Intelligent Music Interfaces: When Interactive Assistance and Augmentation Meet Musical Instruments

Jordan Aiko Deja
jordan.deja@dlsu.edu.ph
University of Primorska
Koper, Slovenia
De La Salle University
Manila, Philippines

Bettina Eska
bettina.eska@ifi.lmu.de
LMU Munich
Munich, Germany

Snehesh Shrestha
snehesh@umd.edu
University of Maryland
College Park, USA

Matthias Hoppe
matthias.hoppe@ifi.lmu.de
LMU Munich
Munich, Germany

Jakob Karolus
jakob.karolus@dfki.de
German Research Center for Artificial Intelligence
Kaiserslautern, Germany
TU Kaiserslautern
Kaiserslautern, Germany

Thomas Kosch
thomas.kosch@hu-berlin.de
HU Berlin
Berlin, Germany

Andrii Matviienko
matviienko.andrii@gmail.com
KTH Royal Institute of Technology
Stockholm, Sweden

Andreas Weiß
andreas.weiss@musikschule-schallkultur.de
Musikschule Schallkultur
Kaiserslautern, Germany

Karola Marky
karola.marky@rub.de
Ruhr-University Bochum
Bochum, Germany

ABSTRACT

The interactive augmentation of musical instruments to foster self-expressiveness and learning has a rich history. Over the past decades, the incorporation of interactive technologies into musical instruments emerged into a new research field requiring strong collaboration between different disciplines. The workshop "Intelligent Music Interfaces" covers a wide range of musical research subjects and directions, including (a) current challenges in musical learning, (b) prototyping for improvements, (c) new means of musical expression, and (d) evaluation of the solutions.

CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools**; **Interaction techniques**; **Interaction devices**.

KEYWORDS

Music Interfaces; Musical Instruments; Self-Expression; Augmented Instruments; Artistic Performance

ACM Reference Format:
Jordan Aiko Deja, Bettina Eska, Snehesh Shrestha, Matthias Hoppe, Jakob Karolus, Thomas Kosch, Andrii Matviienko, Andreas Weiß, and Karola Marky. 2023. Intelligent Music Interfaces: When Interactive Assistance and Augmentation Meet Musical Instruments. In *Augmented Humans Conference (AHs '23), March 12–14, 2023, Glasgow, United Kingdom.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3582700.3582731

AHs '23, March 12–14, 2023, Glasgow, United Kingdom

ACM ISBN 978-1-4503-9984-5/23/03…$15.00
https://doi.org/10.1145/3582700.3582731

1 BACKGROUND & RELEVANCE TO THE CONFERENCE

Humans have been expressing themselves through music for thousands of years starting with primitive flutes found in Germany from approximately 42,000 years ago. Ways for musical expression have constantly been evolving. The first musical instruments with electronic components were built in the early 1930s. Having these electronic components enriched the expression of artists and allowed the creation of the new kinds of music including synthesizer sounds. The constant change has never stopped. Even today new sensors and computational capabilities of musical instruments cannot only be leveraged to broaden further the artists' expressiveness [10, 19], but also enhance teaching scenarios [8, 9], support musicians with disabilities [5], and allow remote collaboration of musicians. Ultimately, *intelligent musical interfaces* can augment the humans' capabilities to express themselves through music.

Initial work in the domain of intelligent music interfaces focused on improving the play performance of students through learning-by-demonstration [11, 16, 21] or by reflecting the performance directly to the student for real-time improvements [2, 7, 14]. Further, musical instruments were augmented by technologies to extend the musical sound space [1]. For example, gestures and musical instruments can be combined to change the pitch of a sound [6, 10, 19]. We expect future musical instruments to integrate interactive

features, promoting self-expression, changing stage performances, and augment the audience's perception of a performance [4].

2 WORKSHOP CONTENT

The workshop "Intelligent Music Interfaces" (IM) lays the foundation for a research field concerning integrating interactive components into musical instruments for creating new ways of musical expression. We aim to connect recent research revolving in this field with the workshop to start, grow, and foster a community around intelligent musical interfaces. This includes the presentation, demonstration, and discussion of existing, augmented and novel musical instruments and technology used during stage performances.

Our workshop offers various research topics in (a) new ways of musical expression and perception, (b) prototyping for improvements, and (c) evaluation of the solutions. Musical expertise is not required to participate in the workshop since we aim to connect researchers from different disciplines.

We plan an in-person workshop let by 2-3 of the organisers, but we are prepared to switch to a full virtual participation if the circumstances do not allow physical participation. Either way, we intend to offer an inclusive format and allow remote participation via Zoom in case special circumstances prevent in-person participation. Details for that are given in the workshop structure below; details for the submission formats are given in the call for participation. We plan interactive sessions where participants can engage with several intelligent music interfaces to foster discussion. The exhibits are from workshops participants and the organisers. The organisers will ensure that there are enough exhibits to fill this workshop part. For this, we need one projector and several power sockets for the participants and demos.

3 GOALS AND OUTCOME

IMI brings together researchers and practitioners from different disciplines to foster interdisciplinary research. After the workshop, we encourage researchers to rework their publications based on the discussions and feedback from the workshop. We will support researchers in submitting their final papers to either arXiv or as preprints on our website. Based on the group work and moderated discussion, the organisers plan to distill critical aspects and the workshop's outcomes into a position paper published open access. The anticipated results are available to research questions concerning prototyping, the study design, and the evaluation of intelligent music interfaces. The feedback of the workshop attendees accompanies these research questions to inspire researchers who are interested in tackling the research questions. Based on the interest of the workshop attendees, we organise regular meetups. We plan to establish a long-term format with a potential future invitation for the authors to contribute to a journal.

4 SCHEDULE

Pre-Workshop Plans: We will distribute information and materials on our workshop website. Information includes the intention, motivation, and potential outcomes of the workshop. Furthermore, the website serves as a platform to advertise and acquire potential workshop participants. The workshop website will be available under the domain teamdarmstadt.de/imi. The website further includes a workshop description, objectives, and possible topics for submissions. It also hosts the call for participation, a link to the submission system, the workshop schedule, further organisational information, and information about the workshop organisers. Accepted papers will be made publicly available on the website before the conference to maximise the preparation time for the workshop and foster discussions. Finally, workshop participants can join our Slack channel to receive updates about the workshop and join our community. These updates are also distributed via email.

Workshop Plan: We plan a full-day workshop for around 20 participants and the following schedule:

(1) **Workshop introduction** (15 min): the organisers introduce themselves, the workshop topic, and the schedule.
(2) **Moderated speed dating** (approx. 15 min): the workshop attendees participate in speed dating sessions to get to know each other by physically grouping them.
(3) **Introduction of interactive session** (10 min): the organisers introduce the interactive session and answer questions. Interactive presentations and demonstrations will be set up before the workshop.
(4) **Interactive music session** (60 min): hands-on experience with different intelligent music interfaces for the participants.
(5) **Short break**
(6) **Keynote** (20 min + 10 min discussion): the keynote will be given by Prof. Max Mühlhäuser on the topic of interactive music exhibits.
(7) **Lunch break**
(8) **Art Pieces** (approx. 3×10 min): participants perform their art piece.
(9) **Short break**
(10) **Pitch presentations** of short papers and research statements (total 70 min): 5 Research Statements 3+2 min (25 min), short break (5 min), and 6 Short Paper 5+2 minutes (42 min).
(11) **Coffee break**
(12) **Moderated discussion and closing** (60 min): the organisers moderate a discussion based on the pitch presentations, art pieces, and interactive demonstrations. Finally, the workshop is closed.

5 RECRUITMENT & REVIEWING

The organisers use their social networks and mailinglists to disseminate the call for participation (see below). Submissions will be collected via EasyChair and reviewed by the IMI PC. Each submission will receive 2-3 reviews from the PC members and external reviewers.

Call for Participation: Playing a musical instrument goes hand-in-hand with many benefits, such as positively impacting mental health or dexterity. Electronic elements have been integrated into traditional musical instruments in the early 1930s to create instruments, such as E-guitars, that offer new ways of music expression.

Electric instruments evolved by combining networking and computational capabilities. These new capabilities can be leveraged to further broaden artists' expressiveness, enhance learning scenarios, allow remote collaboration of musicians, and even create entirely new musical instruments.

In this workshop, we will discuss and interact with intelligent music interfaces of any form. Novel music interfaces could be a new adaption of a traditional musical instrument, an interface for learning, or even supporting software. The workshop is planned to be held in person in conjunction with the Augmented Humans International Conference on March 12th in Glasgow, UK.

Submissions should follow the ACM two-column format with a length between two and four pages, excluding references. We solicit the following types of submissions: *position papers*, *research statements*, *art pieces*, and *interactive demonstrations*. The duration of an art piece is limited to 10 minutes. As interactive demonstrations, we consider demonstrating an intelligent musical interface that workshop participants can try out during the workshop. The authors of interactive demonstrations and art pieces are invited to present a prototype in the interactive workshop session.

Information about submitting papers can be found on the workshop website[1]. Participants will be selected based on the merit of their contribution to the workshop. We support and encourage authors to make their research available on arXiv[2] after the workshop. At least one author of each accepted submission must attend the workshop. All participants must register for the workshop.

Program Committee: The PC consists of the workshop organisers and additional volunteers. The following additional individuals confirmed being part of the PC: Sven Mayer (LMU Munich), Max Mühlhäuser (TU Darmstadt), Rebecca Panskus (Ruhr-University Bochum), Kanyu Chen (Keio University).

6 ORGANISER BIOGRAPHIES

IMI 2022 was conducted in conjunction with CHI 2022 in New Orleans [15]. The organising committee of the second IMI workshop consists of the following researchers and professional musicians. Each of them contributes long-term experiences in organising workshops including Handling IoT in HCI (IoT '17), Reading the Mobile Brain (MUM '17) [3], Designing Assistive Environments for Manufacturing (PETRA '17 - '21)[3], SmartObjects '18 (CHI '18) [20] and SmartObjects '22 (ISS '22) [24], a series of workshops and events about vulnerable road users [12, 13, 18, 22, 23, 27] as well as several local workshops for bands and musicians.

Thomas Kosch is a professor at the Humboldt University of Berlin. His research focuses on physiological interaction, including designing, prototyping, and evaluating physiological user interfaces. In addition, he is an expert in integrating physiological sensing into musical instruments to implicitly and explicitly augment musicians. Thomas is deeply interested in new ways to create music, augment existing instruments, and create tools and feedback mechanisms supporting musical students. He will provide his experience in prototyping and evaluating novel music interfaces. He has been playing the piano, guitar, and saxophone for several years.

Bettina Eska is a Ph.D. student at LMU Munich, where she researches sensor-based feedback systems for HCI for sports. But she is also interested in designing and generating appropriate feedback for other scenarios that require fine motor skills, such as playing musical instruments. Additionally, she has played the flute for over 15 years and gained experience playing in various amateur orchestras and groups several times.

Snehesh Shrestha is a Ph.D. candidate at the University of Maryland (UMD) College Park. His research focuses on AI-assisted music education. He develops technology, tools, and applications to provide real-time feedback during practice for music players. He has open-sourced fast video annotation tool, FEVA [26], developed perception models such as high temporal resolution 3D human pose estimation, AIMusicGuru [25], and currently working on music understanding and feedback models. He is interested in empowering music teachers by creating super-tools that augment their capabilities in understanding their students' strengths and weaknesses. He is also interested in developing technologies that foster good form and habits to avoid injuries and learn better techniques. He has been playing the guitar for 25 years and currently learning to play the violin.

Matthias Hoppe is a PhD student at LMU Munich, where he focuses on mixed reality as a new medium and investigates the application of haptic feedback in virtual reality to alter ones perception. Therefore, he is also interested in how such novel interactions can enhance experiences with novel music interfaces. Matthias has experience in evaluating supportive tools while practicing musical instruments.

Jakob Karolus is a postdoctoral researcher at the German Research Center for Artificial Intelligence (DFKI). His research focuses on the design of proficiency-aware systems leveraging ubiquitous sensing technologies. He is interested in the design qualities of sensor-augmented musician-instrument interaction, connecting his proficiency in playing the keyboard and the guitar for over 15 years.

Jordan Aiko Deja (https://jrdndj.com) is a Ph.D. student working on augmented reality, music learning, and adaptive visualizations in the HICUP research group at the University of Primorska, Slovenia. He is researching augmented reality techniques to teach improvisation in the piano. His main goal is to design interfaces and tools that give their users better ways to understand themselves and how they work

Andrii Matviienko is an assistant professor at KTH Royal Institute of Technology in Stockholm, Sweden. His research focuses on the assisting technology in urban environments, in particular on designing, constructing, and evaluating multimodal and mixed reality interfaces for vulnerable road users. Additionally, he has over 20 years of experience playing trombone in amateur and semi-professional orchestras in Ukraine and Germany, and a bass guitar in jazz/funk/rock bands.

[1] https://teamdarmstadt.de/imi accessed 16-December-2021
[2] https://arxiv.org accessed 16-December-2021
[3] www.petrae.org/workshops/DAEM.html 16-December-2021

Andreas Weiß has over twenty-five years of experience as a musician and music teacher. He is part of several band projects, co-owns the music school Schallkultur in Kaiserslautern, Germany and teaches music theory and practical skills to school students between the age of 10 and 18. In addition, he collaborates with several research institutions by contributing his expertise as a musician to develop and evaluate new smart music interfaces, such as Let's Frets [16, 17]. The practical didactic experience of Andreas will allow workshop attendees to quickly identify challenges and opportunities when using interactive technologies in learning scenarios.

Karola Marky is a professor at the Ruhr-University Bochum. Her research focuses on the self-determination and self-expression of individuals in digital spaces, explicitly considering ubiquitous technology and novel (security and privacy) interfaces based on tangible interaction. She further leverages novel interfaces and interaction techniques to improve musical instruments dedicated to beginners and students. In her free time, she plays the piano and sings. She will coordinate the workshop organisation and contribute with her expertise in evaluating novel intelligent music interfaces.

REFERENCES

[1] Jordan Aiko Deja, Nuwan T Attygale, Klen Čopič Pucihar, and Matjaž Kljun. 2020. Sound 2121: Cross-Reality Transitions Between Real and Augmented Sound Landscapes. In *International Workshop on Cross-Reality (XR) Interaction @ ACM ISS 2020*. CEUR Workshop Proceedings, Virtual and Lisbon Portugal, 1–4.

[2] Jordan Aiko Deja, Sven Mayer, Klen Čopič Pucihar, and Matjaž Kljun. 2022. A Survey of Augmented Piano Prototypes: Has Augmentation Improved Learning Experiences? *Proceedings of the ACM on Human-Computer Interaction* 6, ISS (2022), 226–253.

[3] Christiane Glatz, Jonas Ditz, Thomas Kosch, Albrecht Schmidt, Marie Lahmer, and Lewis L. Chuang. 2017. Reading the Mobile Brain: From Laboratory to Real-World Electroencephalography. In *Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia* (Stuttgart, Germany) *(MUM '17)*. Association for Computing Machinery, New York, NY, USA, 573–579. https://doi.org/10.1145/3152832.3156560

[4] Jiawen Han, George Chernyshov, Moe Sugawa, Dingding Zheng, Danny Hynds, Taichi Furukawa, Marcelo Padovani, Kouta Minamizawa, Karola Marky, Jamie A Ward, and Kai Kunze. 2022. Linking Audience Physiology to Choreography. *ACM Trans. Comput.-Hum. Interact.* 29 (aug 2022), 1–32. https://doi.org/10.1145/3557887 Just Accepted.

[5] Jacob Harrison, Alan Chamberlain, and Andrew P. McPherson. 2019. Accessible Instruments in the Wild: Engaging with a Community of Learning-Disabled Musicians. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '19)*. ACM, New York, NY, USA, Article LBW0247, 6 pages. https://doi.org/10.1145/3290607.3313037

[6] Jakob Karolus, Annika Kilian, Thomas Kosch, Albrecht Schmidt, and Paweł W. Wozniak. 2020. Hit the Thumb Jack! Using Electromyography to Augment the Piano Keyboard. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference* (Eindhoven, Netherlands) *(DIS '20)*. Association for Computing Machinery, New York, NY, USA, 429–440. https://doi.org/10.1145/3357236.3395500

[7] Jakob Karolus, Hendrik Schuff, Thomas Kosch, Paweł W. Wozniak, and Albrecht Schmidt. 2018. EMGuitar: Assisting Guitar Playing with Electromyography. In *Proceedings of the 2018 Designing Interactive Systems Conference* (Hong Kong, China) *(DIS '18)*. Association for Computing Machinery, New York, NY, USA, 651–655. https://doi.org/10.1145/3196709.3196803

[8] Joseph R. Keebler, Travis J. Wiltshire, Dustin C. Smith, and Stephen M. Fiore. 2013. Picking Up STEAM: Educational Implications for Teaching With an Augmented Reality Guitar Learning System. In *Proceedings of the International Conference on Virtual, Augmented and Mixed Reality (VAMR)*. Springer, Cham, Switzerland, 170–178. https://doi.org/10.1007/978-3-642-39420-1_19

[9] Chutisant Kerdvibulvech and Hideo Saito. 2007. Real-Time Guitar Chord Estimation by Stereo Cameras for Supporting Guitarists. In *Proceedings of the 10th International Workshop on Advanced Image Technology (IWAIT)*. The Institute of Electronics, Information and Communication Engineers, Bangkok, Thailand, 256–261.

[10] Annika Kilian, Jakob Karolus, Thomas Kosch, Albrecht Schmidt, and Paweł W. Paweł. 2021. EMPiano: Electromyographic Pitch Control on the Piano Keyboard. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI EA '21)*. Association for Computing Machinery, New York, NY, USA, Article 196, 4 pages. https://doi.org/10.1145/3411763.3451556

[11] Markus Löchtefeld, Sven Gehring, Ralf Jung, and Antonio Krüger. 2011. GuitAR: Supporting Guitar Learning through Mobile Projection. In *CHI '11 Extended Abstracts on Human Factors in Computing Systems* (Vancouver, BC, Canada) *(CHI EA '11)*. Association for Computing Machinery, New York, NY, USA, 1447–1452. https://doi.org/10.1145/1979742.1979789

[12] Andreas Löcken, Mark Colley, Andrii Matviienko, Kai Holländer, Debargha Dey, Azra Habibovic, Andrew L Kun, Susanne Boll, and Andreas Riener. 2021. WeCARe: Workshop on Inclusive Communication between Automated Vehicles and Vulnerable Road Users. In *22nd International Conference on Human-Computer Interaction with Mobile Devices and Services* (Oldenburg, Germany) *(MobileHCI '20)*. Association for Computing Machinery, New York, NY, USA, Article 43, 5 pages. https://doi.org/10.1145/3406324.3424587

[13] Andreas Löcken, Andrii Matviienko, Mark Colley, Debargha Dey, Azra Habibovic, Yee Mun Lee, and Andreas Riener. 2022. Accessible Automated Automotive Workshop Series (A3WS): International Perspective on Inclusive External Human-Machine Interfaces. In *Adjunct Proceedings of the 14th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (Seoul, Republic of Korea) *(AutomotiveUI '22)*. Association for Computing Machinery, New York, NY, USA, 192–195. https://doi.org/10.1145/3544999.3551347

[14] Karola Marky, Julian Fischer, Max Mühlhäuser, and Andrii Matviienko. 2021. Investigating Page Turning Methods for Sheet Music during Piano Play. In *Adjunct Publication of the 23rd International Conference on Mobile Human-Computer Interaction* (Toulouse & Virtual, France) *(MobileHCI '21)*. Association for Computing Machinery, New York, NY, USA, Article 18, 6 pages. https://doi.org/10.1145/3447527.3474863

[15] Karola Marky, Annika Kilian, Andreas Weiß, Jakob Karolus, Matthias Hoppe, Pawel W. Wozniak, Max Mühlhäuser, and Thomas Kosch. 2022. Intelligent Music Interfaces: When Interactive Assistance and Augmentation Meet Musical Instruments. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) *(CHI EA '22)*. Association for Computing Machinery, New York, NY, USA, Article 84, 4 pages. https://doi.org/10.1145/3491101.3503743

[16] Karola Marky, Andreas Weiß, Andrii Matviienko, Florian Brandherm, Sebastian Wolf, Martin Schmitz, Florian Krell, Florian Müller, Max Mühlhäuser, and Thomas Kosch. 2021. Let's Frets! Assisting Guitar Students During Practice via Capacitive Sensing. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI '21)*. Association for Computing Machinery, New York, NY, USA, Article 746, 12 pages. https://doi.org/10.1145/3411764.3445595

[17] Karola Marky, Andreas Weiß, Florian Müller, Martin Schmitz, Max Mühlhäuser, and Thomas Kosch. 2021. Let's Frets! Mastering Guitar Playing with Capacitive Sensing and Visual Guidance. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI EA '21)*. Association for Computing Machinery, New York, NY, USA, Article 169, 4 pages. https://doi.org/10.1145/3411763.3451536

[18] Andrii Matviienko, Wilko Heuten, Alan Dix, and Susanne CJ Boll. 2021. Interactive Technology for Cycling — Ideate, Make – Remote, Together. In *Adjunct Publication of the 23rd International Conference on Mobile Human-Computer Interaction* (Toulouse & Virtual, France) *(MobileHCI '21)*. Association for Computing Machinery, New York, NY, USA, Article 29, 4 pages. https://doi.org/10.1145/3447527.3474870

[19] Andrew P. McPherson, Adrian Gierakowski, and Adam M. Stark. 2013. The Space between the Notes: Adding Expressive Pitch Control to the Piano Keyboard. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) *(CHI '13)*. Association for Computing Machinery, New York, NY, USA, 2195–2204. https://doi.org/10.1145/2470654.2481302

[20] Florian Müller, Dirk Schnelle-Walka, Tobias Grosse-Puppendahl, Sebastian Günther, Markus Funk, Kris Luyten, Oliver Brdiczka, Niloofar Dezfuli, and Max Mühlhäuser. 2018. SmartObjects: Sixth Workshop on Interacting with Smart Objects. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) *(CHI EA '18)*. Association for Computing Machinery, New York, NY, USA, 1–6. https://doi.org/10.1145/3170427.3170606

[21] Katja Rogers, Amrei Röhlig, Matthias Weing, Jan Gugenheimer, Bastian Könings, Melina Klepsch, Florian Schaub, Enrico Rukzio, Tina Seufert, and Michael Weber. 2014. P.I.A.N.O.: Faster Piano Learning with Interactive Projection. In *Proceedings of the Ninth ACM International Conference on Interactive Tabletops and Surfaces* (Dresden, Germany) *(ITS '14)*. Association for Computing Machinery, New York, NY, USA, 149–158. https://doi.org/10.1145/2669485.2669514

[22] Hatice Sahin, Heiko Mueller, Shadan Sadeghian, Debargha Dey, Andreas Löcken, Andrii Matviienko, Mark Colley, Azra Habibovic, and Philipp Wintersberger. 2021. Workshop on Prosocial Behavior in Future Mixed Traffic. In *13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (Leeds, United Kingdom) *(AutomotiveUI '21 Adjunct)*. Association for Computing Machinery, New York, NY, USA, 167–170. https://doi.org/10.1145/3473682.3477438

[23] Gian-Luca Savino, Tamara von Sawitzky, Andrii Matviienko, Miriam Sturdee, Paweł W. Woźniak, Markus Löchtefeld, Andrew L. Kun, Andreas Riener, and

Jonna Häkkilä. 2021. Cycling@CHI: Towards a Research Agenda for HCI in the Bike Lane. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI EA '21)*. Association for Computing Machinery, New York, NY, USA, Article 107, 5 pages. https://doi.org/10.1145/3411763.3441316

[24] Martin Schmitz, Sebastian Günther, Karola Marky, Florian Müller, Andrii Matviienko, Alexandra Voit, Roberts Marky, Max Mühlhäuser, and Thomas Kosch. 2022. Rethinking Smart Objects: The International Workshop on Interacting with Smart Objects in Interactive Spaces. In *Companion Proceedings of the 2022 Conference on Interactive Surfaces and Spaces* (Wellington, New Zealand) *(ISS '22)*. Association for Computing Machinery, New York, NY, USA, 64–67. https://doi.org/10.1145/3532104.3571470

[25] Snehesh Shrestha, Cornelia Fermüller, Tianyu Huang, Pyone Thant Win, Adam Zukerman, Chethan M Parameshwara, and Yiannis Aloimonos. 2022. AIMusicGuru: Music Assisted Human Pose Correction.

[26] Snehesh Shrestha, William Sentosatio, Huiashu Peng, Cornelia Fermuller, and Yiannis Aloimonos. 2023. FEVA: Fast Event Video Annotation Tool.

[27] Tamara von Sawitzky, Philipp Wintersberger, Andrii Matviienko, Andreas Löcken, Andreas Riener, and Florian Michahelles. 2021. Workshop on Intelligent Cyclist Support Systems and Applications. In *Mensch und Computer 2021 - Workshopband*, Carolin Wienrich, Philipp Wintersberger, and Benjamin Weyers (Eds.). Gesellschaft für Informatik e.V., Bonn, 1–3. https://doi.org/10.18420/muc2021-mci-ws12-122