Automatic Generation Control for a Two Area Power System Using Deep Reinforcement Learning

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Problem Statement & Aim

An increase in photovoltaic power generation, and battery energy storage systems is causing Australian power system dynamics to become more non-linear, driving a need to explore novel control architectures to improve frequency control performance. This research aims to investigate the feasibility of controlling the power system frequency with a neural network.

Reinforcement Learning

Reinforcement learning is a branch of machine learning concerned with an agent's sequential decision making to maximise cumulative expected reward.

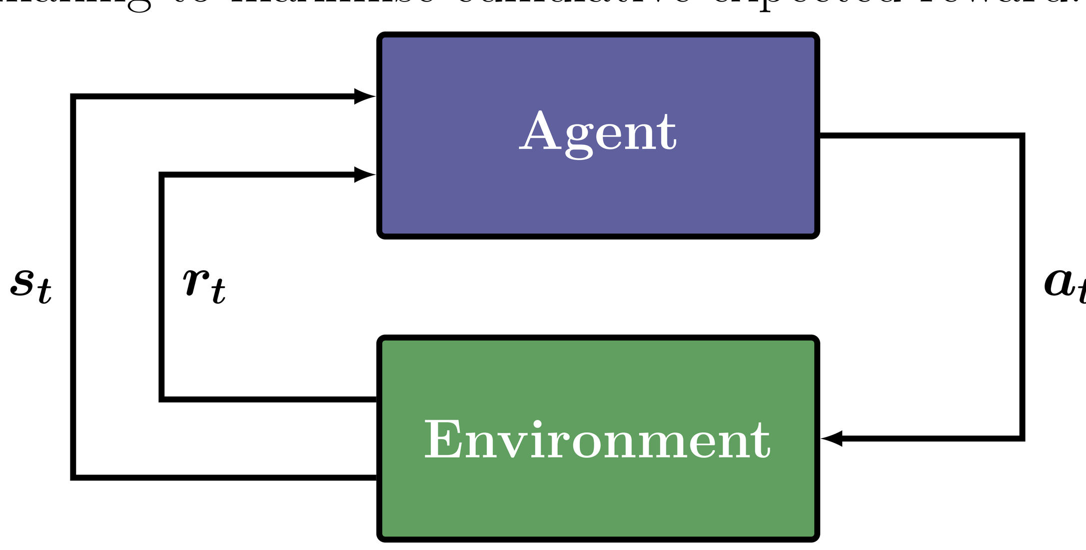


Figure 1: The agent exists in some environment and at each time step observes state $s_t \in S$; and takes an action $a_t \in A$. Following this, the agent then receives a reward $r_t \in R : S \times A \times S \to [R_{min}, R_{max}]$.

The Environment

The control objective is to maintain inter-area power transfer, whilst regulating the frequency of each area.

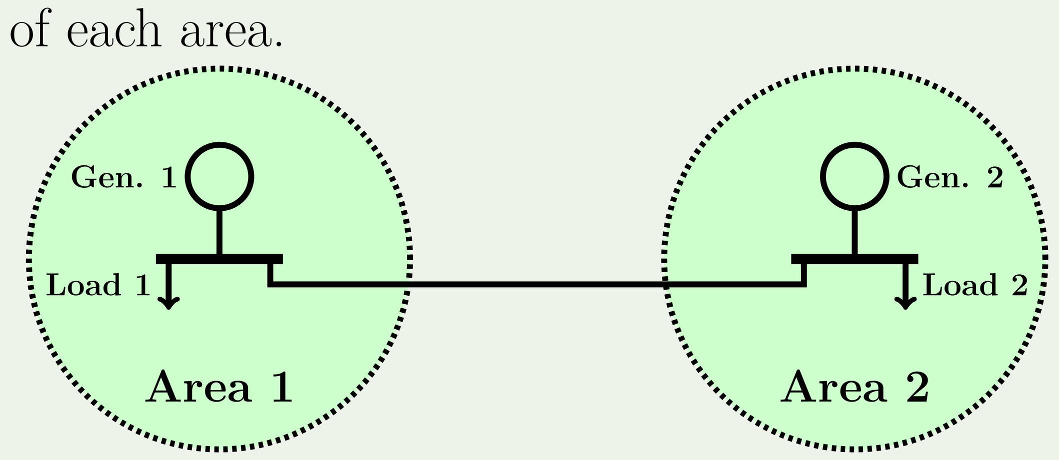


Figure 2: Two power areas connected via a transmission line. Each power area consists of: a governor controlled generator and a stochastic load demand.

The Environment: A More Detailed View

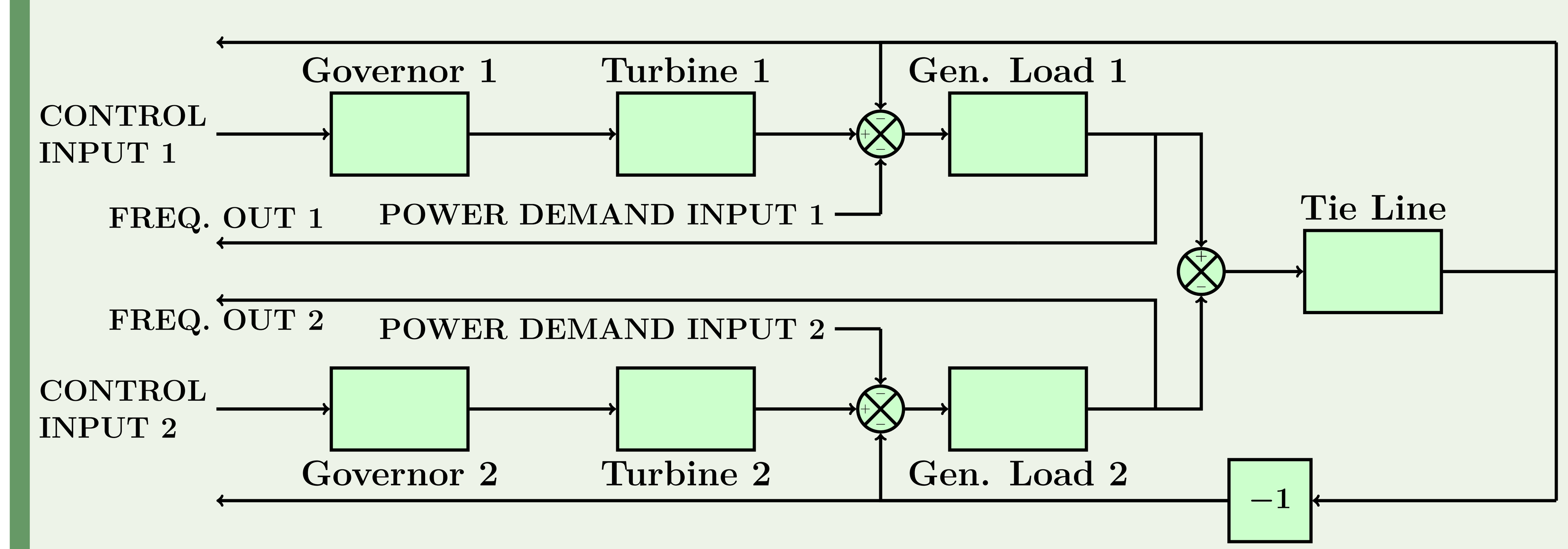
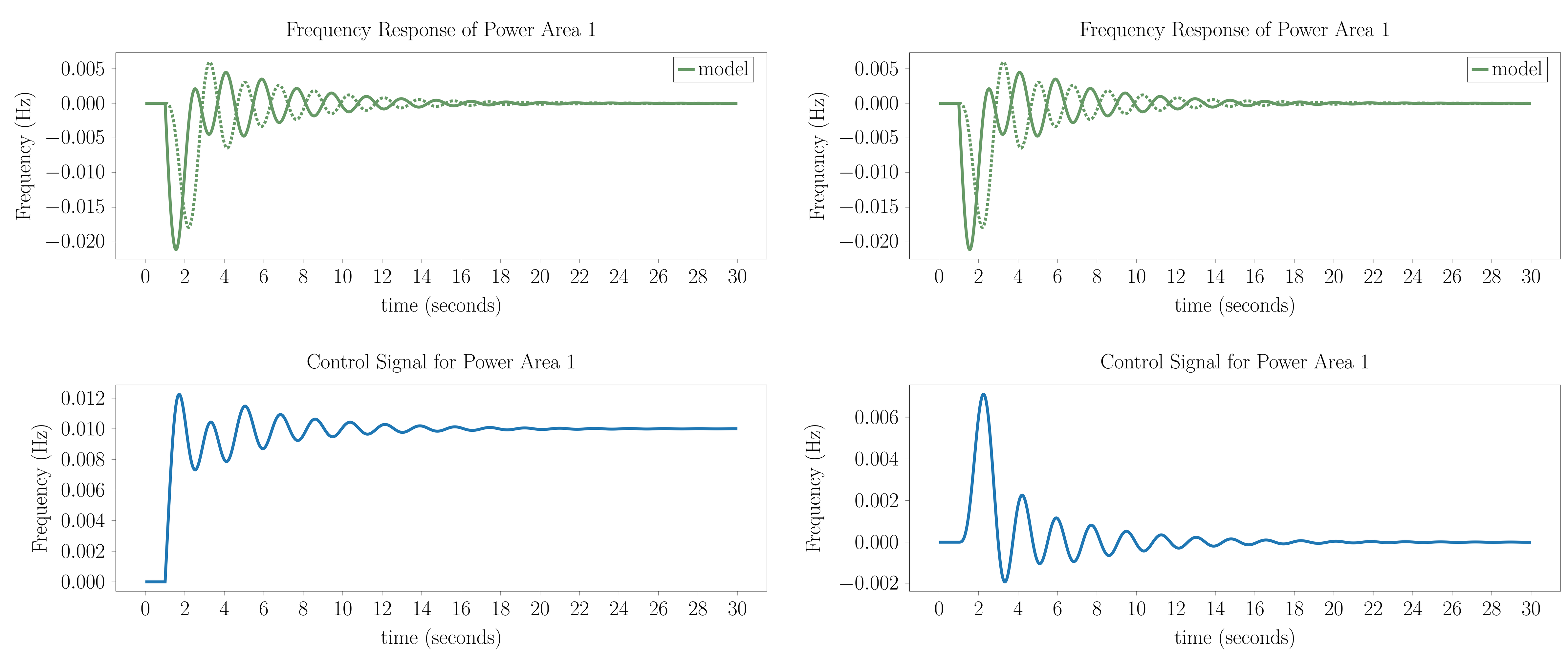


Figure 3: Block diagram of two area power system connected via a tie-line. Generators are modelled using governor and turbine models. Governors, turbines, generator loads, and tie-lines are all modelled using first order linear systems. Simulation is undertaken in the temporal domain.

Results Comparison from Preliminary Experiments



PI Controller

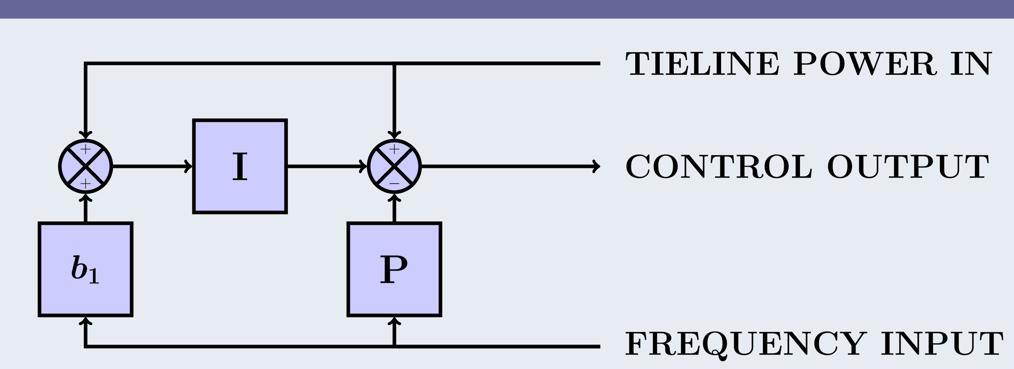


Figure 4:Block diagram of the PI controllers used to classically control power system frequency. Two feedback loop proportional integral (PI) controllers are used to control the frequency and the tie-line power flow. A single PI controller is connected to each power area.

DDPG Controller

Neural Network Architecture

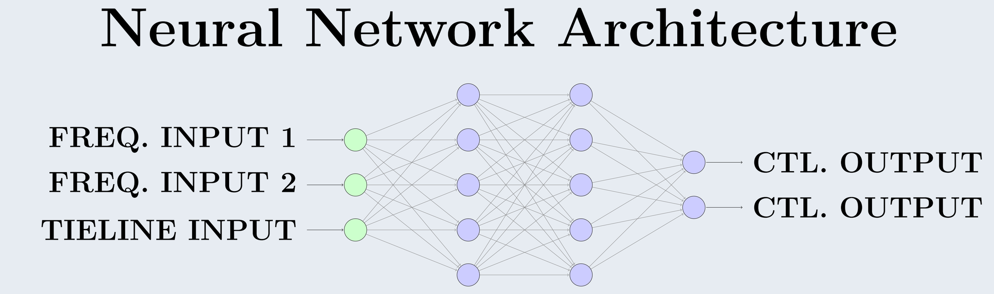


Figure 5: Indicative architecture of a neural network.

Preliminary Experiment Setup

DDPG Controller Evolution

Research Direction