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Abstract

This report summarises my exploration into the phenomenon of synchronisation of oscillators. I have taken an abstraction of multiple . Our final model is based on a traffic grid in Chicago and uses multiple different timing systems to try to reduce traffic. Our results are then represented using a GUI that updates during run time and can be saved as an mp4 file.

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Introduction

1 Problem Statement

One of the most interesting physics phenomina is the synchronisation of interconnected networks. This phenomenon extends far beyond simple mechanical oscillators and manifests in numerous natural and engineered systems, from fireflies flashing in unison to power grid stability and even pedestrian footbridge dynamics. Understanding the mathematical principles behind synchronisation has always been an idea that I have wanted to experiment with for a long time.

2 Scope

In this study, I will examine different models to describe the connections between different oscillators and how they can be applied to both the power grid and human movement

1. What are the effects of the number of oscillators and the coupling strength on the time taken to synchronise?
2. How does introducing a reactionary delay affect the time to synchronise?
3. Is there a way to predict if a non-zero coupling strength will eventually cause synchronisation?
4. How does network topology affect synchronisation dynamics?

Overall, the project is designed to provide insights into the nature of synchronisation within dynamic systems and identify conditions needed to produce or reduce synchronisation.

3 Objectives

The primary objective of this project is to build a robust simulation environment that accurately models synchronisation equipped with different network systems. The intended outcomes and objectives are as follows:

1. Simulation Development: Create a discrete event simulation that mimics the behaviour of synchronising systems. The simulation will include differing connections of networks and include time delays.
2. Comparison of Network types: Implement full, star and ring networks. Evaluate how each system influences final synchronisation, time to synchronise and.

3. Performance Metrics Analysis: Collect and analyse data on critical performance metrics for each timing strategy. The main metrics include average wait time per vehicle, the number of junction passes, and the overall traffic throughput.

4. Adaptive System Design: Develop and evaluate an adaptive traffic signal system that can adjust timings under various traffic conditions. The adaptive system shall be flexible and able to alter its parameters to achieve maximum network efficiency.

5. Guidance for Urban Traffic Management: Ultimately, the project aims to provide insights that can inform urban traffic management decisions, highlighting how particular timing strategies can mitigate congestion and improve the performance of urban road networks.