# One Solution for Building Reconfigurable Multi-Projection Systems Using the Adobe AIR Platform

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*Abstract* – **Continuous adaptation of video multi-projection systems can be required to maintain special screen geometries and settings. Increasing popularity of the Adobe AIR platform, as well as easy access to new software for creating projects using this technology, leads to the issue of its integration with reconfigurable video multi-projection systems. This paper presents one solution for building reconfigurable special-purpose video multi-projection systems using the Adobe AIR platform which is less expensive and more versatile and flexible than other existing solutions. The system enables us to project images which are adapted photometrically and geometrically to arbitrary screens. This solution offers adaptability that allows users to easily create a multitude of screen layouts in minutes, which are later available at the touch of a button. The solution was experimentally tested using a system for multimedia presentations titled "An Oblique Plane Projection System", developed for the Digital Mini-Museum of the Faculty of Electronic Engineering, University of Niš, Serbia.**

*Keywords* – **Special-purpose video multi-projection systems, Reconfiguration and maintenance, Adobe AIR, Multimedia presentations.**

## I. INTRODUCTION

In recent years, as a consequence of ever increasing computer performance and the advancement of video projection systems, a variety of video multi-projection systems have been built by both research and commercial institutions. The multimedia experience created by these systems makes them ideal for a variety of applications in science, visualization, entertainment, business, and education. Special-purpose video multi-projection systems, which are able to reproduce multimedia presentations with high realism, represent a key component for the successful introduction of immersive multimedia projections, such as dome projections, large projection walls or 360° cylinder projections. A variety of multi-projection systems have been proposed for this purpose, for example the ones described in [1] and [2]. While these systems are very effective at providing different special video effects to users, continuous maintenance can be required for reconfiguration of these systems. Special screen geometries gain more and more attention as a valuable tool for video multi-projection systems, but require adaptation of projected images. Projected images can be adjusted in photometrical and geometrical sense to arbitrary screen geometries. This makes it harder to develop interactive applications, which require a fine grained control of the projected images. Therefore, a couple of interactive hardware and software solutions for modification of projected images of reconfigurable multi-projection systems have been proposed in the past, e.g., in [3], [4], and [5].

Increasing popularity of the Adobe AIR platform and easy access to new software for creating projects using this technology, leads to considerations on how to integrate it with the reconfigurable video multi-projection systems. With the AIR platform, Adobe intends to provide a versatile runtime-environment that allows existing Flash, ActionScript, HTML and JavaScript code to be used as Web applications that have many characteristics of more traditional desktop programs [8]. Adobe AIR internally uses Adobe Flash Player as the runtime environment, and ActionScript 3 as the sole programming language [8]. Flash applications must specifically be built for the Adobe AIR runtime in order to utilize additional features it provides, such as the solution for adaptation of projected images of reconfigurable multi-projection systems.

This paper presents one solution, developed on the application level, of a reconfigurable special-purpose multi-projection system. We use the Adobe AIR platform and extend it by adding photometrical and geometrical adaptation of projected images to arbitrary special screens. This solution also enables users to easily create a multitude of screen layouts for special-purpose multi-projection systems in minutes which are later available at the touch of a button. Solution was experimentally tested using a system for multimedia presentations "An Oblique Plane Projection System", developed for the Digital Mini-Museum of the Faculty of Electronic Engineering, Niš, Serbia.

The paper is organized as follows. Section 2 shortly introduces multi-projection systems. In section 3, the Adobe AIR platform is presented. In Section 4, the proposed solution for building reconfigurable special multi-projection system using the Adobe AIR platform is described. Features of the proposed implementation were experimentally tested in Section 5. Section 6 offers some concluding remarks and directions for future work.

## II. MULTI-PROJECTION SYSTEMS

A video projection system is typically a display that uses a high intensity light source to project video images on the screen. They are used for large screen TV displays, as well as multimedia presentations. Unlike CRT, plasma, and LCD

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displays, which are direct view video technologies, projection systems use an indirect-view video technology, in which the image size is enhanced by projecting the image on a screen. Video projection is accomplished using either front projection or rear projection [6], [7]. Front video projection systems can achieve an image size ranging approximately from 0.9 to 7.62 m. Super-bright, large-scale, and very high-resolution digital projection systems are becoming indispensable tools of modern front video projection system, but they are also very expensive. Prices for high-end projectors run into tens or even hundreds of thousands of dollars, which keeps these devices from wider use. Front projection systems are typically used for computer-based presentations as well as projection TV systems for large rooms or auditoriums [6], [7]. Rear video projection is a method of projection that combines a projector and viewing screen into one unit. A rear projection system contains an integrated video projector that is aimed at a mirror to achieve an image size ranging approximately from 100 to 200 cm. The rear projection systems are popular choices for home theater systems in which room size prohibits the use of front projection systems [6], [7].

The main idea of multi-projection system is to connect a given number of video frames to one image of ultra-high definition that can be presented either at a large planar screen (projection wall) or at screens with a curved surface (360° panoramas or spherical domes). Most of them use a cluster of synchronized PCs, in which each PC serves only one projector. The problem of the high-resolution video synchronization, decoding, photometric screen adaptation, and blending can be simplified by using dedicated hardware. In [3], multi-projection system uses a PCI plug-in card for conventional PCs and it is able to control up to four separate projectors. In the second case, when using two graphics processing units (GPUs) with multiple video outputs, the total cost of multi-projection system is reduced.

In general, in order to be able to seamlessly blend multiple projectors to create very large projections or different shape of images, the intensity and position of overlapping pixels must be accurately controlled.

## III. The Adobe AIR Platform

AIR (abbreviated from Adobe Integrated Runtime) is a cross-platform runtime system [8]. It is developed and promoted by Adobe, as a tool for production of rich Internet applications (RIA - web applications that have many of the characteristics of desktop applications), that can be processed on both desktop and mobile systems and which are programmed using Adobe Flash, ActionScript, HTML, JavaScript, or Ajax [8]. The Adobe AIR runtime supports Windows, Mac OS X, Blackberry, Android, and iOS operating systems. Adobe AIR first appeared in 2008 and the latest version is 3.0 [9].

The architecture of Adobe AIR is shown in Figure 1. On the internal level, AIR uses Adobe Flash Player as the runtime environment, and ActionSript as the programming language. The use of AIR allows existing Flash, ActionScript, HTML and JavaScript programs to be used as part of web applications with features similar to the classical desktop applications.

When Adobe AIR is used as the runtime for processing rich Internet applications, there is no need for a browser. In contrast to browser-based web applications, applications deployed with Adobe AIR need to be packaged, digitally signed, and installed on the user's local file system [10]. In this way, they can have access to local file systems, which is an advantage over applications that run in a browser and are significantly more limited in this sense.

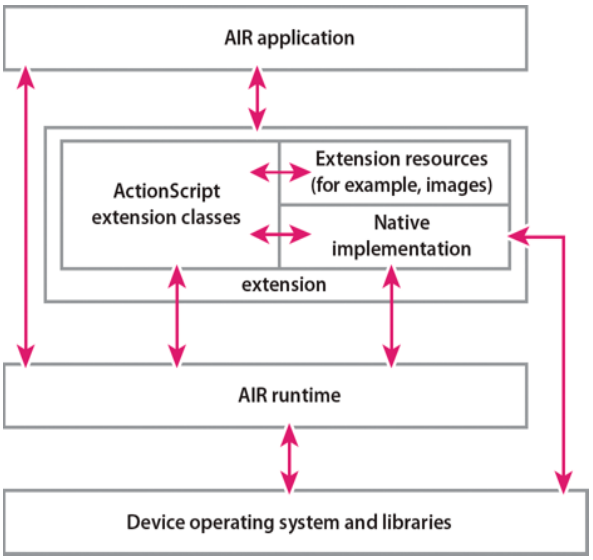


Fig. 1. Architecture of Adobe AIR [11].

## IV. A Reconfigurable Special-Purpose Multi-Projection Video System using the Adobe AIR Platform

In this section, we describe a software solution that can be used in reconfigurable special-purpose multi-projection video systems. The solution is created by using the Adobe AIR platform. Besides the standard video player commands, we additionally implemented few other functionalities that are required for simultaneous running of multiple videos. These functionalities enable synchronization of videos and their adaptation to projection screens.

Synchronization of video files so that they start at the same time, was done by using the ActionScript code. This software solution supports different types of video files including the ones with extensions such as *flv*, *mp4*, *mov*, etc.

The solution is tailored for multiple simultaneous video projections. The videos are defined through a configuration XML file. An example of a configuration file for two multi-projection system (with two projectors) configuration is shown in Figure 2. The solution loads the video files from the locations stored in XML file. Switching between a pair of videos of parallel projections is performed through an interactive menu. Each title in the menu refers to the pair of video files defined in the XML configuration file.

```
<item title="Projection 1"
 function="showVideo(movieDown1.mp4, movieUp1.mp4)">
</item>

<item title="Projection 2"
 function="showVideo(movieDown1.mp4, movieUp1.mp4)">
</item>
```

Fig. 2. Part of configuration XML that loads a pair of video files.

Because the resolution of projectors or displays can be different, the solution provides a mechanism for their adaptation to arbitrary resolutions. One example of the mechanism for adaptation to screens for multi-projection system (with two projectors) is shown on Fig. 3. This functionality scales the video files to fit the resolution of the used projector or displays. Also, the image that is shown on the screen can be rotated and flipped. Due to this, the solution can be used for either rear or front projection, as well as for projections from top and bottom.

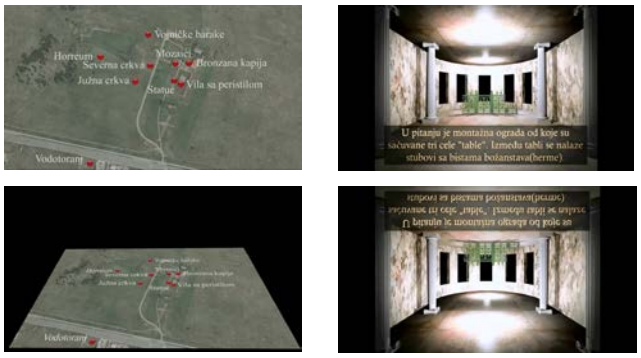


Fig. 3. Example of the mechanism for adaptation of videos to screens for special-purpose multi-projection system (original projected images – above) and (adapted projected images – below).

This solution enables to adapt the images to be projected from the desired angles, as well as on non-flat surfaces. This option is implemented by using 3D functionalities provided by the Flash Player. Using these functionalities, we can adjust images to the projection surface.

## V. Experimental Results

The proposed solution for building reconfigurable special-purpose multi-projection system using the Adobe AIR platform was experimentally tested using a special system for multimedia presentations “An Oblique Plane Projection System”, developed for the Digital Mini-Museum of the Faculty of Electronic Engineering, Niš, Serbia. This multi-projection system is used for presentation of multimedia contents and enables a novel approach to the presentation of cultural and historical heritage. The system allows visitors to museums or archaeological sites to view 3D reconstruction of historic buildings with descriptions and their former spatial locations. In this way, museums or archaeological sites can better present the cultural and historical content and attract a larger number of visitors.

The basic principle on which the system is based is a projection technique known as “Pepper’s Ghost” [11]. The “Pepper’s Ghost” projection technique is an illusion used in theatres, haunted houses, dark rides, and in some magic tricks. Using plate glass, Plexiglas or plastic film and special lighting techniques, it can make objects seem to appear or disappear, to become transparent, or to make one object morph into another. It is named after John Henry Pepper, who popularized the effect [11]. Modern examples of Pepper's ghost effects can be found in various museums in Europe.

The presented solution enables synchronized presentation of two separate multimedia presentations, with requirements for special lightings to create optical illusions at certain moments in the presentation. The first presentation is projected at the horizontal plane (element 6 in Fig. 4) and the second at an oblique glass plane, which creates the effect of “Pepper’s Ghost” (element 5 in Fig. 4). The image that appears in the horizontal plane comes out of the projector (element 2 in Fig. 4) and is directed towards the mirror (object 1 in Fig. 4) which is located in the rear of the system. The mirror image projects back on the horizontal plane (object 6 in Fig. 4). Image of a tilted plane is reflected from the display mounted in the upper part of the system (element 3 in Fig. 4). A covering plane (element 4 in Fig. 4) separates the electronic part of the device from the viewing area, preventing unwanted and covering a large part of the picture in the mirror.

Video signals to the projector and display originate from a single video graphic card, with two video outputs and use the resolution of 1920×1080 pixels. The prototype system has a *Viewsonic* PJD5134 projector, a *Fujitsu* L-22T4 LCD monitor, and a PC with *Intel* i5-2320 processor at 3 GHz with 8 GBs of RAM and the *Linux* operating systems.

In the Digital Mini-Museum of the Faculty of Electronic Engineering Niš, the system is in daily operation from November 2013. The system displays three multimedia presentations - "Reconstruction of Objects of Ancient Mediana", "Pictures of Old Niš, from the Late 19th and the Early 20th Century" and "3D Models of Old Houses Which No Longer Exist". The system also displays a presentation called "3D Models of Patents of Nikola Tesla", which represents a basis for the development of multimedia presentations with specific requirements for the Nikola Tesla Museum in Belgrade. Fig. 5 shows a part of the presented system while playing the presentation on the ancient Mediana. This figure, besides the two synchronized planes, also shows a part of the mirror used for reflecting the signal from the projector.

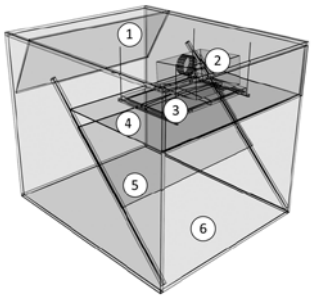


Fig. 4. A perspective view on the “An Oblique Plane Projection System”- (1) mirror, (2) projector, (3) display panel, (4) covering plane, (5) oblique plane and (6) horizontal plane

Fig. 5. A part of the multi-projection system - "Horizontal plane" (map of ancient Mediana site – below), and "Oblique plane" (sculpture from ancient Mediana site – above)

## VI. CONCLUSION

Reconfigurable special-purpose multi-projection video systems for multimedia presentations are widely used in various institutions. In general, there are two major calibration tasks for the reconfigurable multi-projection systems: the geometrical and photometrical system calibration. This paper describes a software solution for calibration of the reconfigurable special multi-projection video systems using the Adobe AIR platform. It was found that the use of the Adobe AIR platform for calibration of projected images provides a simple approach, which is more flexible and less expensive than other existing solutions. The solution is experimentally tested using a system for multimedia presentations "An Oblique Plane Projection System", developed for the Digital Mini-Museum of the Faculty of Electronic Engineering, Niš, Serbia. Since its introduction in November 2013, the system showed high stability and reliability and easy adaptation for new projections.

Our future work on this topic will mostly be concentrated on extending the current software solution to various other special-purpose multimedia projection systems and introducing new features into the oblique plane projection system.

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