MODIFIED CA MODEL BASED ON TWO COUPLED VAN DER POL - MULTIVIBRATOR AND NONLINEAR CURRENT MEDIUM

S.T. Belyakin

MSU, Physics of Faculty, Department of General physics, Moscow, Russia

119991, Khokhlov street, 1(2)

Tel.: (+7 495)939-51-56, e-mail: belyakin1962@mail.ru

In This paper, we consider a nonlinear current medium of cardiac arrhythmia represented by coupled, continuous-time differential equations, van Der Pol - multivibrator.

The mathematical model of CA is a system of three differential equations of the second order, with elements of feedbacks [1-3] and external periodic action $f = A\sin(2\pi nt/\tau)$ (1).

$$\begin{aligned}
&\ddot{x}\tau^2 + \dot{x}\frac{2\tau}{1-\mu^2} + x\frac{1}{1-\mu^2} = \mu\tau^2(\ddot{y}+\ddot{z}),\\
&\ddot{y}\tau^2 - \dot{y}\tau(1-\frac{y^2}{u^2}) + y = -\mu\tau^2\ddot{x} + A\sin\left(\frac{2\pi nt}{\tau}\right),\\
&\dot{z}\tau + z(1+\frac{z^2}{u^2}) - u = -\mu\tau^2\ddot{x}
\end{aligned} \tag{1}$$

Phase portraits of the system (1) are shown in Fig.(1,2):

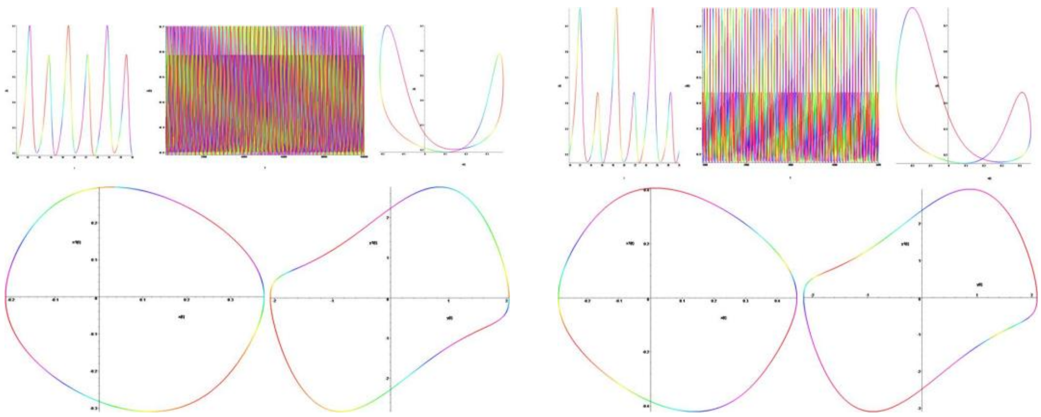

Fig.1. Time and phase portraits of the system (1) at $u = 1$, $\mu = (0.3, \sqrt{0.5})$ and $\tau = 1$.

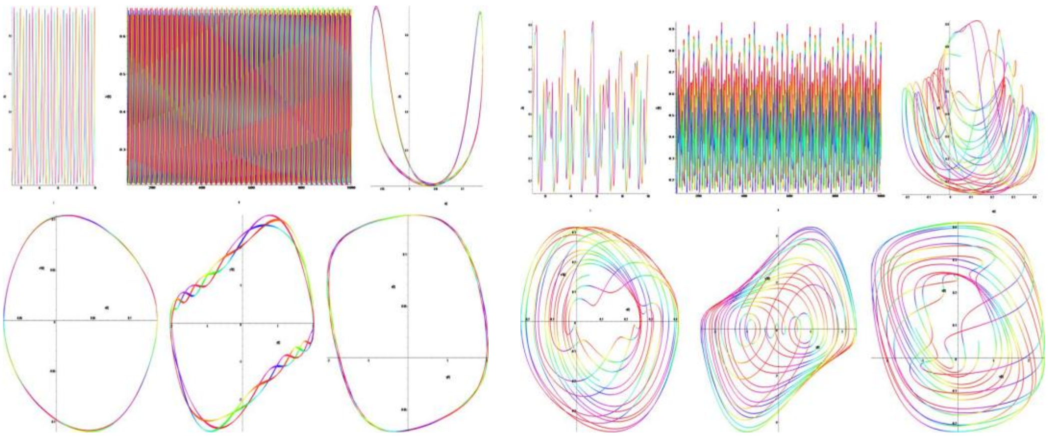

Fig.2. Time and phase portraits of the system (1) at A = (1,2), u = 1.0, μ = (0.1,0.3), n = (1,0.25) and τ = 1.0.

In the absence of external periodic action, the system (1) periodic degenerate and has a constant period, there is no bifurcation of the system Fig.1.

When A = 1.0, u = 1.0, μ = 0.1, n=1 and τ = 1.0, the system (1) has a bifurcation, that is evident time and phase portraits when A = 2.0, u = 1.0, μ = 0.3, n = 0.25 and τ = 1.0, the system (1) has a multiple bifurcation, seeking to chaos, that is evident time and phase portraits Fig.2.

Summary: Developed a modified non-linear current environmental CA model based on two coupled van Der Pol - flop circuit useful for studying and predicting the behavior of cardiac arrhythmic processes in single human atrial cell.

References:

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