A-Level Coursework

# Analysis

## Introduction

### Background

* Discussion with music teacher

When looking for a problem that I could apply my computer science coursework to, I had a discussion with the head of music at our school to see if there were any problems facing the department that could be solved with the application of computer science.

In the discussion, it was revealed that student engagement was a problem within the music department, especially for the younger years. We started discussing ideas that could be used to try and interest students in the subject and we came up with the idea to create a self playing instrument.

The teacher mentioned how a self playing instrument could become a quite useful teaching tool to demonstrate how specific instruments create sound, which is an important part of one of the modules in the syllabus. The instrument could also be used to demonstrate how to play the instrument by being something that students could imitate. This would be very useful because it would show the student what to do in order to play the song and what the song should end up sounding like at the end and so the student can teach themselves which means the teacher can then focus on helping other students learn.

### Currently

* Example of what currently happens

Currently, to demonstrate how to play various instruments requires lots of one on one lessons. This is of course is incredibly vital, and not something that there isn’t going to be a perfect substitute for, however, a lot of a teachers’ time in these lessons is spent letting the student practice and giving feedback rather than introducing the student to new pieces. If the device created could give an example of what the tune should sound like, then the student would be able to listen themselves and correct the mistakes that they are making by mimicking the device, which means this could be done outside of the one on one lessons and so the teacher could focus more on introducing the student to new pieces, which is a much better use of the teacher’s time.

In the full class size music lessons, the idea is help introduce the students to the instruments for the first time and get them able to understand the basic principles and techniques behind using them. For this, there is only so much the teacher can help by just giving instructions. For the students to properly take in the information, it would be necessary for the students to watch close up what is happening and how everything works and also be able to interact with the device.

### Overview of requirements (not SMART yet)

* Easy to set up
* Simple to use
* Robust
  + Cannot be broken by y7s
* The Device needs to be easy to set up
  + The device will be used by students and teachers alike and so should be easy enough for them to learn how to use in minuets
* Be easy to understand how it works from a music perspective
  + It should be easy to see how the sound is being made and the pitch is being augmented
* Allow students to easily see what it is doing and copy it
  + Should be able to look at the decive as it is playing it and be able to play along
* Be interactive
  + Be able to plug into other MIDI devices such as keyboards.
    - Must atleast work with the keyboards found in music department
    - Ideally should work universally with any MIDI keyboard around
    - MIDI port
* Be versatile
  + Should be able to be used for demonstrations in class and also self teaching musically instruments
* Be robust so it cannot be broken easily by the younger years
* Increase student attention in lesson
  + Must be interesting/unusual
  + Must be simple to explain how the music aspect of it works

### Possible Solution

* Robotic wind instrument learning aid
  + Describe what it would do
    - Demonstrate fingering interactively
    - Provide something to copy
  + How it would help

For the solution I decided to automate a tin whistle. I chose a tin whistle for a few reasons:

* It is a relatively simple instrument
  + This means it is easy for the students to see what is going on and copy what the robot is doing
* It is an inexpensive instrument
  + This removes the worry that the instrument will be damaged in a way that would end up costing obscene amounts of money
* It’s quite small
  + This makes it easier to build around and transport
* The mechanics could easily be applied to other wind instruments with only a few modifications

The solution would consist of two main parts. The Tin whistle itself, which will be controlled by an Arduino, and a companion program for a windows PC that would allow the user to quickly and easily select songs to play on it and send instructions down to the tin whistle to control it.

To control the tin whistle, I intend to use an Arduino Uno programmed to receive midi commands and then move servos to change notes. I intend to follow the MIDI specification as closely as I can to make the device as versatile as possible and allow it to interact with other MIDI devices.

The desktop program will also be biased around MIDI. It will allow the user to import MIDI files that the user has created, or that have been downloaded off the internet, select whichever tracks that they would like the device to play, and then send it down a USB cable to the Arduino.

### Solution refinement

* Further discussion
  + Tin whistle
    - Easy
    - Principles apply to other instruments
  + To make it interact, make it use with an actual midi keyboard to make it more interactive
  + Allows people to associate notes with fingering (image of keyboard with notes drawn on)
  + If well known tunes could be played, then it would more motivate the students
    - Midi file input
* Solution will consist of Desktop Program to be run on windows and a program running on the Arduino to control the servos and fans to play the tin whistle
* Desktop program
  + Take Midi Files as input
  + Display the tracks found in the MIDI file on timelines
    - Allow the user to select which of these tracks should be sent to the device
  + Play, pause, rewind, skip buttons that can be used to control what the whistle is playing
  + Playback speed control to allow learners to slow down playback for bits they are struggling with and then speed it up when they become more confident
* Arduino Program
  + Receive live MIDI events
  + Interpret these events
    - Find out what they are saying to do (eg, note on, note off, or something irrelevant)
  + Act upon these events
    - Move servos
    - Change Airflow

### SMART Objectives

* Must be interactive
  + Must connect and be controlled by the keyboards in the music department to allow the students to play with it
* Be easy to set up
  + Must have a small number of first time set up steps
    - Eg 6 (These are examples and are subject to change)
      * Plug in data cable
      * Plug in power supply
      * Open Desktop program
      * Select communication port for the Arduino
      * Open File
      * Play
  + Must have a small number of subsequent set up steps
    - Eg 5 (These are examples and are subject to change)
      * Plug in cable
      * Plug in power supply
      * Open Desktop program
      * Open file
      * Play
* Be versatile
  + Can be used to demonstrate how the instrument itself works
    - Allow clear sight at all aspects of the instrument and moving components
  + Can be used as a self teaching aid
    - Should be able to work without intervention to allow the student to play along
    - Should have a metronome feature to allow the user the keep time
      * May be part of the Desktop program
  + Can be used to just let the students experiment with to involve them in the subject
    - Connect to the keyboards in music and then play the notes sent to it to allow the students to intuitively learn the link between the letters of the notes, the keys on a keyboard, the sound of the instrument and the position of the fingering

### Scope of Solution (NOT SURE ABOUT THIS PART, SO LEFT IT FOR NOW)

* Initial project baised on tin whilstle only
  + Could be remapped to other instruments, (change values in a table)
* Only be able to blow for the tinwhislte, not for other instruments with reeds
* Not synthesised output
* Only play the notes that can be played on the tin whistle anyways
* Midi conversion would be adapted to what a tin whistle can play. May not necessarily be universal.

### Objectives (THINK THIS HAS MOSTLY ALREADY BEEN COVERED)

* What it can do
* 6 servos
* Ardunio
* Companion program on pc

# Documented Design