

Tesseract Project Revisit

Preliminary Sensor Selection

MSE 3302 B

Alan Harris
250901911

Robert Potra
250914807

Andrew Randell
250911270

Kevin Wang
250908180

February 14, 2019

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1 Introduction

To perform the task autonomously the robot requires information about its surroundings. Sensors are used to relay information about the changing environment to help the robot make decisions. The entire problem was divided into tasks that require different sensing capabilities, and therefore, the tasks include tracking the robot's position relative to the perimeter, detecting the tesseract, detecting the pyramid, and tracking the robot's position for outdoor applications. Key requirements for each task include:

2 Sensor Specifications

Table 1: Add caption

	Range	Accuracy	Sensitivity	Sample Rate	Stability	Repeatability	Linearity	Implementation Ease	Elegance	Long Life	Non-Contact
Local Position											
LVDT (probes)		1	1	1	1	1	1			1	
Ultrasonic	1	1		1	1	1	1	1	1	1	1
Potentiometer (probes)		1	1	1	1	1	1				
Limit Switch (bump into walls)						1		1			
Capacitive				1						1	1
Encoders (on wheels)	1			1			1	1	1	1	1
Global Position											
GNSS	1	1					1	1	1	1	1
RADAR	1	1	1		1	1	1		1	1	1
SONAR						1	1		1	1	1
LIDAR	1	1	1	1	1	1	1		1	1	1
Computer Vision	1	1	1	1	1	1	1		1	1	1
Tesseract Detection											
Hall Effect		1		1			1	1	1	1	1
Magnetometer	1	1	1	1		1	1	1	1	1	1
Reed Switch						1					1
Computer Vision	1								1	1	1
Pyramid Detection											
IR Receiver	1	1		1			1	1	1	1	1
Computer Vision	1								1	1	1

2.1 Local Position

2.1.1 Concept Selection

LVDT, Potentiometer, and Limit Switch were eliminated first because of the dependence on wall contact. These are not feasible as contacting the wall will quickly wear the sensors, and will also endanger the robot. In addition, the range is far too small, and should not be limited to a simple binary contact.

Encoders on the wheels were ruled out as there is a strong dependence on full traction of the wheels. The slightest loss of grip will throw off the sensors entirely, and will give inaccurate readings.

Capacitive Sensors were eliminated because the scale of the measurements is far too small for the size of the robot. Considering that the wall area is quite large, a capacitive sensor will not be able to provide the range necessary to accurately tell us local position.

Finally, RADAR, SONAR and Computer Vision were eliminated as the implementation of these systems is quite complicated and costly. While they perform well on the GO/NO GO screening, they fall short in comparison to the selected sensors.

The chosen sensors are ultrasonic, as well as LIDAR.

2.2 Tesseract Detection

2.3 Pyramid Detection

2.4 Global Position

From a macro perspective, the vehicle will need to know an approximate location of where it is on a map, as well as the approximate locations of pyramid(s) and tesseracts.

GNSS (Global Navigation Satellite System) is the global positioning technology that is applicable. GNSS is a generic world-wide term used to describe satellite navigation systems. The specific technology used is dependant on the region where it is being used. Regional technologies include GPS, GLONASS, Beidou, and Galileo. This technology provides *approximate* latitude, longitude, and altitude metrics to their host device.

Hardware Implementation of GNSS on devices is very straight forward with GNSS Modules. These modules are integrated GNSS receivers which can easily be implemented onto devices. They generally require a power input and provide NMEA 0183 GNSS coordinates over a UART connection. A table below has been compiled of high ranking GNSS modules. The controller must support UART communication for compatibility with most GNSS modules.

Software Implementation will require prior mapping of the power plant. The GNSS will provide approximate coordinates on this software map. This will be used in conjunction with local sensing techniques to make informed decisions about the locations of the autonomous system relative to the tesseract and pyramid(s).

3 Controller

3.1 Navigational Map

The robot completes a survey of the area creating a software map in memory. All sensor readings are included in this survey. After the survey has been completed, the system will have a map of

the area in which it operates. This map will continuously be updated as the system operates. The map can be used for autonomous navigation.

4 Modeling

5 Project Timeline

Week of:

Feb. 11	Preliminary Sensor Selection Deliverable: Step 2 Due Feb. 15th <ul style="list-style-type: none">• Prepare and finalize report for step 2 deliverable
Feb. 18	Research Applicable Actuators <ul style="list-style-type: none">• Restate and redefine actuator specifications• Identify possible actuator options based on previous concepts
Feb. 25	Continue Actuator Design <ul style="list-style-type: none">• Concept generation using possible actuator options• Refine logic connecting the sensor data to actuator actions
Mar. 04	Finalize Actuator Simulations <ul style="list-style-type: none">• Perform actuator simulations using Simulink• Begin preparing report for step 3 deliverable• Perform concept selection using actuator simulation results and analysis
Mar. 11	Preliminary Actuator Selection Deliverable: Step 3 Due Mar. 15th <ul style="list-style-type: none">• Continue preparing and finalize report step 3 deliverable
Mar. 18	Evaluate Sensor and Actuators <ul style="list-style-type: none">• Evaluate the proposed system of sensors and actuators• Create a kinematic system model and perform analysis using Solidworks
Mar. 25	Obtain Feedback and Iterate <ul style="list-style-type: none">• Identify possible problems with the proposed system of sensors and actuators• Refine analysis for the transducers, control device, kinematics, and power supply
Apr. 01	Finalize Final Simulations and Report: Step 4 Due Apr. 5th <ul style="list-style-type: none">• Continue preparing final report for step 4 deliverable