Geographical Tracking

One of the major objectives in this project is for the robot to track its position inside the storm drain, so that the surface can be marked and indicate where the said obstruction is located from the surface (Figure x.xx). There are a handful of possible ways of doing this, but most exceed the allocated budget, or are too complex.

A picture containing iPod

Description automatically generated

GPS

An idea that was brought up, but immediately rejected, was the use of a Global Positioning System (GPS). GPSs are found in many appliances and applications, such as cellular devices, computers, satellite phones, and more. Originally, the use of a GPS was for military use, but has then been extend to commercial and public use. The way a GPS works, is by taking advantage of the many satellites that orbit the Earth and use triangulation to pinpoint the location of the device using GPS (Figure x.x1). As to why this idea was rejected, it’s because in order for a GPS to work, it has to be within the sight of multiple satellites. Since the environment in which the robot will operating in is underground, there is no line of sight for the satellites, making this idea unsound.

A picture containing object, first-aid kit

Description automatically generated

It is possible to create a makeshift GPS for the robot, but that would require additional components that would have to be separate from the robot, as well as requiring financing from the budget.

Radar

The use of radar is within the scope of the project, it would allow for tracking distance traveled in an accurate fashion, as well as be used to detect any obstructions inside the storm drain. The way a radar functions is by transmitting signals with an antenna and receiving the bounced signal to determine the distance, size, and location of an object (Figure x.x2). By using radar, another object may have to be lowered in alongside the robot, to act as a starting marker for the robot, but detecting cave-ins and obstructions would be easy, and efficient on time.

A picture containing object, gauge

Description automatically generated

Radar would a good option for tracking distance traveled, but it would require more financing, and advanced code in order to properly use the radar. Additionally, more components would be needed in order to construct the radar, increasing the complexity and maintenance of the robot. In addition, there are several conditions in which the radar would not function properly, or to its full potential. The first condition would be that the storm drains aren’t always leveled, meaning that if the robot was traversing the pipe with deviations in terrain, there is a chance that the marker that was placed as a starting point, may not be detected by the radar due to difference in elevation, thus ruining the point of the starting marker. Secondly, there are slight turns within the storm drain pipes, meaning that the starting marker may be out of sight, and thus ruining the point of the starting marker again. Thirdly, any obstacles that are inside the drain can possibly prevent the sonar from functioning.

Another use of radar is Ground Penetrating Radar (GPR). This allows for finding objects located underground, from the surface. Using radar in this fashion would be practical in finding cave-ins and obstructions inside the storm drain, but it doesn’t allow for the user to evaluate the conditions inside the storm drain, along with the fact that pipes may run under buildings in which the user won’t be able to properly follow the layout of the storm drain pipes. To further reason as to why GPR isn’t a good idea is the fact that obtaining a GPR is expensive and would require funding over the designated budget.

Overall, radar is a good idea as a concept, but it adds onto complexity as well as financing. There are also many things that can inhibit the radar from functioning, meaning that the radar would need specific or perfect conditions for it to operate as expected. Furthermore, with the conditions inside the storm drains, using radar would not be the most optimal or practical option to track the robot’s traveled distance.

Sonar

A similar idea that was considered, was the use of Sonar, which is very similar to radar (Figure x.x2). Instead of radio waves, sonar uses and manipulates sound waves at a high frequency in order to locate any objects. This concept is similar to how bats use echolocation, in which a pulse of sound is released, and a receiver then calculates the position and distance of an object based on the time it takes for the echoed sound to return. Just as the radar had its specific conditions in which it would function properly, sonar has conditions that mirror that of radar, such as using a starting marker. Furthermore, sonar would be more complicated and complex due to the fact that sound waves will bounce off the surrounding walls more inside the storm drains, and overwhelm the receiver, thus inhibiting the sonar from operating properly.

In this case, using sonar would be inconvenient to implement, especially in the conditions that the robot would be working in; it would require additional funding and advanced math techniques to properly map out and understand the incoming data. Overall, sonar seems to be one of the less likely ideas, due to its inconvenience and complications.

Tether Length

A rudimentary idea that is taken into consideration is to just measure out the length of the tether once the robot discovers any cave-ins or obstructions inside the storm drain. In order to do this a few concepts were brought up that could help with measuring.

One concept discussed was to place the tether on a reel and calculate the length of tether used based on how many rotations the reel has gone through. One reason as to why this concept was reject was because of its inaccuracy. By using tether off the reel, the radius would constantly get smaller, thus requiring a remeasurement of the radius.

Another concept, involving a reel, was to mark up the tether to indicate a unit of length, feet, yards, meters, etc. and then have the tether run through a sensor that would count each mark, resulting in a total distance traveled. This idea proved to be practical

Marking Tether

Hose Wheel Sensor

Hose Wheel rotations

Wheel Rotation

Slippage

Types of Wheels

Calculate

Laser(mouse) Sensor