

### 3.3 Lidar Marble Detection

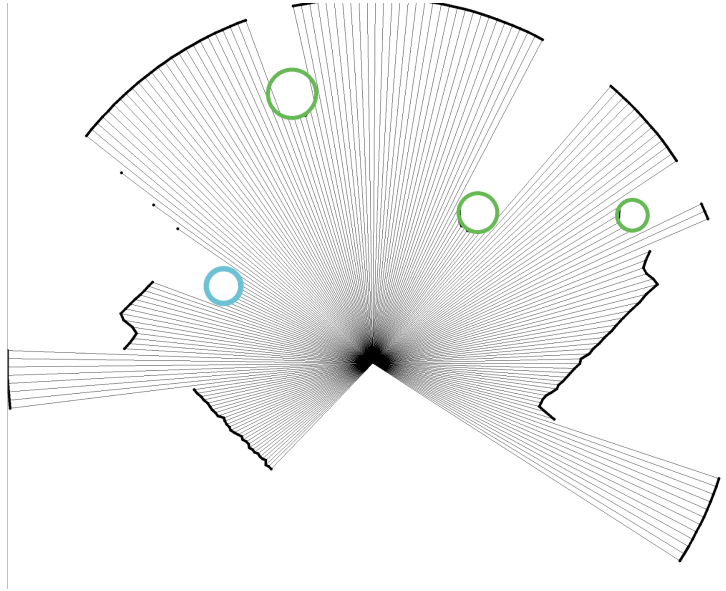


Figure 23: The Lidar Marble Detector in action.

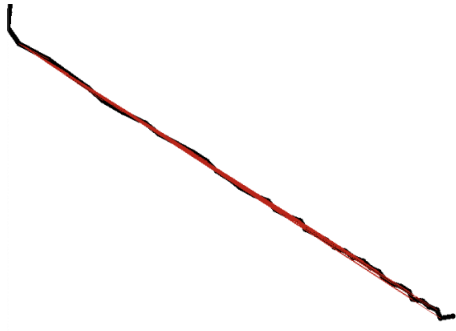
#### Key Concept

To detect nearby marbles using the data from the lidar.

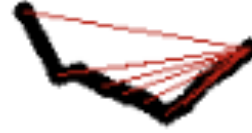
#### Implementation

The marble detection algorithm using lidar data works by grouping the data points into different segments based on the distance between the points. If two consecutive points are too far apart given by a threshold, the points belong to two different segments. Hereon the segments will be classified as either straight or curved lines. To determine whether the segments are curved or straight, the following process is exercised:

- Calculate the value of the slopes from the first point to all subsequent points in the segment.
- Determine the biggest difference in the slopes.
- If the biggest difference in the slopes is below a given threshold, the segment must be a straight line. Otherwise it is classified as a curved line (see figure 24).



(a) Straight line segment with virtually no difference in slopes.



(b) Curved segment with slopes and a larger difference between slopes.

Figure 24: Difference in differences between slopes on a straight and curved line.

The straight line segments are hereby disregarded. Moreover the curved segments are further analyzed to determine their respective centers and radii. Three points are chosen from the segment. One at one end of the segment, one at the other end of the segment and one at the center of the segment. From these three points it is possible to determine the center of the circle and its radius. The perpendicular bisectors of the chords between the points will intersect at exactly one point; this being the center of the enveloping circle (See figure 25).

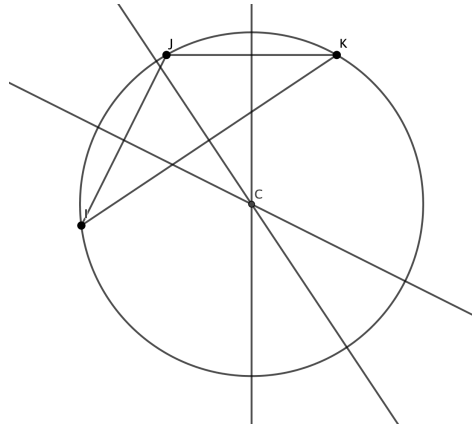


Figure 25: Finding the center and radius of a circle with three points.

If the radius of the circle is between a lower and upper threshold there is a good probability that the circle is in fact a marble. The detector will then notify the robot, who in turn will revolve until it is facing the marble. In case of multiple marbles the direction of the closest marble will be forwarded.

The Lidar Marble Detector performs consistently and robustly and is useful as it rapidly and efficiently scans its surrounding for marbles. It only succumbs to marbles that spawn inside the walls of the map. It is distinctly affected by the noise on the signal from the lidar as well, which interferes with a perfect detection rate. This could be mediated by creating a filtered superposition of multiple lidar-scans for a smoother view of the terrain. This solution has however not been explored since the marble detection works well enough as is. For more tests with the Lidar Marble Detector see appendix.