Learning Sign Language with Reservoir Computing

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1 Introduction

1.1 Background

Recurrent Neural Networks (RNNs) are computational models that are inspired by the modularity of mind. What distinguishes RNNs from other artificial neural networks is that the neurons are connected in a cycle, which functions as a memory that preserves prior inputs [6]. Recurrent neural networks are highly effective for processing sequential data such as time-series predictions, Natural Language Processing (NLP), and machine translation [7]. In spite of these applications, RNNs are considered to be difficult and computationally expensive to train due to the gradient-decent problem. [6].

To overcome these limitations, Jaegar and Maas have independently developed a new approach called Reservoir Computing (RC), where each proposed *Echo State Networks* (ESN) and *Liquid State Machines* (LSM) respectively[6]. Reservoir Computing is derived from RNNs in which the recurrent part is a random and fixed dynamical system (the reservoir) [2]. One of the features of RC is that the output layer is trained rather than the input layer, which can be accomplished by using a simple algorithm such as linear regression. This method can reduce the training cost significantly [1].

Sign language is a visual language used by hearing-impaired people. it allows them to communicate through hand gestures and motions instead of spoken words. Sign language recognition systems, are often implemented using machine learning techniques in order to correctly classify and interpret these gestures for effective communication and understanding.

1.2 Description of Project

Throughout my initial research, I have found several projects that apply different classification methods, including Recurrent Neural Networks (RNN), Convolution Neural Networks (CNN), and K-Nearest Neighbour (KNN). These approaches were used to analyse different datasets of raw images, short videos, and sensory gloves.

The primary objective of my project is to classify hand gestures in Australian Sign Language (Auslan) using reservoir computing. To achieve this, I will use a dataset of Auslan signals [4] and experiment with various RC techniques to identify the most effective classification approach. 95 samples from five signers were collected using instrumented gloves.

Moreover, instrumented gloves employ the attached sensors to convert the hand movements into electrical signals which are used for gesture recognition[3]. Compared to information extracted from videos, glove technology provides accurate and concise data[5].

2 Analysis

As I move forward with the project, it is crucial to consider any problems that I might encounter later. One of my main concerns with the data is that the glove may produce incorrect positional data when the transmitters are not facing the monitor, this affects the sagittal plane and the receivers on the monitor are unable to tell which direction the hand was pointed [5]. If this problem occurs, I will try a different classification technique or try adding noise to the data to increase the performance of the model.

Another possible issue could be the sudden change of my project. I have limited time to do research along with having other assessments, making it more challenging to meet the project's expectations while fulfilling my other academic commitments. To mitigate this, I might need to set more realistic goals and experiment with fewer classification approaches.

3 Plan of action

Week4	Research RC to further understand the implementation and usefulness. Test out sign language recognition examples.
Week5	Set up a GitHub repository. Continue research as above.
Week6	Find python libraries that apply RC method. Look into the Survey and Analysis report
Week7	Start writing the Survey and Analysis report. Do more research if needed.
Week8	Document the requirements of the project in details.
Week9	Continue writing Survey and Analysis report.
Week10	Finalise the report and share it with the supervisor to obtain feedback.
Week11	Submit Survey and Analysis report.
Christmas vacation	Start prototyping and implementation.

Table 1: A rough plan of work to be completed

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