My graduate research is focused on robot navigation and path planning. To be specifically, I established a new way of environment modeling for navigation function method, which is a potential-field-based path planning method, with computational expedience for complex environment. This analytical potential-field-based path planning method is proved to be global convergent in dynamic environments without unwanted local minima. In order to get a robust path planning method that can be used in real applications in autonomous driving and robot areas, with limited computational resources and high success rates, I also introduced a novel RRT extension algorithm based on approximate navigation function local planners. Taking the advantages of the environment modeling method, workspaces and obstacles can be expressed analytically with the distributions given by the perception team. Compared to other RRT family algorithms, this algorithm is able to generate a valid path in less iterations with less nodes thanks to the obstacle avoidance ability of the local planner. This algorithm is implemented in C++.