrees and direction to the motor  
3. Check motor’s performance  
b)  
1. Perform test a) 10 times  
2. Check motor’s accuracy |
| Microcontroller | a. Be able to receive inputs and generate right output signals  
b. Be able to store data | 20 points |
| | a)  
1. Power the microcontroller with 5V  
2. Connect a LED to the microcontroller  
3. Program the microcontroller to light the LED up when a digital signal of high is received  
4. Input the signal through a constant DC voltage as a logic high via function generator  
5. Check if the circuit behaves normally  
b)  
1. Power the microcontroller with 5V  
2. Connect the microcontroller to several LED’s  
3. Program the microcontroller to store the data upon receiving it, and display it on LED when the button is pushed  
4. Push the button and check if the circuit behaves normally |
4. Tolerance Analysis

In terms of our project, the high level goal is to make two pets to be fed by the right food in the correct amount. More specifically, for every time the food is dispensed, 100g of food should be released. The maximum tolerance allowed is +/- 15 g so we are able to keep track of pets’ food consumption in a more accurate way. Among all components, bluetooth latency will not have significant effect because it should not happen at the time of dispensing. The accuracy of the servomotor at the gate of the dispense does not have a huge impact on our high level goal. This is because the amount of food dispensed is controlled by the weight sensors so that it will still be able to dispense the right amount, although the off of angle might cause the dispensing process to be not as smooth.

On the other hand, the weight sensors we will be using, which consist of load cells and AD modules, are the most essential part of our project, because we want to make sure that the correct amount of food is dispensed so that we can obtain the accurate information of each pet. The load cells we are going to use will have a range from 0-5 kg. To test the tolerance of the sensor, we will be loading different amount of food onto the plate and check its accuracy compared to the actual one. Though normally the food container will not be big enough to hold 5 kg, it is still important to test its extremes cases. To perform the test, we will put food of exactly or slightly over than 5 kg on the load cell and see if it’s measuring correctly. The results will be recorded in the notebook.

5. Cost and Schedule

5.1. Cost

<table>
<thead>
<tr>
<th>Labor</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhuokai Zhao:</td>
<td>2.5 * 50</td>
<td>$5,000</td>
</tr>
<tr>
<td>Ziyun He:</td>
<td>2.5 * 50</td>
<td>$5,000</td>
</tr>
<tr>
<td>Fan Ling:</td>
<td>2.5 * 50</td>
<td>$5,000</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>$15,000</td>
</tr>
</tbody>
</table>
Parts List:
1. Arduino (free in the lab)
2. Four HX711 Load Cell Weighing Sensor AD Module ($9 each)
3. Four Load Cell Sensor 0-5 kg ($6 each)
4. Two Arduino T010051 Motor ($14.36 each)
5. Two RFID Module ($8.99 each)
6. Two Buckets for Food Container and Outside Cone Shape ($4+$8)
7. HC - 06 Wireless Bluetooth Transceiver Module($5.99)

Sum planned parts cost: $118.71

Grand Total: $15,118.71

5.2. Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Task</th>
<th>Responsibility</th>
</tr>
</thead>
</table>
| February 8 | -Finish Project Proposal  
-Prepare for Mock Design Interview                                 | Ziyun He        |
|            | -Finish Project Proposal  
-Prepare for Mock Design Interview                                 | Fan Ling        |
|            | -Finish Project Proposal  
-Prepare for Mock Design Interview                                 | Zhuokai Zhao    |
| February 15| -Complete the Eagle Assignment  
-Consult Experts                                                      | Ziyun He        |
|            | -Complete the Eagle Assignment  
-Consult Experts                                                      | Fan Ling        |
|            | -Complete the Eagle Assignment  
-Select and Acquire Equipment, such as Servo, Weight Sensors, RFID, and Bluetooth Module | Zhuokai Zhao    |
| February 22| -Complete Soldering Assignment  
-Build “Profile” Tab for Phone App                                    | Ziyun He        |
|            | -Complete Soldering Assignment  
-Build and Test the Power Module                                      | Fan Ling        |
|            | -Prepare for Design Review  
-Design and Acquire PCB                                                 | Zhuokai Zhao    |
| February 29| -Build “Setting” Tab for Phone App                                   | Ziyun He        |
|            | -Build and Test the Power Module                                     | Fan Ling        |
|            | -Test and Find the Right Spin Speed for Both Servomotors             | Zhuokai Zhao    |
|            | -Design and Acquire PCB                                               |                 |
| March 7 | - Build “Setting” Tab for Phone App  
- Design and Acquire PCB  
- Test and Find the Right Spin Speed for Both Servomotors  
- Test the Weight Sensors and Obtain Their Limits | Ziyun He |
| March 14 | - Build “Data” Tab for Phone App  
- Build the Outside Supporting Structure, Gates, Food Plates, Dividers and Containers  
- Test the Weight Sensors and Obtain Their Limits  
- Build the Outside Supporting Structure, Gates, Food Plates, Dividers and Containers | Zhiyuan He |
| March 21 | - Build “Data” Tab for Phone App  
- Build the Outside Supporting Structure, Gates, Food Plates, Dividers and Containers  
- Build and Test Bluetooth Module  
- Test Sensor and Servo with PCB  
- Complete R&V Table  
- Build and Test Bluetooth Module | Zhiyuan He |
| March 28 | - Test App Functionalities with PCB  
- Test Sensor and Servo with PCB  
- Test Bluetooth and RFID Modules with PCB | Zhiyuan He |
| April 4 | - Finalize R&V Table  
- Prepare for Mock Demo/Debug  
- Prepare for Mock Demo  
- Finalize PCB  
- Finalize R&V Table  
- Prepare for Mock Demo | Zhiyuan He |
| April 11 | - Testing and Debugging App Functionality with PCB  
- Prepare for Mock Presentation  
- Testing and Debugging Sensor and Servomotors  
- Prepare for Demo  
- Testing and Debugging RFID and Bluetooth Module  
- Prepare for Demo | Zhiyuan He |
<table>
<thead>
<tr>
<th>Date</th>
<th>Tasks</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 18</td>
<td>- Corner cases and Optimization with App</td>
<td>Ziyun He</td>
</tr>
<tr>
<td></td>
<td>- Prepare for Mock Presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Corner cases and Optimization with Sensors and Servomotors</td>
<td>Fan Ling</td>
</tr>
<tr>
<td></td>
<td>- Prepare for Mock Presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Corner cases and Optimization with RFID and Bluetooth Module</td>
<td>Zhuokai Zhao</td>
</tr>
<tr>
<td></td>
<td>- Prepare for Demo</td>
<td></td>
</tr>
<tr>
<td>April 25</td>
<td>- Complete Final Paper</td>
<td>Ziyun He</td>
</tr>
<tr>
<td></td>
<td>- Prepare for Presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Final Paper</td>
<td>Fan Ling</td>
</tr>
<tr>
<td></td>
<td>- Prepare for Presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Final Paper</td>
<td>Zhuokai Zhao</td>
</tr>
<tr>
<td></td>
<td>- Prepare for Presentation</td>
<td></td>
</tr>
<tr>
<td>May 2</td>
<td>- Finalize Final Paper</td>
<td>Ziyun He</td>
</tr>
<tr>
<td></td>
<td>- Finalize Final Paper</td>
<td>Fan Ling</td>
</tr>
<tr>
<td></td>
<td>- Finalize Final Paper</td>
<td>Zhuokai Zhao</td>
</tr>
</tbody>
</table>