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UAV using Dec-POMDP model for increasing the level of security in the company

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Abstract

One of the most important jobs for every company has always been keeping a high level of security. Various methods of information systems are being applied to ensure and increase the level of security. Unmanned aerial vehicles (UAV) that spread very rapidly in recent years are being applied in various fields. Autonomously controlled UAVs can fulfill almost any job. Markov decision processes on the other hand, play significant role among algorithms that deal with decision-making problems.
This article proposes model that uses UAVs and can be used to support and improve information systems security level of a company. The most significant property of drones used in proposed model is that they do their job by directly connecting and sending information to each other. To get the best result decentralized partially observable Markov decision process (Dec-POMDP) was used. To gauge the level of security, calculations of the data were shown with fuzzy data set. In the end, details of the model and proposals are given.

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Keywords: Fuzzy Logic; DEC-POMDP; Markov decision processes; unmanned aerial vehicle; information systems; decision making under uncertainity.

1. Introduction

Unmanned aerial vehicles (UAVs), in the light of technological developments of recent years, has increasingly become popular in the fields of academic studies and engineering applications. UAV, in many cases allows fast and safe solutions or analysis to be performed, particularly in military applications, natural disasters, monitoring of

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various sports activities, traffic control, illegal construction, etc. In addition, both companies and ordinary people use UAVs to produce different solutions to many problems in daily life.

Today, many security systems are used to protect some area. Techniques used vary according to the size of the area. In large areas, it is harder to provide security. When we say land security, we understand protection from all hazards that may be in the field, and ability to control the desired location at the desired time. Different solutions are used to solve these problems. Placing security cameras, checking certain areas at certain times are some examples of solutions. However, these solutions do not provide full-time protection of area. Placing lots of cameras in large areas requires very large budgets. Even in areas where camera systems are installed, due to the limitations of the system the risk of blind spots is always high. And solutions that use man power to provide security require lots of resources in large areas as well. For this reason, new solutions with better options are necessary.

In this article, MDP was used as decision-making algorithm. In this solution, multiple UAVs are used. These UAVs can send information to each other. As UAVs states and observations are not certain and partly observable, Dec-POMDP algorithm is used in the model to eliminate this problem. Security level is set according to the results of the observations from the UAVs. Fuzzy logic is used in calculation when retrieving results of these observations. As the values obtained are not final results, the level of security is determined from the fuzzy logic calculations mentioned in the article[1-4].

2. Decision-making algorithms

Decision-making is one of the most important and desirable skills of agent. The agent takes input from the environment, makes a decision and fulfils his decision. Decision-making is choosing an action from a pre-determined set of actions established by designer. Agent's work depends on the action chosen. According to the current state, decision-making algorithm determines the strategy for the choice of the optimal action [5].

2.1. Partially observable Markov decision process

POMDPs provide partially observable area with changeable decision-making system. Partially observable environment means that the agent does not have the right to directly access his own state, and the situation should be solved according to observations. POMDP is well adapted to the area where decision-making is done according to sensor with the participation of the robot. POMDP is natural partially observed model for MDP model. Formally, we define POMDP as multilateral. S, A, T, $R$and γ, are derivatives from the MDP model, where S is status group, A is actions group, T is conversion function, R is awards function, γ is the discount factor.[6-10]. We look at MDP as the MDP highlight of POMDP. The remaining terms are marked as Z and O[13, 15].

2.1.1. Observations

$Z = \{z_0, z_1, ..., z_L\}$is group of agent's all possible observations of the environment. Observation is a part of information about the environment. Only Z_t observation may appear at the time step t, but the group of observations Z includes multiple observations flow. Z can be determined by continuous observations, but to do this we have to examine the measurable sustainable environment.

2.1.2. The observation function

We denote this function by O. It defines the probability of observation of action a in state s and is expressed as

$$O(s, a, z) = P(z_{t+1} = z | s_t = s, at = a) \; \forall t \tag{1}$$

2.1.3. The history and state of belief

Agent in partially observable environment can not enter the current state S directly. However, the agent receives observations that provide direct access to the state at every step. Overall, these observations are not sufficient to guarantee knowledge of the state.

The most obvious way to keep track of the state of the agent is to keep the history of actions and observations of agent. We denote the history with h_t. The history of observations is expressed as

$$h_t = \{a_0, z_1, a_1, z_2, ..., a_{t-1}, z_t\} \tag{2}$$