REAL TIME BEAT TRACKING

AUTOMATICALLY SYNCHRONISING A DIGITAL AUDIO WORKSTATION TO A LIVE DRUMMER

Ben Adey – Supervised by A/Prof A.J. Wilkinson

INTRODUCTION

Digital Audio Workstations (DAWs) are used by modern rock bands in live performances to play backing tracks and loops. Bands keep in time with the DAW by listening to a click track, a metronome that clicks at a constant tempo in time with the backing track or loop played by the DAW.

In this project, the aim was to create an alternative to click tracks by making a program that synchronises the DAW to the band, instead of the other way around. The proposed system allows a band to play at a naturally varying tempo while the DAW keeps in time.

APPROACH

- It was decided to track the drums since the drums provide the dominant rhythm in a rock band.
- The system focuses on detecting kick and snare drum hits because kick and snare are strong indicators of the beat.

- The beat of both the drummer and DAW is represented symbolically using a **beat position** function.
- **Beat position** is a continuous variable, measured in beats, representing how much a musical performance has progressed.
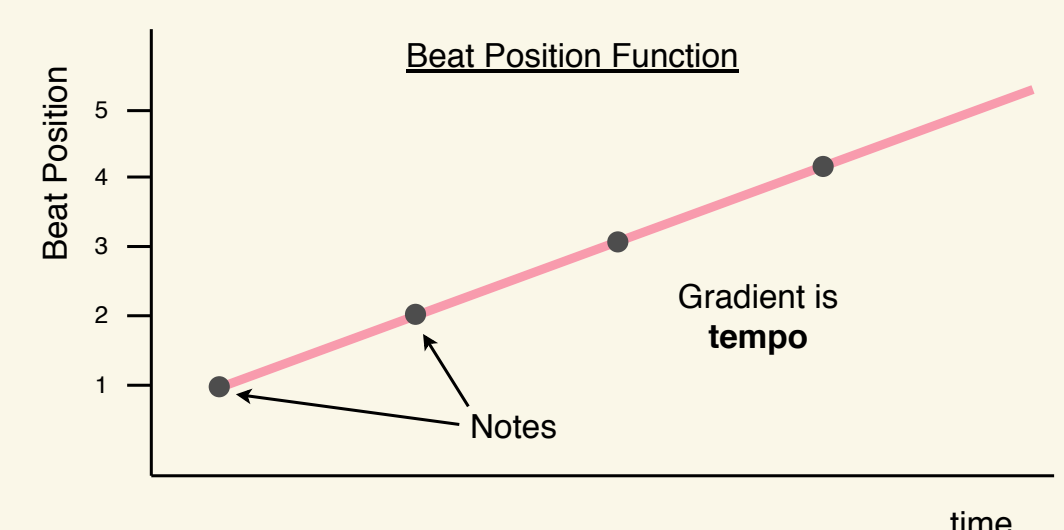
SYSTEM DESIGN
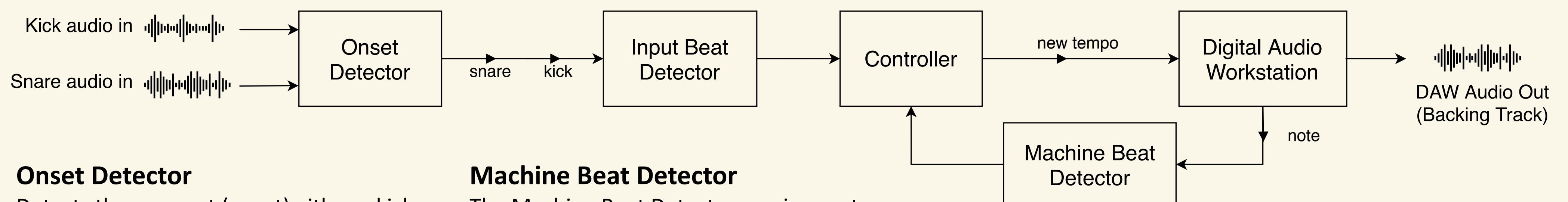
Onset Detector

Detects the moment (onset) either a kick and snare drum is hit. It works by calculating the growth in signal power across 11 frequency bands. If the growth exceeds a threshold, the Onset Detector outputs a message, either "**kick**" or "**snare**".

Input Beat Detector

The Input Beat Detector receives kick and snare onsets and produces an estimate of the input (drummer) Beat Position function. The input Beat Position function is a prediction of how the drummer's beat position will change over time. It changes as the drummer's tempo fluctuates.

Machine Beat Detector

The Machine Beat Detector receives notes from the DAW at a fixed rate and produces the machine (DAW) beat position function. The machine beat position function represents how the DAW's beat position will change over time. It changes whenever a new tempo is sent to the DAW.

Controller

The Controller sets the DAW's tempo so that the machine beat position function intercepts the input beat position function.

### Digital Audio Workstation

The DAW MainStage was used in this project. Other popular DAWs include Ableton Live, Logic and FL Studio.
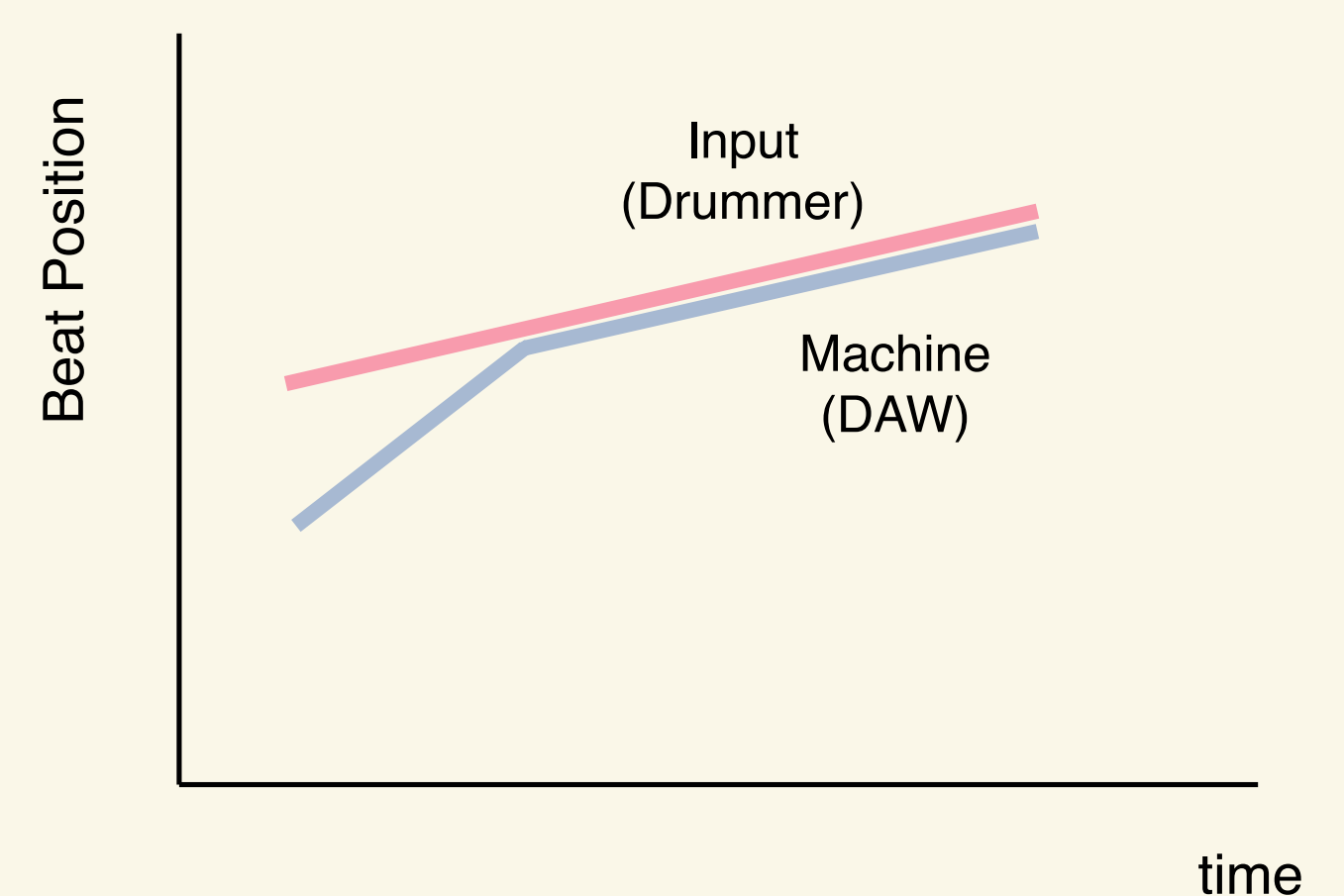
RESULTS

The system was tested by playing 31 test performances and counting how many beats the system accurately synchronised.

- **27/31** tests were synchronised adequately.
  - 9 of these had 100% accuracy.
  - 13 had slightly wobbly starts, but the system regained the beat.
  - 5 had perfect starts with a few slightly inaccurate beats during the performance.

- **4/31** tests were inaccurately synchronised.
  - In 4 cases, the system lost the beat completely at some point in the performance.
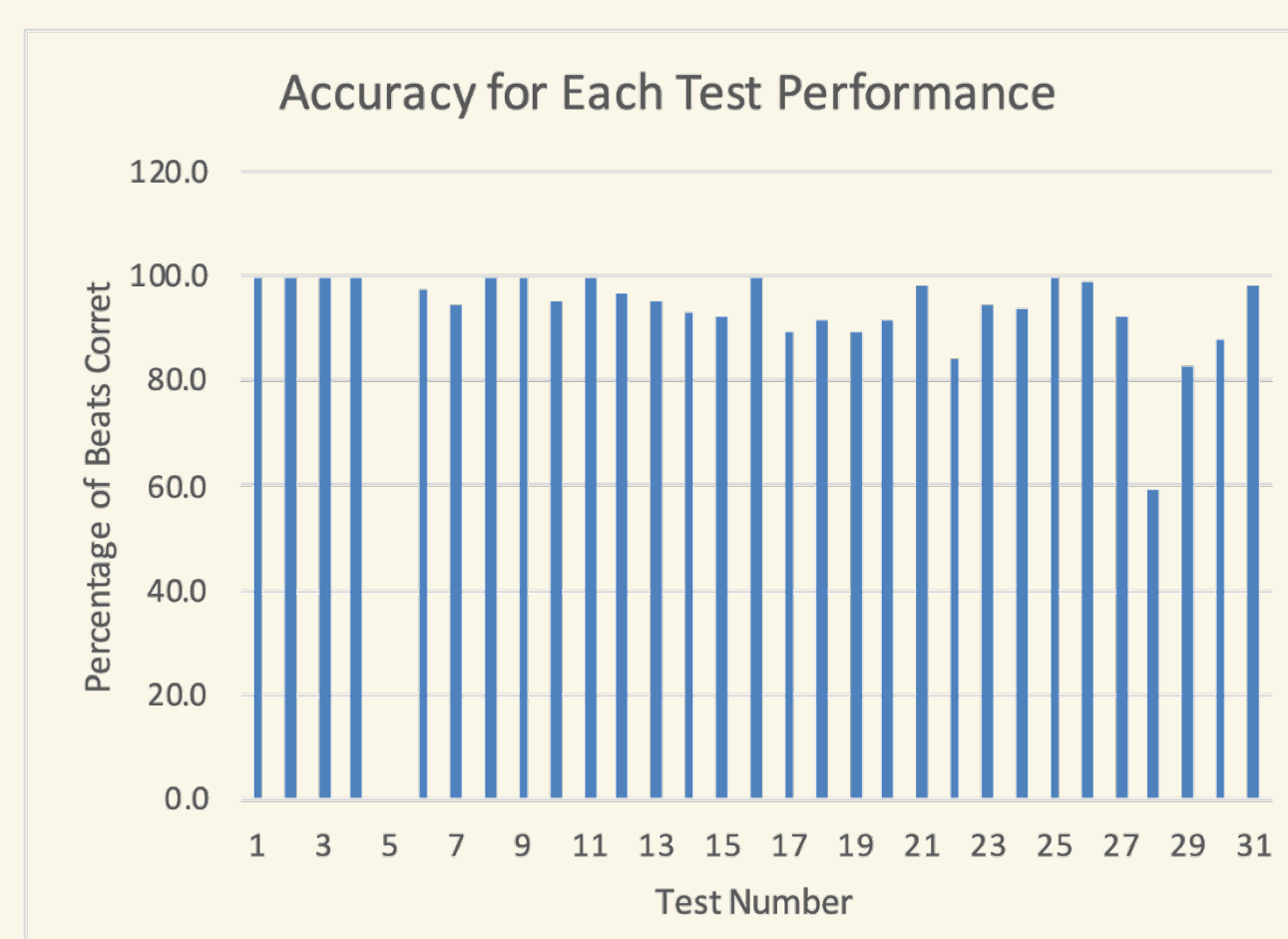
CONCLUSIONS

- The system is a working proof of concept. It was able to adequately synchronise most of the test performances.

- However the system needs improvement to be robust for use in a live performance.

- Inaccurate predictions made by the **Input Beat Detector** were the reason for inaccurate synchronisations.

- Further research and development is required to improve the Input Beat Detector and therefore the whole system.

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD