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A GENERALIZED MODEL OF ACTIVE MEDIA WITH A SET OF INTERACTING PACEMAKERS: APPLICATION TO THE HEARTBEAT ANALYSIS

SERGEY RYBALKO

Department of Nuclear Engineer and Management, School of Engineering,
The University of Tokyo, Tokyo 113-0032, Japan
rybalko@nuclear.jp

EKATERINA ZHUCHKOVA

Institute of Theoretical Physics, Faculty II,
Technical University of Berlin, Berlin 10623, Germany
ekaterina@physik.tu-berlin.de

KAZUYUKI DEMACHI

Department of Nuclear Engineer and Management, School of Engineering,
The University of Tokyo, Tokyo 113-0032, Japan
demachi@nuclear.jp

Some models treat the cardiac tissue as an active conductive system, taking into account oscillatory properties of heart cells. In this case the cardiac rhythms can be described on the basis of the dynamical system theory [Loskutov et al., 2004].

In this work we developed a general simplified model describing a network of oscillatory elements coupled by their response to internal depolarization of mutual stimulations. Our primary aim was to keep the model as simple as possible and to introduce a minimal number of parameters. Therefore, in our model the pacemakers are fully characterized by their intrinsic cycle length T. Their interaction is described by phase response curves (PRCs) . At first, we considered two interacting pacemakers to demonstrate the basic concepts of the model. Then we applied our approach to construct a pacemaker network model with global coupling. As a next step, this PRC based model of coupled pulse oscillators was applied to derive an additional, useful for controlling, model of three pacemakers of the cardiac conductive system. Our further intention was to go on to the next level and represent each pacemaker as an ensemble of interacting oscillatory elements. Extrapolation of the approach to the one- and two-dimensional matrices (or lattices) of pacemaker cells allows to construct active media with a set of oscillators coupled to nearest neighbors.

References

Loskutov, A., Rybalko, S., and Zhuchkova, E. (2004). Model of cardiac tissue as a conductive system with interacting pacemakers and refractory time. *Int. J. Bifurcation and Chaos*, 14(7):2457–2466.