1. Introduction

A mechatronic chordophone (MC) is a robotic variation of a musical instrument that generates notes via plucking, bowing, or striking stretched strings. As the parameters for a chordophone to generate sound is by plucking a string, this literature aims to explore the variations of picking and damping mechanisms of current chordophone.

2. Picking mechanism

Picking mechanism (PM) used in MCs encompasses a motor connecting to a controller unit. When this motor is active an amplitude is produced by striking the string with a guitar pick. Conditions such as picks per second (pps), picking consistency and volume range should be considered when determining the feasibility of a PM. A simple variation of a PM design is the push-pull PM as observed in Figure 2.1 was also used as the PM for the Aglaopheme [1] [2].

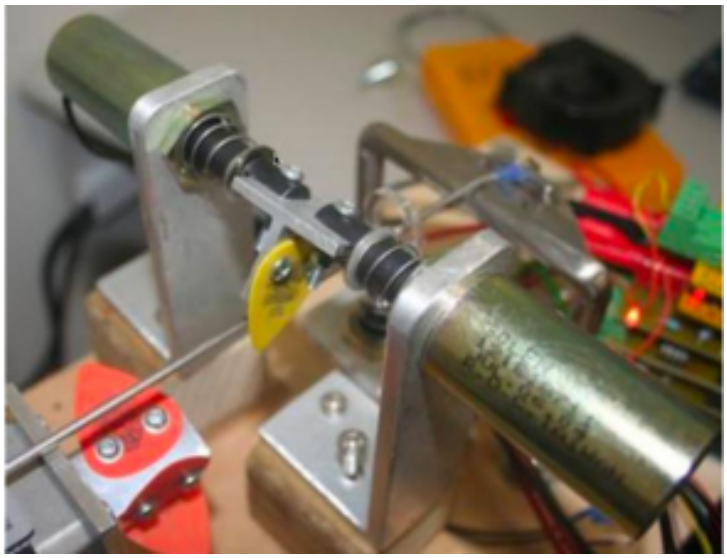

Figure 2.1: Push-pull mechanism [1].

Two solenoids are configured in a push-pull manner with a pick over a string, striking the string as a guitarist would. However, the disadvantage to this design is the bulky configuration of the solenoids and the lack of dynamic picking intensity. Furthermore, the push-pull configuration may contribute to additional background noise thus, generating a greater signal to noise ratio for the transducer. To address this disadvantage, the Protochords revolving PM is recommended [3]. This PM incorporates a pancake stepper motor and utilises a five-arm rotary pickwheel to maintain a compact design as shown in Figure 2.2 and has a pick rate of 32 pps.

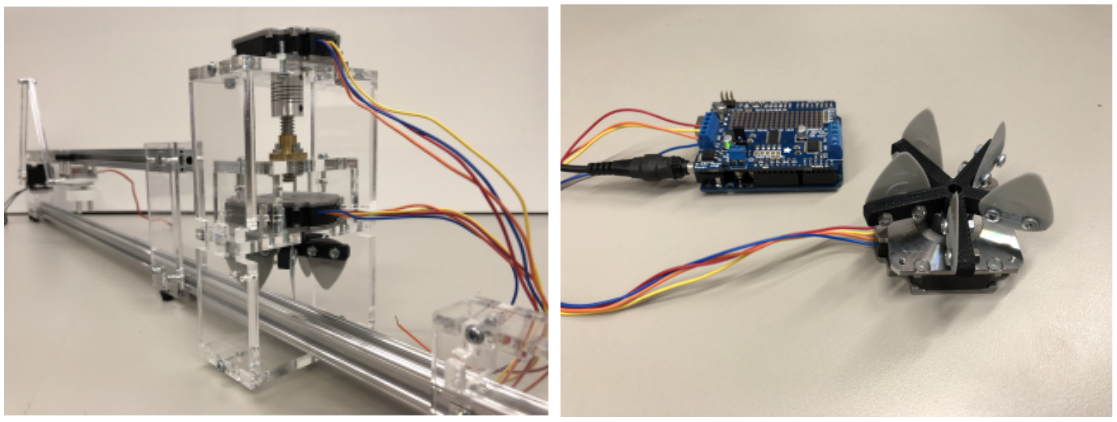

Figure 2.2: Protochord's revolving PM [4].

The Protochord's PM also reaps the benefits of dynamic volume intensity by bringing the pickwheel closer to the string to play louder and further away to play softer using a leadscrew driven motor, producing volume ranging from -36.45 dB to -28.26 db [3]. This design is more advantageous than a servo volume adjuster as the servo motor only has a lower variety of volume [5]. However, picking consistency at lift levels greater than 1 mm may deteriorate precision at higher picking intensity.

This is expected as the picking surface area increases and thus negligible. New iterations of the revolving PM include silicone pads inserted between the pick and the pick wheel to replicate a more human feel to the plucking. Furthermore, the front and back PM design will emphasise different harmonics of the vibrating string thus varying timbre production. Furthermore, the Protochord may benefit from an additional feature which alters the angle of the guitar pick.

3. Damping mechanism

Damping mechanism (DM) used in MCs utilises a servo motor(s) connecting to a controller unit. When this motor is active, the resonating string would be damped producing a muted effect or attenuate the amplitude. To determine the feasibility of a DM, features such as harmonic uniformity, rate of damping and expressiveness will be considered. A typical design for a DM can be observed in Figure 3.1 where a palm-muting mechanism was used for the Protochord DM.

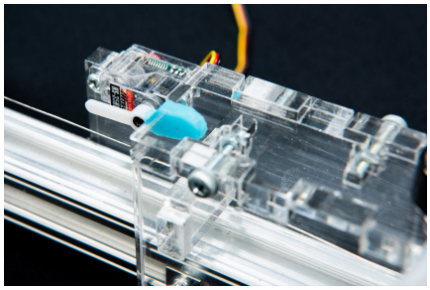

Figure 3.1: Protochord's palm-muting mechanism. A system that uses a nano servo motor and a silicone sleeve to mute the string lightly [4] [6].

The servo motor of the Protochord's palm muting mechanism can produce a variety of muting. By changing the power applied to the servo, different preload pressure can be applied, producing a variety of effects ranging from string slaps to mutes. Additionally, compared to the efficacy of foam, the silicone material used produces a more natural feel to the DM as it replicates human skin [6]. However, the transient analysis of different damping materials was not conducted in these literatures. Thus, the true efficacy of the damping material is up for debate. As illustrated in Figure 3.2 a picked and muted string, an attack which is determined by preload pressure of the servo and the rate of attenuation is dependent on the damping material.

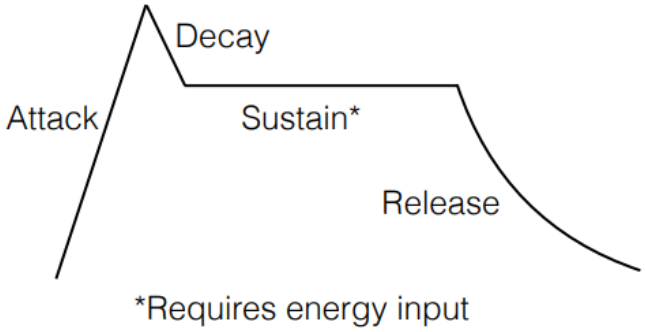

Figure 3.2: expected transient analysis of DM.

However, the disadvantage of only incorporating a palm mute DM limits the MC's expressive movement and the variety of sounds the MC produces. Therefore, it is also recommended to consider an additional DM near the fretting mechanism similarly to Figure 3.3 to elevate the expressiveness of the overall DM. The moving DM on the strumBot will allow for expressive and dynamic variations of muting by engaging mute near the nodes of the wave, analogous to how a guitarist or a bassist would produce. Additionally, it may also provide the option to produce a harmonic note.

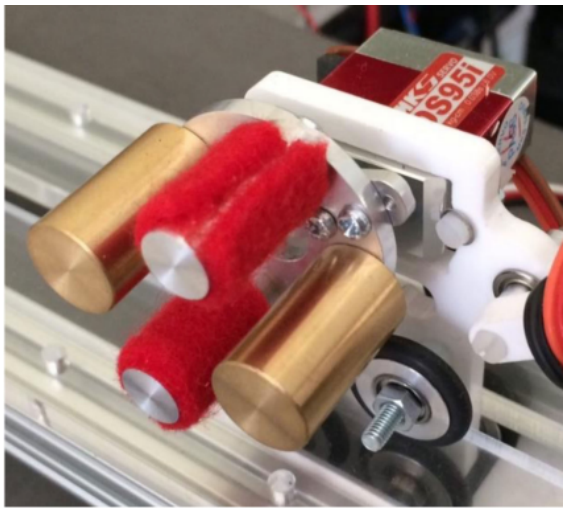

Figure 3.3: StrumBot's clamping mechanism. A design that incorporated the DM into its fretting disk. [6]

4. Conclusion

In conclusion, although current research provides a sufficient framework for designing PMs and DMs. A timbre analysis of the revolving PM could be conducted and a varying picking angle could be implemented. DMs could benefit from a more quantitative approach to the damping comparison such as a transient analysis of the different DM's materials compared to a transient analysis of a guitarist/bassist string damping.

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