Real-time Motion Capture for Performing Arts and Stage

Serguei A. Mokhov
mokhov@cse.concordia.ca

Amandeep Kaur
ama_k@cse.concordia.ca

Mehak Talwar
m_talwa@cse.concordia.ca

Keerthana Gudavalli
k_gudava@cse.concordia.ca

Miao Song
m_song@cse.concordia.ca

Sudhir P. Mudur
mudur@cse.concordia.ca

Figure 1: Black Box testing, West Island Performance, Artist Performance at CCIFF, Lab Visit

ABSTRACT

How can software engineers and artists work effectively together to create real-time CG for performing arts on stage? We answer that with Illimitable Space System (ISS) and a live performances. Since 2012, ISS evolved its reusable pipeline architecture for interactive projection mapping, voice recognition, real-time audio/video effects through gesture and motion to achieve mixed reality and immersive visual effects for stage. ISS is a configurable toolbox for multimodal interaction and serves as a platform for artists to enhance their performance.

In 2016-2017, we deployed ISSv2 during Chinese New Year Galas held in West Island, Montreal as well other other events and educational outreach activities. We followed agile software engineering practices to adapt to the new productions. ISS can be configured with different visual effects profiles according to the requirement. Computation artists and designers can make the said effects without formal software engineering training.

CCS CONCEPTS

• **Human-centered computing → Graphics input devices**; • **Information systems → Multimedia content creation**; • **Computing methodologies → Computer vision**; • **Applied computing → Sound and music computing**;

KEYWORDS

Illimitable Space System (ISS), OpenISS, Processing, Jitter/Max, OpenGL, real-time, human-computer interfaces, interaction, computer graphics education, projection mapping, RGBD cameras

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TALK OVERVIEW

The Illimitable Space System (ISS) is a configurable multimodal interaction and visual effects toolbox for artists to enhance their performance. In ISS the requirements change according to the production. Thus, we adopted agile software engineering methodology to conform to the requirements by building different profiles for specific productions [Mokhov et al. 2016]. In every profile the visual effects are configured according to the nature and demand of the production. After the configuration is done we design the system's extensions according to the visual effects and implement it in the Max and Processing IDE with the help of Java and other libraries like OpenGL. During deployment, the system is first tested using depth cameras in the research lab and then acceptance testing is done on the day of the real production on the stage to adjust the system accordingly. We made subsequent improvements to the ISS after every production. See a more recent rendition at TEDxConcordia: https://www.youtube.com/watch?v=YgwnEmHFwI8 with martial arts. We've also given GEM, SIGGRAPH, and SIGGRAPH Asia courses on the topic in the past with the most recent available in [Mokhov et al. 2017b]. In Figure 2 was the original high-level architecture of ISSv2 [Mokhov et al. 2017a].

We involve students with multidisciplinary backgrounds into the rapid development and productions. Below are some of their earlier experiences. We will also describe in the talk more recent experiences at CHI/ChineseCHI 2018 (see the supplemental video) including the ongoing development of the OpenISS core (https://github.com/OpenISS/OpenISS) and its new interactive broadcast capability of OpenISS-as-a-service.

West Island. The Chinese New Year was celebrated in West Island, Montreal, where we had the interactive media performance [Li et al. 2016]. First, we configured ISSv2 according to the requirements of

this production. Next, in the theatre, on the day of production we adjusted the positions of the camera and the projector so that they are calibrated to capture the artist properly and project perfectly on the screen. The next step was fine-tuning. This involved practice to match audio and video output and making sure that the projector's shutter opens at the right time to start the performance. In this we experienced educational benefits for the team work in a stressful and very agile environment.

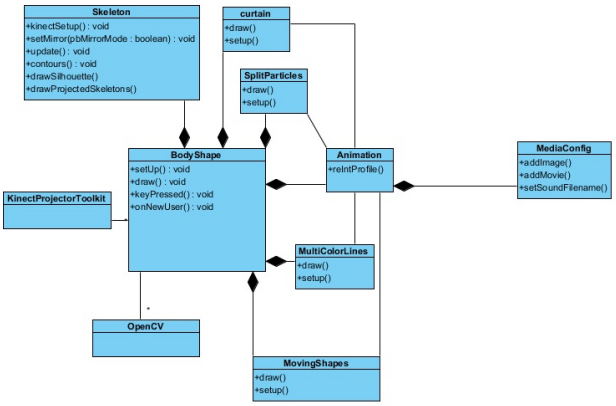

Figure 2: High-level ISSv2 architecture

CCIFF. As a part of the Canada China International Film Festival (CCIFF.ca) pre-launch, we demonstrated the ISS system integrated with a dance performance and live music ([Song et al. 2016]) in 2016 and 2017. We first tested it in the black box space provided by Concordia University simulating the actual theatre, by testing visual effects to synchronize with the artist. On the day of event, we first set up all the equipment. Then, we calculated the distance of the screen to the depth camera to calibrate it. We then rehearsed with the performer. At the time of actual performance, our team operated the whole system. One team member operated the production laptop while others handled the projector and the live band to synchronize with the performance.

Extending ISS. ISS can be easily extended with visual effects using simple environment of `setup()` and `draw()`. Setup is used to initialize the basic parameters of the effect and draw is for actual visual effects. The students integrated several effects from computation artists and the OpenProcessing platform, e.g., such as `MovingShapes` [Bezas 2011]. While integrating they changed the control of these visual effects, from mouse-based, to artist movement driven. During implementation, we encountered a number of problems, which needed suitable rectifications. Some had the coordinates were scattered outside the screen. For others the original brightness of the shapes in the effect seemed much reduced after integration into ISSv2's pipeline, and again, the coordinates of the shapes on the screen were not properly adjusted. For others, the stand-alone effects showed multiple colors while the integrated effects only showed one color.

Continuous integration methodology. In the design and development of ISS, we have adopted Continuous Integration Methodology, which is similar to DevOps in that it needs frequent deployments, with rapid release cycles, continuous introduction of new features and testing. This allowed us to introduce new features based on frequent changes in requirements in a more stable software development environment, described in detail in [Mokhov et al. 2017a].

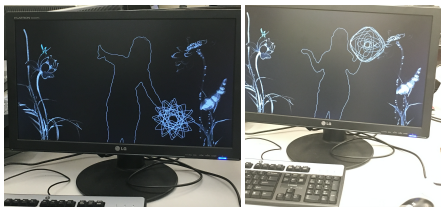

Figure 3: Integration of the MovingShapes effect

Improving ISS. The back-end of ISSv2 visual effects' pipeline was the major part of software education. We re-factored certain methods in the `Animation` and other classes. The new classes were renamed as well as their methods naming were standardized. We mainly focused on moving the methods into separate classes, simplifying the method names, applying naming conventions throughout the body of the classes. In this process the students learned how to update the code frequently to prevent it from software aging.

Ongoing and future development. We are incorporating more visual effects and refactoring the pipeline to include OpenISS, multiple depth cameras support and multiskeletal tracking for the need to capture more performers in detail at the same time. This and active real-time online broadcast and browser rendering are actively researched. Additionally, rendering multiple visual effects based on real-time interactions with an artist mandates different testing methodologies from conventional software testing. Multiple visual effects, active at any time cannot be tested by testing single piece of code as in unit testing. Presently, we create test profiles in which we add and run only needed effects. We are planning to adapt new testing methodologies in order to make this process more efficient.

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