The traditional pursuit-evasion game considers a situation where one pursuer tries to capture an evader, while the evader is trying to escape. A more general formulation of this problem is to consider multiple pursuers trying to capture one evader. This problem can be viewed as a tool that assists planners in developing strategies for autonomous entities (such as UAVs or robots) pursuing another similar entity (another UAV or robot) to prevent it from accomplishing an adversarial task. This general multi-pursuer one-evader problem can also be used to model a system of systems in which one of the subsystems decides to dissent (evade) from the others while the others (the pursuer subsystems) try to pursue a strategy to prevent it from doing so. An important challenge in analyzing these types of problems is to develop strategies for the pursuers along with the advantages and disadvantages of each. In this thesis, we investigate three possible and conceptually different strategies for pursuers: (1) act non-cooperatively as independent pursuers, (2) act cooperatively as a unified team of pursuers, and (3) act individually as greedy pursuers. The evader, on the other hand, will consider strategies against all possible strategies by the pursuers. We assume complete uncertainty in the game i.e. no player knows which strategies the other players are implementing and none of them has information about any of the parameters in the objective functions of the other players. To treat the three pursuers strategies under one general framework, an all-against-one linear quadratic dynamic game is considered and the corresponding closed-loop Nash solution is discussed. Additionally, different necessary and sufficient conditions regarding the stability of the system, and existence and definiteness of the closed-loop Nash strategies under different strategy assumptions are derived. We deal with the uncertainties in the strategies by first developing the Nash strategies for each of the resulting games for all possible options available to both sides. Then we deal with the parameter uncertainties by performing a Monte Carlo analysis to determine probabilities of capture for the pursuers (or escape for the evader) for each resulting game. Illustrative results consisting of several Monte Carlo simulations for different scenarios and examples of a pursuit-evasion games are provided. Results of the Monte Carlo simulation show that in general, pursuers do not always benefit from cooperating as a team and that acting as non-cooperating players may yield a higher probability of capturing of the evader depending on what strategy the evader may use.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2013, Sharif University of Technology

Committee in Charge:
Marwan Simaan, Chair, Electrical & Computer Engineering
Zhihua Qu, Electrical & Computer Engineering
Azadeh Vosoughi, Electrical & Computer Engineering

Approved for distribution by Marwan Simaan, Committee Chair, on June 15, 2017.

The public is welcome to attend.