Truck Loading Using an Autonomous End-Loader

Functional Requirements List and Performance Specifications

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I. Introduction

The autonomous truck loading project will utilize an end-loader to locate and navigate to a load and scoop the load. It shall then proceed to locate and navigate to a truck and empty the bucket into the truck. This process will continue until it is deemed that the truck is filled. Encoders and beacons shall be utilized to determine end-loader position and motor drive requirements to achieve the desired destination. A Silicon Labs development board will be used for overall system control. The final goal of the project will be to have a functional autonomous system fill the truck as quickly and accurately as possible, while maintaining a low system cost.

II. System Description

The system will consist of a velocity sensor for the tracks, position sensors for the bucket arms, a bucket tilt sensor, truck and pile location sensors. A Silicon Labs development board shall be used for system control of the end-loader, motors for both tracks and individual motors for the bucket tilt and lift arms. The sensors will feed information about vehicle, truck, load, and bucket positions to the Silicon Labs development board, which will process the information and control the motors via pulse-width modulated signals appropriately. The Silicon Labs development board shall be mounted on the end-loader along with a power source. Figure 1 shows the overall system block diagram.

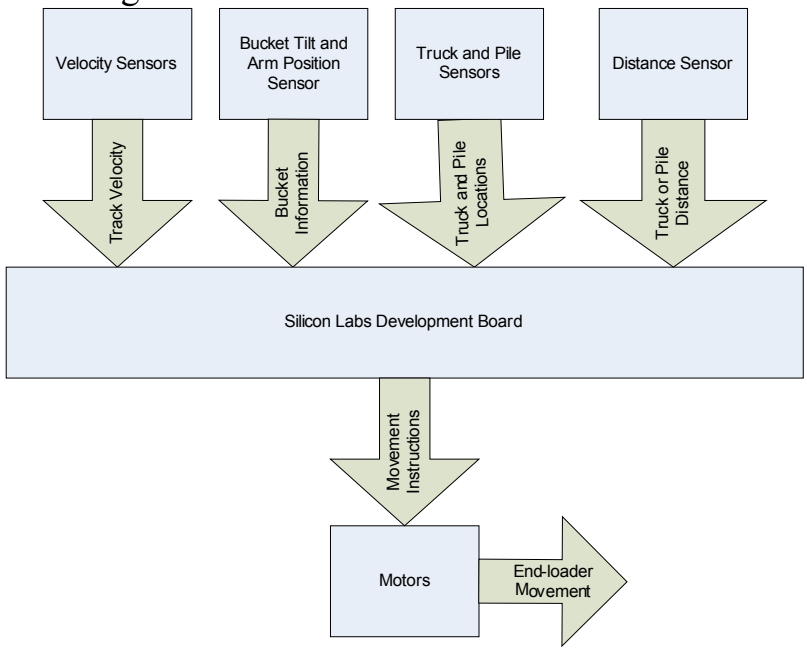

Figure 1: System Block Diagram

III. Vehicle Requirements

Initially, the vehicle sensors must be able to ascertain the bucket and arm positions. The initial positions of the bucket and arm are essential to determine how the bucket and arm should be moved in order to scoop up the load. Other vehicle sensors shall then be able to locate beacons on a pile of material and the truck that will be loaded, conveying the changing directions and distances to the microprocessor throughout operation. The microprocessor, discussed in greater detail momentarily, will interpret this information to navigate towards the material or truck as needed.

Sensors will be a critical part of the project. Currently these are still in the research phase as we are investigating the best type to use for each requirement. Mounted on the front of the vehicle, a position sensor shall determine the distance from an object. This information will be fed into the microprocessor which shall combine this data with the data from the beacons to accurately scoop the load or dump the load into the truck. The encoders shall be used to accurately turn and drive the vehicle, better gauging the vehicle movement throughout the process. Figure 2 below shows the location and purpose of each sensor. The vehicle track motors shall be able to sustain vehicle drive for a full or empty bucket.

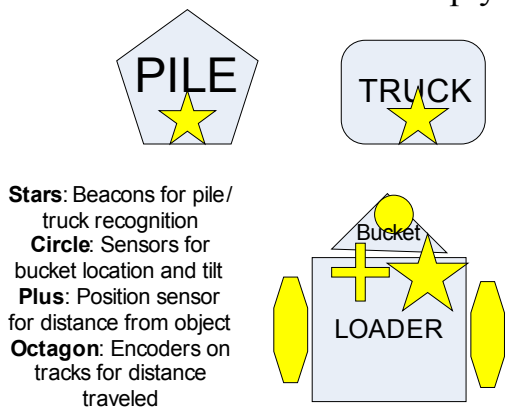

Figure 2: Sensor Locations and Purposes

Once the vehicle has arrived at the load, it shall be able to scoop the load into the bucket if the bucket is empty. After navigating to the truck, the vehicle shall be able to raise the arms and dump the full bucket into the truck. The arm motor shall be able to raise and lower the bucket and the bucket motor shall be able to alter the bucket tilt with both a full or empty bucket. The vehicle batteries shall be able to sustain operation until the truck has been fully loaded five times.

IV. Software Requirements

The microprocessor shall be programmed using assembly language. It shall generate a fixed period pulse-width modulated (PWM) signal for each of the motors. These will control the movement of the tracks, the bucket arm and the tilt of the bucket. A PWM signal will be used to control the amount speed of each motor so that they can be more accurately controlled. The software shall also be able to function independently of user input. Some provision shall also be given for human intervention in case of vehicle problems and for debugging purposes.

The software shall utilize the sensor signals from the beacons to locate the target, either the truck or the pile. It shall also use these signals to determine how to perform the next action. The required action would be driving to the pile and scooping from the pile or driving to the truck and dumping the bucket in the truck. The software shall function in a manner that moves the vehicle and bucket smoothly, without spilling the load or running into the truck. After locating the truck and load, the vehicle shall be able to turn and continue to know where the truck and load are positioned by utilizing the rotary encoders for position data. The information from the rotary encoders will be fed into the microprocessor which shall track the vehicle movement. The software shall be able to complete the entire loading and unloading process accurately and as quick as possible.

References

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