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Dynamical Traps as Stationary Point Generalization for Social System Dynamics

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The proposed work discusses the human fuzzy rationality being a particular implementation of the bounded capacity of human cognition. Humans just are not able to distinguish between two strategies of behavior similar in property. So when the dynamics of a system governed by an individual (operator) deviates from the optimal conditions not too substantially the operator sees no reason to correct it. Therefore the active behavior of the operator is stagnated until the system deviates substantial form the optimal conditions. Then, naturally, the operator corrects the system motion returning it to some proximity of the optimal motion. This behavior is called the fuzzy rationality. If the optimal motion can be treated as some equilibrium point then the system dynamics inside its certain neighborhood will be also stagnated, reasoning us to regard this effect as dynamical traps. The particular goal is to demonstrate that the fuzzy rationality can be responsible for complex emergent phenomena in social systems.

The following particular systems and phenomena are considered in detail.

(i) A dynamical system with partial equilibrium. These systems imitate, for example, car following and the corresponding model of dynamical traps is a natural generalization of the notion of stationary point.

(ii) An unstable system whose stability is due to human control. As a characteristic example, balancing a virtual over-damped pendulum is studied in detail. The concept of dynamical traps is applicable in this case if the system instability without human control is a slow process.

(iii) A model taking into account the bounded capacity of human cognition in choosing the appropriate actions to correct the current state of a controlled system. By way of example car following is considered again. It is demonstrated that due to the effect at hand the governing equations of car dynamics no longer belong to Newtonian mechanics. Namely, such systems are described by an extended phase space containing also the particle acceleration as an individual phase variable and, as a result, the governing equation is of order higher than two with respect to time derivative.

(iv) New type non-equilibrium phase transitions in chains of oscillators with dynamical traps. In particular, it is shown that such systems admit a new mechanism of instability not related to the change in the form of regular “forces” as is the case in the classical theory of phase transitions in physical media.

This presentation is partly based on the following publications:

[1] I. Lubashevsky, ACS **15**, 1250045 (2012).
[2] I. Lubashevsky & D. Parfenov, CMSIM No 1, 31 (2013).
[3] A. Zgonnikov & I. Lubashevsky, CMSIM No 1, 60 (2013).
[4] I. Lubashevsky, S. Kanemoto, A. Zgonnikov, T. Miyazawa, & D. Taniguchi, Proc. 2[nd] Int. Conf. on Automatic Control, Soft Computing and Human-Machine Interaction (23-25 April, 2013, Morioka, Iwate, Japan), p. 185.