1 Risk Model

Risk is modelled as a function, $\mathbb{R}^3 \to [0, 1]$ which is use to determine the risk at every (x, y, z) location within the search space. In order to determine risk in 3-space, we obtain a 2-D risk model which models the risk at the minimum altitude. This function $R_0 : \mathbb{R}^2 \to [0, 1]$ determines what the risk would be at the minimum altitude. This is assumed to be given to the algorithm *a priori* or can be determined at any time during the iteration of the algorithm. This ground risk, R_0, is modelled as a lookup table rather than a combination of basis functions in order to give a more generic model for risk that can be used in any use case of the algorithm. To determine the 3-D risk, $R(x, y, z)$, we perform an exponential decay on the given ground risk value, $R_0(x, y)$. 3D risk is defined as follows:

$$R(x, y, z) = R_0(x, y) \cdot \exp\left(-\frac{z^2}{K \cdot R_0(x, y)^2}\right)$$

Even though risk in 3D is evaluated and is not simply a lookup table, one can be used instead. This representation for 3D risk is ideal for modelling fires, detection by hostile agents, or any stimuli that would decrease monotonically as the altitude increases.

For the experiments, we have used nine different scenes for the representation of the ground risk, R_0. To generate these scenes, we used the diamond-square algorithm [1] to generate random terrain maps that have values from zero to one. The diamond-square algorithm generates realistic random risk scenes that represent the 2D ground level risk as anticipated. Random terrain maps have also been used in [2].

References

[1] A. Fournier, D. S. Fussell, and L. C. Carpenter, "Computer rendering of stochastic models," *Commun. ACM*, vol. 25, no. 6, pp. 371–384, 1982.

[2] L. Murphy and P. Newman, "Risky planning: Path planning over costmaps with a probabilistically bounded speed-accuracy tradeoff." in *IEEE International Conference on Robotics and Automation, ICRA 2011, Shanghai, China, 9-13 May 2011*. IEEE, 2011, pp. 3727–3732. [Online]. Available: http://dx.doi.org/10.1109/ICRA.2011.5980124