ABSTRACT

The work presented in this thesis deals with the basic features of non-linear systems, the possible ways of coupling them to achieve synchronisation. Different types of synchronisation, methods to classify and characterise them and the criteria for stability of the synchronised states are also discussed. Continuous and discrete dynamical systems and their bifurcation structure are discussed in detail. The phenomenon of synchronisation is discussed and different coupling schemes applied to synchronise two or more systems are studied. Different types of synchronisation, stability and characterisation of synchronised state are given in detail. The dynamical states and bifurcation structure of a two dimensional discrete system called Gumowski-Mira map (GM) and its variant called Modified Gumowski-Mira (MGM) map are analysed in detail. Different types of coupling schemes are introduced in GM map and MGM map and the performance of each in realising synchronisation is analysed. Their synchronisation is studied using similarity function, stability analysis, synchronisation and stabilisation times and available basin in the parameter as well as initial value plane. Two regular arrays that work under the drive response mechanism is studied in detail with the GM map as the local unit and a connection that involves a nonlinear function forming part of the map function. In the vertical array, synchronisation is found to occur simultaneously while in linear horizontal array, synchronisation sets in sequentially. In the case of horizontal array we observe the novel feature called bunching effect that reduces the total response time. A horizontal array of $N$ identical systems with open ends is constructed with the local dynamical unit as a Predator-Prey map. Cluster formation is observed for lower values of coupling coefficients. The scaling behaviour of three different order parameters ($d$, $\rho$, $\sigma^2$), near synchronisation transition is studied and the critical exponents are isolated. The concluding remarks highlight the relevance of the present work and possible future work arising from it.

Keywords. Nonlinear dynamical systems, Chaos, Gumowski-Mira map, stability, bifurcation, synchronisation, intermittency, additive parametric coupling, control of chaos, bunching effect, Predator-Prey map, scaling behaviour.