**Project Outline: Harry Moss 10478272**

Scope and Motivation of the Project

Currently, in the world of guitar musical effects, the most populated and well-established form of signal manipulation involves the use of an external, grounded foot-switch – most prominently perhaps in a live setting, outside of the musical studio. There are an almost infinite number of different effects available, with an almost eye-watering level of choice available on the market today ranging from simple battery-powered reverb pedals to state-of-the-art, mains-fed loop station pedal boards [1] to transform a guitarist’s, bass guitarist’s, and even a curious keyboard player’s stage presence to a completely different level.

So what is the issue here? There is no issue exactly – it is simply a question of how can we make this more efficient? Various manufacturers have taken their approach of an all-in-one multi-effects pedal to market before – none of this is new – I personally own a *Line 6 Firehawk FX* pedalboard, which offers the player an enormous multitude of effects that can be programmed (at a very high-level to ensure it is user-friendly) directly from a free app that is downloadable after purchase [2]. There is even an option to engage in an online community, where other users of the *Firehawk* can save and upload their own programmed guitar/bass ‘presets’ for you to download onto your own *Firehawk* pedalboard. The range of effects is undoubtedly impressive with this system, and it solves the issue of an overwhelming number of separate pedals on the market today by condensing them all into one package; so how would this compete in a stage setting?

There is only one major problem, space.

The *Firehawk* clocks in at roughly ½ metre long and ¼ metre wide, weighing just under 6.4 kg (not to mention a case that weighs ~1 kg extra) which is hardly uncommon amongst other multi-effects pedal systems already on the market, showing that a package like this one really comes at a cost – not to mention its £348 price tag! [3] With all the other equipment that a guitarist or bassist (particularly those playing electric) would undoubtedly be carrying already (amplifies/cables/instruments) to and from a performance, there is little room to add in many more *desirable* as opposed to *essential* items such as these; they would rather limit themselves to a few small footswitches they could carry in the pockets of their jacket along with their eye shadow and flares.

This is where this project comes in. A symbiotic, multi-effects, but most importantly – *on-board* guitar pedal. This system will, upon completion, sit not on the floor, but at the guitar end of the cable. Along with several slider switches and potentiometers soldered and wired in to offer additional control, the device will replace the current ¼ inch input jack already sitting just below the electric guitar’s strings with a new one; it will feed through into a dedicated real-time DSP system already *inside* the guitar. This will have Bluetooth functionality, allowing the user the freedom and benefits to program any effects they want from their smartphone in the exact same way as the pedalboard described previously, but without the constraints of an additional, cumbersome piece of equipment demanding itself to be dragged around, along with a much fairer and reasonable price tag (a *BF706* DSP module costs only £59.50 [4], and a *Raspberry Pi Zero W* will cost even less than this [5]). There is also further reason for a wild, stage-loving musician to purchase such a system – there is no longer a requirement to be stationary and standing next to a foot-pedal to switch effect mid-performance. So long as they were using a radio-controlled I/O jack, a guitarist could in theory run around, enter a mosh pit, or even crowd surf for a whole set knowing that he/she has full, real-time control over the sound of their instrument.

Aims and Objectives

1. **Identify any further requirements needed for an electric guitarist/bassist in a live performance setting:** this can be realised by interviewing other players of guitars and basses and asking them about their thoughts and opinions of the current situation involving multi-effects music pedals.
2. **Identify any constraints in fitting the device inside the guitar:** upon investigation, this may demand modifications to the body of the guitar, which would increase costs and be much less desirable for users of expensive vintage guitars that may want to resell in the future. There may also be a cost in creating a modified scratchpad to fit the external control slider switches and potentiometers, which would again be undesirable. The possibility of mounting the board externally (i.e., fixed to the guitar body out of the way) will be considered.
3. **Derive a working wireless system of tweaking/programming the on-board effects:** the most obvious process to achieve this so far would be using Bluetooth, in particular with a mobile app, as it would be a very quick and user-friendly method of editing the various levels of signal manipulation with a touch of a button.
4. **Identify the most suitable DSP platform for the project:** this will be achieved by using and comparing two chips: the *Raspberry Pi Zero W* (with a soundcard attached on top) and the *BlackFin* *BF706*. The two will be analysed and tested rigorously using C/C++ and DSP assembly code to gauge their performance in real-time. Latency and any additional delays will be compared using *CrossCore* Embedded Studio (in the case of the *BF706*) [6] and then *Raspbian/NOOBS* or otherwise (for the *Raspberry Pi*). Further considerations will also be given to their cost, in addition to their overall power consumption. The size of the chip also matters, as this may affect where it can be mounted inside (or outside) the guitar.
5. **Quantify the number of external control switches needed:** further collaboration with other musicians and their personal preferences will ensure this gets well established. To reach a larger sample population of guitarists, research will be carried out online as to the average number of pedals/effects a player would typically bring to a live performance. This would then translate directly into the number of external controls that the user can use in real-time.
6. **Identify the 5 most important musical guitar effects (in order of preference) as a foundation for the project:** this will again be determined by further research into what electric guitarists (the commercial market) as a whole feel is the most important effect, along with considerations of programming complexity (a simple distortion effect is much easier to create than an adaptive FIR filter, for example) in order to manage the timeframe of this project. The method will be to realise the most popular and preferred effect in a stable, working manner first and foremost, then to implement the other 4 effects in order of importance if the project has successfully hit milestones on schedule and created leeway for sound exploration.

Bibliography

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[4] Mouser Electronics, ‘ADZS-BF706-EZMINI’, 2021, [Online] Available: <https://www.mouser.co.uk/ProductDetail/Analog-Devices/ADZS-BF706-EZMINI?qs=NEWnq6vH5Lfi%252B01kB0zKAw%3D%3D>

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[6] Analog Devices, ‘ADSP-BF70x Series’, 2021, [Online] Available: <https://www.analog.com/en/products/landing-pages/001/adsp-bf70xseries.html>