CSE 145: Brilliant Pad Poo Vision Project Specifications

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# Project Charter

## Project Overview

## The Brilliant Pad is a device that has the purpose of being an automated potty for dogs. Our project is to improve the Brilliant Pad device by adding a vision system through extra components such as a camera to increase its ability to detect a dog on the pad and to allow the pad to determine how soiled it is ie. 10%, 20% soiled. With this vision system, the Brilliant Pad will be able to automatically advance a soiled pad given a threshold of soiledness.

## Project Approach

## We are using a Raspberry Pi Zero and a Pi Zero Camera to detect waste on the BrilliantPad. Using a widely available computer vision library, OpenCV, we aim to use the image output of our Camera module to distinguish between a clean pad and a dirty pad, and to detect when a dog is present on the pad. The overall goal is to integrate our system with the Brilliant Pad’s current control module and design.

## Project Objectives, Milestones, and Major Deliverables

Below are the key milestones and objectives that our team has established for the Brilliant Pad Poo Vision. These key milestones are further broken down into weekly milestones later in the document.

**Key Milestone 1 - Create and design mechanical prototypes to mount the Camera on the Brilliant Pad**

**Definition:** Mock-up of the mount  
**Deliverable:** Pictures of the mount setup on the Brilliant Pad  
**Expected Date of Completion:** 2/7

**Key Milestone 2 - Web Presence and Documentation**  
**Definition:** Create a “web presence” and document all required information about our project. Goal is to also document information well for the Brilliant Pad company.  
**Deliverable:** Accessible webpage  
**Expected Date of Completion:** 2/7

**Key Milestone 3 - Gathering and Analyzing Information of the Pad**  
**Definition:** Image processing  
**Deliverable:** A video demonstration of the camera capturing a picture and processing it into relevant information needed for the pad.  
**Expected Date of Completion:** 3/2

**Key Milestone 4 - Communicate with Brilliant Pad**  
**Definition:** Using UART to tell the Brilliant Pad to advance the pad  
**Deliverable:** A full working product that can detect the dog and how soiled the pad is, and advance the pad  
**Expected Date of Completion:** 3/9

## Constraints, Risk, and Feasibility

The main stumbling blocks involve gaining enough knowledge of OpenCV to create a suitable vision system for the goal that we are trying to accomplish. Realistically, we will be able to gather data in the form of images and video from our Camera. We will have to start with small goals - for example, being able to detect simple shapes and contours.

We may be constrained by our choice of camera or microprocessor. For example, if the images generated by the Pi Zero camera do not have enough resolution, computer vision may not be that effective. Luckily, dog waste does not necessarily need to be detected in high resolution. We are also constrained by the current design of the Brilliant Pad, as the Camera must be mounted in a way such that it does not obstruct the dog and in a way that makes manufacturing simple for the company.

Risks include not be able to find the proper resources to complete this project. For example, it may not be possible to find enough image data to sufficiently train a machine learning algorithm to distinguish waste. However, with the wide amount of labeled images online this should not pose to be an issue. Despite these concerns, we believe that the key milestones of this project will be attainable.

# Group Management

## Roles

Our technical roles are as follows:

* Designer - Richard, Kevin, Derek
* Programmer - Richard, Kevin
* Hardware/Mechanical - Derek, Kevin

For management, each of us are responsible for completing our assigned milestones as well as ensuring that the other members have the information they need to complete their milestones.

## Decisions

Our team will frequently meet and make decisions on a consensus basis.

## Communication

All of the team members live together, so we can easily communicate together in person, or through Facebook. Additionally, we will document all technical information and necessary files through Google Drive.

## Dealing with Setbacks

It is easy to determine when we’re off schedule by comparing our progress to the milestones that we set for ourselves.

If we fall behind we will evaluate the situation to determine why we fell behind and work accordingly. We may re-evaluate priorities of functions and milestones and we may shift some of the roles around to help us get back on track.

# Project Development

## Hardware and Software

For hardware, we are using a Raspberry Pi Zero and Pi Zero Camera. We also have access to the control module and PCBA of the Brilliant Pad.

For software, we are using OpenCV and Python.

For mechanical design, we will use Solidworks to create 3D models and 3D print mounts for prototyping.

We have already ordered our Raspberry Pi and the associated camera, and they have both arrived. Alan Cook, the CEO of Brilliant Pet, has sent us a Brilliant Pad to work with.

## Testing

Testing will be done in stages. Each milestone that we set should be able to be tested individually, and should be able to be tested with the equipment that we have on hand. Most testing can be handled fairly easily, though for the actual testing of the vision system for the Brilliant Pad we will likely begin with “simulated” waste before testing with actual waste.

## Documentation

Documentation will be done on Google Drive. This will include all relevant documents, assignments for this class, and any research that we find. We will also document code files in Google Drive.

# Project Schedule

**Key Milestone 1 - Create and design mechanical prototypes to mount the Camera on the Brilliant Pad**

**Definition:** Mock-up of the mount  
**Deliverable:** Pictures of the mount setup on the Brilliant Pad  
**Expected Date of Completion:** 2/18

**Weekly Milestone 1 - Planning**

**Definition:** Defining system specifications, assembling list of parts, create block diagram/system architecture  
**Deliverable:** List of system specifications, list of parts, block diagram  
**Expected Date of Completion:** 1/28  
  
**Weekly Milestone 2 - Designing**  
**Definition:** Determine how and where the camera/sensor should be mounted on the Brilliant Pad, determine required dimensions  
**Deliverable:** Drawing of expected placement, dimensions of mounts  
**Expected Date of Completion:** 1/28  
  
**Weekly Milestone 3 - CAD**  
**Definition:** Create 3D CAD for Camera + Raspberry Pi mounts  
**Deliverable:** Screenshot of 3D Models  
**Expected Date of Completion:** 1/31

**Weekly Milestone 4 - Building**  
**Definition:** 3D Print the model that was created, and mount the required devices onto the Brilliant Pad  
**Deliverable:** Picture of the Pi Camera mounted onto the Brilliant Pad in various angles  
**Expected Date of Completion:** 2/7

**Weekly Milestone 5 - Reiterate**

**Definition:** After mounting the devices on the Brilliant Pad, make adjustments as needed

**Deliverable:** CAD models with adjustments and pictures of the Pi Camera and Raspberry Pi mounted

**Expected Date of Completion:** 2/18  
  
**Key Milestone 2 - Ongoing Documentation of Process**  
**Definition:** After every milestone is completed, there should be documentation stating what was done, by who, and when it was completed. Documentation is especially important so that Brilliant Pad engineers can make use of our design.  
**Deliverable:** Completed, accessible webpage  
**Expected Date of Completion:** 3/17  
  
**Weekly Milestone 1 - Website Created**  
**Definition:** Create a “web presence” and document all required information about our project.   
  
**Deliverable:** Accessible Website  
**Expected Date of Completion:** 2/7

**Key Milestone 3 - Gathering and Analyzing Information of the Pad**  
**Definition:** Image processing  
**Deliverable:** A video demonstration of the camera capturing a picture and processing it into relevant information needed for the pad.  
**Expected Date of Completion:** 3/2  
  
**Weekly Milestone 1 - Image Capture**  
**Definition:** Capturing an image on the Raspberry Pi.  
**Deliverable:** Show an image of the camera’s POV when mounted on the Brilliant Pad.  
**Expected Date of Completion:** 1/28  
  
**Weekly Milestone 2 - Isolate Pad Area from Non-Pad Area  
Definition:** Identify and extract the relevant parts of the image.  
**Deliverable:** Show a black and white image separating pad from no pad (waste).  
**Expected Date of Completion:** 2/4  
  
**Weekly Milestone 3 - Soil Level**  
**Definition:** Determine what percent of the pad is covered by waste  
**Deliverable:** A video demonstration showing the module is able to detect how soiled it is with simulated waste  
**Expected Date of Completion:** 2/11  
  
**Weekly Milestone 4 - Analyzing Pad**  
**Definition:** Determine if the pad should be advanced based on the level of dirtiness of the pad  
**Deliverable:** A notification that indicates the pad should be advanced (blink an LED)  
**Expected Date of Completion:** 2/18  
  
**Weekly Milestone 5 - Detecting Presence of the Dog**  
**Definition:** Determine whether the pad should advance or not based on the presence of the dog  
**Deliverable:** A notification that indicates the pad will advance (blink an LED)  
**Expected Date of Completion:** 3/2  
  
**Key Milestone 4 [Extra] - Communicate with Brilliant Pad**   
**Definition:** Using UART to tell the Brilliant Pad to advance the pad  
**Deliverable:** A full working product that can detect the dog and how soiled the pad is, and advance the pad  
**Expected Date of Completion:** 3/9

**Weekly Milestone 1 - Send a Signal to the Brilliant Pad**

**Definition:** Communicate with the Brilliant Pad (using an Arduino or Raspberry Pi)

**Deliverable:** A video demonstration of the Raspberry Pi/Arduino being able to talk to the Brilliant Pad (i.e. advance a pad)  
**Expected Date of Completion:** 2/25

**Weekly Milestone 2 - Integration of Vision System with Brilliant Pad**

**Definition:** Telling the Brilliant Pad to advance the pad given input from our vision system  
**Deliverable:** A video demonstration of the vision unit advancing the pad   
**Expected Date of Completion:** 3/9