TEMPLE
UNIVERSITY

PROJECT PROPOSAL
BinBot

REVISION HISTORY

Revision #	Author	Revision Date	Comments
1.0	Sean Reddington	Aug. 30, 2019	initiated
1.1	Sean Reddington	Sept. 12, 2019	First group proposal

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Project Abstract

Many cities around the world, including Philadelphia are littered with loose garbage. CleanPHL has created a heatmap of Philadelphia which categorizes how littered different parts of the city are based on a *Litter Index[i]*. This document proposes a technical project to create an autonomous robot that collects loose garbage off the street. This robot would identify trash by communicating with a server that identifies trash using machine learning, measure the distance to the trash, again with machine learning, and then navigate to the trash using a set of treads. It would then pick up the trash using a mechanical arm. After retrieving the trash, the robot would locate the nearest trash receptacle and place the trash within it, locating the bin and measuring distance using machine learning.

High Level Requirement

The robot would capture video feed through a camera and target any garbage to be collected using an object classification machine learning model. This machine learning model would identify if there is an object to be collected while also determining the location of the object from the robot. In the early stages, the live feed would be displayed to a human operator to confirm the garbage classification, further training the model. The robot would then move within distance of the target object and pick the object up using an arm or claw mechanism.

In addition, the robot will need to identify walls and impassible terrain so that it can successfully reach its destinations. This will be accomplished with machine learning as well. Since it is not possible to have the machine learning model within the robot itself, the robot will connect to an outside server which will perform these functions and communicate with it wirelessly.

Conceptual Design

The prototype robot would be built from an Arduino robot kit. The robot would require automotive abilities suitable for outdoor city terrain, such as an electric motor to provide movement capabilities, and treads to move, a live feed video camera with wireless broadcasting capabilities, and a mechanical arm and dump bin to collect the object. The robotic functionality will use Arduino's provided software suites, i.e. Arduino programming language and IDE. There is an Arduino kit which already provides the parts needed for the project's prototype.

Using the video camera data, an image classification machine learning model would be used to identify any garbage to be collected, in addition to calculating the distance between the robot and its destination. The machine learning application could be developed using TensorFlow, OpenCV, or other potential machine learning tools. Since an Arduino will not have the necessary processing power, the video data will be sent to a remote server to execute the machine learning processing. The data processing will likely be outsourced to a Nvidia GPU supported Linux server provided by the course professor, Dr. Charlie Wang. Some additional server options include the Temple server or third-party options such as Google's Cloud Machine Learning Engine, or Amazon Web Services.

Use Cases

While the initial idea was built around cleaning litter off city streets; BinBot has several applications that it could be useful for. For example; University and college campuses, movie theatres, concert halls, convention centers, and sports stadiums. These locations require continuous upkeep that may not be efficiently maintained by normal employees.

Background

Begin the initial proposal of the project, much research has not been done towards similar projects/products. However, a quick Google search shows the ideas from this proposal are far from unique. However, this may serve as an advantage when searching for a machine learning model and training data for the project. Image recognition and distance calculation are also fields rich with research that will be utilized in this project.

Required Resources

Depending on the processing power required, cloud based processing services may be needed whether from Temple or third-party vendors. The hardware for the robot would also be require. A potential robotics kit is Xiaor Geek's Arduino Mega 2560 Robot Tank Car Kit[ii]. This kit contains all of the hardware needed for the physical robot, including a motor, treads, a camera, proximity sensors, an arm and claw, and the Arduino board itself. Depending on the scope of the project, the hardware can be scaled down to just an Arduino or RasberryPi board including a video camera.

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[i] https://cleanphl.org/

[ii] http://www.xiaorgeek.com/store/arduino-mega-2560-gfs-wifi-video-robot-tank-car-kit-with-4-dof-robot-arm.html