Multi-agent Model of Information Interaction among Unmanned Vehicles

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1. Introduction

- Currently, due to the development of the Industry 4.0 paradigm, the cyberspace of transport systems is actively developing in the world. These are complex cyberphysical systems that appear as a result of interaction among people, software, and Internet services through technological devices and communication networks.

- When considering cyberphysical systems, it is necessary to evaluate the security of such system from the information interaction point of view. The key factor is a hackers gaining the ability to influence physical and production processes through informational interaction.
2. An unmanned vehicle as a vulnerable object of a cyberphysical system

- An unmanned vehicle combines five technology groups:
  - 1) a human-vehicle interface;
  - 2) sensors that provide data on the operation of the vehicle and its parts;
  - 3) sensors that provide data on the external road environment, sources of dynamic data in real time about the area around the vehicle;
  - 4) automatic control of the operation and functions of the vehicle;
  - 5) artificial intelligence, which combines the operational data in the car with external data on the roads and uses it to activate automated vehicle controls
The scheme of interaction of unmanned vehicles in the infrastructure of the cyberphysical system of a smart city
3. Multi-agent system model

- The mathematical model of a multi-agent system of information interaction of unmanned vehicles in the conditions of infrastructure Smart Transportation can be represented as follows:

\[
\text{MAS} = (\text{Agent}, \text{Type}, \text{Com}, \text{Env}, \text{Stat}, \text{Res}), \quad (1)
\]

\[
\text{Agent} = (\text{Name, Type, M}_{\text{IMS} \text{Type}}) \quad (2)
\]

\[
\text{M}_{\text{IMS} \text{Type}} = (\text{KB, f, Inp, Out, RA, Script}) \quad (3)
\]

\[
\text{Agent}^{G_1} = (\text{Com}^{G_1}, \text{Inp}^{G_1}, \text{Out}^{G_1}, \text{Str}^{G_1}, \text{RA}^{G_1}, \text{Script}^{G_1}), \quad (4)
\]

\[
\text{Agent}^{G_2} = (\text{Com}^{G_2}, \text{Inp}^{G_1}, \text{Out}^{G_2}, \text{Str}^{G_2}, \text{RA}^{G_2}, \{\text{MSA}\}), \quad (5)
\]

\[
\text{MSA} = (\text{SMA}(t - 1), \text{SMA}(t), \text{SMA}(t + 1), f^{G_2}, \text{KB}^{G_2}), \quad (6)
\]
Conclusion

- In this paper, the main interfaces of the interaction of unmanned vehicles with infrastructure objects Smart Transportation are considered. At the system-wide level, the roles of the main agents are defined and the processes of their interaction with the Smart Transportation infrastructure are described. The described approach is the development of the ideology of situational management with the allocation of three roles of agents of a multi-agent system, which will further simplify the modeling of cyber-physical systems with the support of the required level of quality of service.

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