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AN EFFICIENT GENERALIZATION OF THE RUSH-LARSEN METHOD FOR SOLVING ELECTRO-PHYSIOLOGY MEMBRANE EQUATIONS*

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Abstract. In this paper we describe a class of second-order methods for solving ordinary differential systems coming from some problems in electro-physiology. These methods extend to the second order of accuracy a previous proposal by Rush and Larsen [IEEE Trans. Biomed. Eng., 25 (1978), pp. 389–392] for the same problem. The methods can be regarded in the general framework of exponential integrators following the definition of Minchev and Wright [NTNU Tech. Report 2/05 (2005)]. However, they do differ from other schemes in this class for the specific form of linearization we pursue. We investigate the accuracy, stability, and positivity properties of our methods. Under simplifying assumptions on the problem at hand, our methods reduce to classical multi-step methods. However, we show that in general the new methods have better stability and positivity properties than the classical ones. We present a time-adaptive formulation which is well suited for our electro-physiology problems. In particular, numerical results are presented for the Monodomain model coupled to Luo-Rudy I ionic model for the propagation of the cardiac potential.

Key words. nonlinear ordinary differential systems, electro-physiology, Rush-Larsen scheme, time-adaptivity

AMS subject classifications. 65M12, 65L05, 35K65

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