Demystifying tabla through the development of an electronic drum

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ABSTRACT

The tabla is a traditional pitched two-piece Indian drum set, popular not only within South East Asian music, but whose sounds also regularly feature in western music. Yet tabla remains an aural tradition, taught largely through a guru system heavy in custom and mystique. Tablas can also pose problems for school and professional performance environments as they are physically bulky, fragile, and reactive to environmental factors such as damp and heat.

As part of a broader project to demystify tabla, we present an electronic tabla that plays nearly identically to an acoustic tabla and was created in order to make the tabla accessible and practical for a wider audience of students, professional musicians and composers. Along with development of standardised tabla notation and instructional educational aides, the electronic tabla is designed to be compact, robust, easily tuned, and the electronic nature allows for scoring tabla through playing. Further, used as an interface, it allows the use of learned tabla technique to control other percussive sounds. We also discuss the technological approaches used to accurately capture the localized multi-touch rapid-fire strikes and damping that combine to make tabla such a captivating and virtuosic instrument.

Author Keywords

Tabla, cultural instruments, Indian Music, Novel interfaces, electronic drum

CCS Concepts

•**Applied computing** → **Sound and music computing;** *Performing arts;* •**Social and professional topics** → Cultural characteristics; •**Human-centered computing** → **Interface design prototyping;**

1. INTRODUCTION

Our motivation is to democratise the playing of the tabla and we have developed an electronic tabla to assist in this mission. The tabla is a pair of traditional Indian hand drums that offer a rich distinctive array of timbres attractive to composers and musicians around the world; but buying, maintaining, and especially learning to play the tabla is often intimidating. Tabla is taught aurally with no notation and through a conservative *guru-shishya parampara*, or guru-disciple tradition. The guru-disciple teaching system requires a student to affiliate themselves to a guru through ritual ceremony with the bond being more than merely instruction on how to play the instrument. It is considered an act of transmission at a spiritual level. The student becomes part of the family or lineage of the guru in their *gharana*, or school [4]. The current tradition also focusses on solo improvisation rather than repertoire written by third-party composers. Training expects students to learn basic rhythm cycles (*taala*) and improvisational skills as part of a path towards soloistic virtuosity and performance flair.

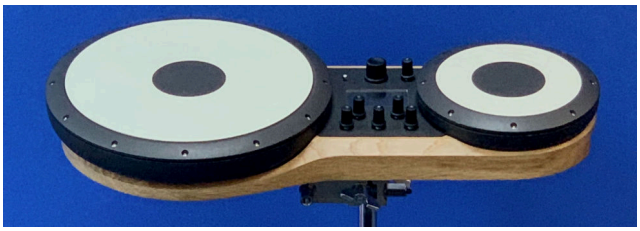

Figure 1: The electronica tabla

While the guru-disciple tradition is effective at producing virtuosic solo improvisors and can act as a valuable means of maintaining contact with cultural history especially for South East Asian emigrants, the traditions and the system's inherent mysticism have discouraged outsiders from adopting and utilising an otherwise exciting musical instrument. Tabla playing remains largely confined within South East Asia and the wider Indian diaspora. Further, the traditional learning paradigm does not offer appropriate training routes for those interested in ensemble play or simply wanting to learn a favorite Bollywood piece.

The electronic tabla is part of a wider effort to demystify Indian music. We have successfully launched a western score-friendly tabla notation, the *Universal Indian Drum Notation* (UIDN), a series of instructional books, and an educational web-series.[1] We also run workshops around the UK teaching tabla to a wide range of students: from primary school beginners, to percussion students at internationally respected music conservatoires. These workshops have helped us build our understanding of what aspiring tabla players and educators outside the guru-disciple tradition need to help them learn and teach tabla.

While there are definitely those who will feel that encouraging people to learn outside of the guru-disciple tradition is an anathema, we believe that demystifying Indian music and making it more widely accessible within and outside

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[1] `https://keda.co.uk`

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the Indian diaspora is a positive action. We are not looking to replace the current traditional system, but to offer an accessible ensemble-friendly alternative which may even inspire a student to pursue more traditional paths. There is a clear interest by both non-Indian composers and musicians to incorporate the tabla into their musical lexicon, and with an already respected cultural and esteemed place within music, enabling easier uptake of the tabla may help it join the pantheon of popular instruments to learn.

This paper provides an introduction to the tabla, prior work, the motivations informing our design criteria for the tabla and why we believe the electronic tabla can address these. Lastly, we provide an overview of our implementation to capture the tabla's complex playing interaction and our success at building an instrument where acoustic tabla technique can transfer almost seamlessly to the electronic version.

2. AN INTRODUCTION TO THE TABLA

Traditional tablas are tuned drums using tensioned animal skin drumheads. What sets the tabla apart from many other hand drums throughout the world is the inclusion of a circular spot of carbon paste on the drumhead. The weight provided by the paste extends the length of resonance, thus enabling sufficient sustain for a player to add a glissando: one of the tabla's most distinctive sounds. The paste also creates the overtones that gives the tabla its characteristic sound [12].

Figure 2: Acoustic tablas: the bayan (left) and the smaller dayan (right) with a tuning hammer.

The tabla pair is made up of the bayan, a wider bodied lower drum and a higher pitched dayan (Figure 2). Each drum is played with one hand using unique techniques distinct from most other hand drums. While it is beyond the scope of this paper to explain all the striking and damping techniques in detail, as an example we will discuss the *Ge* stroke with Figure 3 otherwise illustrating the main strikes. The *Ge* involves striking the center of the bayan in an undamped manner with the heel of the palm on the drum. Pressing into the drum with the palm heel changes the pitch of the attack. Sliding the heel over the surface of the bayan head after a strike produces the tabla's distinctive glissando. For more details on the tabla and how to play it, see Kapur's overview [6], our site, or the many ethnographic publications on the instrument.

3. PRIOR WORK

Trying to capture the intricacy of tabla play using technology is not a new idea. Ajay Kapur has indeed already built an electronic tabla based controller the eTabla [6]. Kapur's eTabla was not developed to accurately replicate the tabla but, "to make an instrument that could be used to create an audio and visual experience that allows performer expression, and enamors the audience." Kapur measured striking and damping actions by placing force sensitive resistors at strategic locations on an acoustic tabla. These were able to generate MIDI signals used to control a synthesis technique based on banded waveguides along with driving real-time graphics to generate a more immersive audience experience.

One of Kapur's main goals "was to preserve the traditional feel and performance characteristics of North Indian classical Tabla drumming while electronically extending the variety of sounds available to the player." [6] something not feasible using commercially available electronic drums. Indeed, since Kapur's eTabla in 2003 [6], the electronic hand percussion market has not significantly advanced with the Korg Wavedrum[2] and the Roland Handsonic[3] still the primary offerings. While both are useful and capable as drumming instruments/interfaces, as Kapur observed, neither are appropriate for capturing tabla technique. Keith McMillan's Boppad [4] is a more recent entry into the market of hand drummable surfaces though it is not clear how well it could capture and understand multi-touch gesture based tabla techniques. Lastly, though not designed explicitly for hand percussion, the Sensel Morph[5] is a high resolution multi-touch pressure sensitive trackpad likely capable of tracking the strikes and gestures required to play tabla; however, it is unavailable in a tabla-head-shaped form factor, and our experiences with the Morph in unrelated research is that it has a very hard and unforgiving surface unlike a natural drumhead.

Similarly, there have been few new methods for capturing hand drumming beyond Tindale's et al. [15] review of sensor strategies for capturing percussive gestures. In [8], McCloskey et al. discuss using infra-red light deflection based tables as a drum interface, and Sokolovskis also offers an interesting method for capturing snare hits using near-field infra-red reflectance sensors and physical modelling of the strike behaviour on the drum [13].

4. TABLA IN THE CLASSROOM

Though the bulk of tabla instruction is through the guru system, tabla is a popular instrument within the Indian diaspora with sufficient demand that it is sometimes taught at a basic level within schools. Unfortunately, in our experience running workshops, the fragility of tablas means the classroom set is often damaged and in poor condition making it hard or impossible to play. As pictured in Figure 2, tabla use a hammer for tuning and within a classroom of young kids, a misplaced hammer can quickly lead to torn and damaged heads. Similarly, unsupervised, tablas are hit with drumsticks, which destroys them. Teachers are often not tabla experts themselves and are therefore unfamiliar with how to maintain, tune and repair the instruments.

A second issue with tabla in educational settings is simply size. A pair of tablas in a case are roughly 20"x12"x12". Consequently a classroom's worth of tablas takes up significant storage space. The electronic tabla is designed to be more compact. It retains the traditional head size and floor outline, but is only 3" high meaning stacked, it takes a quarter of the storage space of an acoustic instrument.

Lastly, tabla is a tuned instrument. Tuning of the drums

[2] https://www.korg.com/us/products/drums/
[3] https://www.roland.com/
[4] https://www.keithmcmillen.com/products/boppad/
[5] https://sensel.com/

is done by tapping the wooden tuning blocks and platted rim with a hammer to increase or decrease head tension. This can be intimidating to beginners and impractical in a classroom. Tuning can even be a problem for professionals as the natural skins used to make the heads tighten in heat, for example under stage lighting in concerts and sunshine in outdoor performances. A well-tuned tabla may become significantly out of tune as a venue warms up. Using the electronic tabla, tuning becomes trivial. Turning a knob, we can instantly digitally repitch the audio to the performer's preference and the pitch will remain stable no matter the environmental conditions.

5. NOTATING THE TABLA

As an aural tradition, tabla music is largely undocumented. The tradition insists that one must "say it, then play it." Though intuitive and effective for native speakers of Indian languages, it excludes people for whom the sounds don't sit naturally on the tongue. It also requires extensive memorisation. While aural training is essential for learning musical paradigms and articulation, well-defined notation is far more efficient for enabling quick reproduction of extended patterns or musical compositions. Ethnographic notations such as Kippen and Widdess [7, 16] are based on *bhols*, sounds used in traditional teaching. Bhol based notation is problematic to intuitive music reading in that the bhol sounds do not always relate to the actual linked drum sound and again, pronunciation can be very foreign to non-Indian musicians reading them [4]. Moreover the mere quantity of text required to document even a short rapid pattern is visually challenging to parse in real-time.

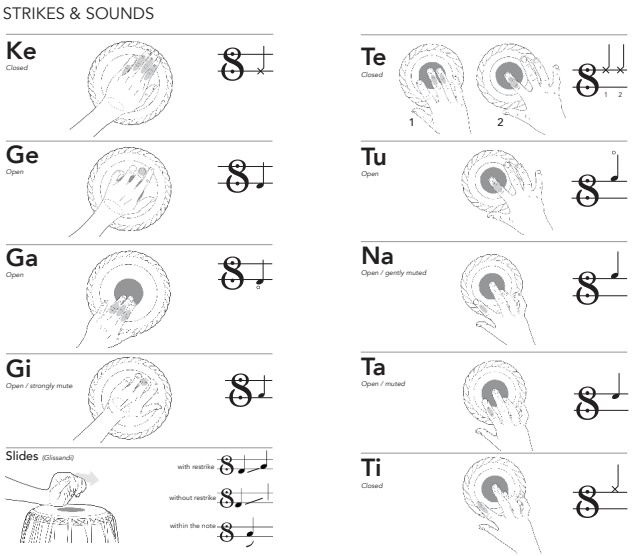

Figure 3: Tabla notation showing the sounds, basic strike technique, and the UIDN notation (bayan left, dayan right). Dashes illustrate hand rest locations and grey areas show strike contact locations.

Our notation is based on a simple two-line stave using standard universal nomenclature, noteheads and rests, as used in western music. Figure 3 illustrates the specific notation used for each of the the strikes paired with the sound names traditionally used. Steinberg's Dorico,[6] a major notation software, has adopted the UIDN within its software [2]. Figure 4 demonstrates a phrase notated for tabla using UIDN. We have found our notation has indeed facilitated playing repertoire. For instance, we've conducted workshops using our new notation that involved both traditionally taught tabla players and western percussionists. A traditionally taught tabla player noted that the western musicians were able to reproduce a specific rhythmic pattern in a matter of minutes, something that had taken him months to accurately reproduce learning aurally [4].

One could critique the need for notation by saying that the traditional tabla performance is based around improvisation with no need for repertoire; yet, existing interest in tabla transcription is evidenced by the many academic efforts to transcribe tabla using audio analysis [5, 3, 14] and is one of the motivations for Kapur's eTabla [6]. Further, lack of notation continues to restrict tabla's wider accessibility, use within non-improvistory composition and, as the workshop example shows, notation can assist learning. We have a small but growing community of composers and performers utilising UIDN. For instance, during the 2020 COVID-19 lock-down, BBC Concert Orchestra percussionist Stephen Whibley was able to learn and perform a 30 second piece by Bhamra with no face-to-face contact [11].

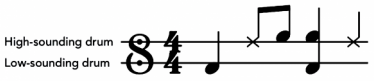

Figure 4: Example UIDN phrase for tabla.

Lastly, while the ability to translate playing into MIDI, may appear routine, it has genuine importance within the context of tabla notation. Being an aural tradition where hand notation has not been the norm and is not currently well established, notation through performance becomes especially relevant as a means for documenting patterns. Using the electronic tabla to generate notation through MIDI enables an intuitive way to score tabla.

6. DRUM IMPLEMENTATION

Rather than utilizing a capacitive or force sensing resistor based matrix similar to the approaches in the Boppad or Sensel or indeed any techniques closely related to existing drum tracking technology [15], we have opted to reduce sensor complexity and bespoke sensor fabrication requirements by basing the design on optical reflectance sensors. Inspired by Sokolovskis [13] and our own experiences with optical sensors [10, 9], we can detect and localise strikes along with whether there is a pre-existing contact enabling simultaneous hit and damp tracking. The head implementation also aligns with the expected elasticity when striking or pressing an acoustic skinned hand drum. This gives the electronic tabla a livelier more natural playing feel.

One of the hallmarks of tabla performance are extremely rapid strikes. While a snare drummer may strike every 100ms, we measured tabla expert Bhamra's strike rate to be around one strike every 60ms. Along with the standard goal of minimizing latency to maximize responsiveness, this rapid strike rate means the strike detection algorithms are required to detect and localize strikes quickly with minimal debounce time in order to be ready to capture the next hit. We used a Bela[7] as our embedded engine: reading sensor electronics at 22,050 Hz, performing detection algorithms, running a basic user interface, and generating audio. The electronic tabla includes an OLED screen for selecting tuning, sensitivity, and setting other preferences. User Interface control is performed using rotary encoders instead of

[6] `https://new.steinberg.net/dorico/`

[7] https://www.bela.io

potentiometers in part due to Bela's low number of default analog inputs and our high target sample rate.

While we explored using a more responsive sound engine, such as the convolutional filtering techniques explored by Aimi [1] and physical modelling based approaches of Kapur [6], for simplicity we are currently using a sample based sound engine. We have created a large and rich sample bank of 254 different tabla sounds pitched at different tunings. Samples are pitch shifted within a limited window for tuning and generating the tabla's characteristic pitch bend. Which sample to play is selected by a combination of damping and striking characteristics including their respective location. Similarly, pitch bend is measured by the amount and location of a damp. Though the zoned approach makes the electronic tabla less intuitive as a general hand drum, it is highly effective for allowing near seamless reproduction of tabla sounds when using correct tabla technique.

Figure 5: Bhamra playing the electronic tabla along-side the acoustic tabla. Bhamra is playing in his normal seated performance style.

For a demonstration of the electronic tabla, pictured in Figure 1, please follow the link to a video demonstration of it in duo with a pair of acoustic tabla:
`https://vimeo.com/414725354`

7. FUTURE WORK

The electronic tabla is reaching the end of the prototyping stage and is nearing commercial launch. The tabla is a starting point for improving accessibility of Indian drumming. We plan to add sound libraries for additional drums such as the *khol*, *dholak*, and *matiki* along with further investigation into alternative more responsive means of sound generation. We are also looking to enable limited physical re-positioning of the individual drumheads within the base to accommodate player preferences and seeing how our sensing approach works with acoustic drumheads. Theoretically, the same physical behaviours should apply meaning the approach should transfer, however more complex system dynamics may turn out to impede effective measurement.

8. CONCLUSIONS

The Indian tabla is an exciting, unique and beautiful sounding instrument, yet mysticism and limitations of the the guru-disciple tradition have slowed its wider adoption outside the Indian diaspora. In our efforts to make the tabla more accessible, we have developed an electronic tabla that plays, feels, and sounds highly similar to the acoustic tabla. Playing the electronic tabla vs. the original is akin to playing an electric guitar instead of an acoustic. Our electronic tabla is designed to be easily maintainable without specialist expertise; compact, to better fit in school music instrument closets; easily tuneable and that the pitches remain stable in changing environmental conditions. Our electronic tabla also enables accurate and easy generation of MIDI driven notation which, used with our Universal Indian Drum Notation, will allow scoring tabla parts to be done using a familiar interaction. Last but not least, the flexibility of digital sound engines like the one used in the electronic tabla will open up a wide range of soundscapes to tabla players looking to leverage their virtuosic technique to play sounds well beyond those afforded by the acoustic tabla.

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