

5D movie theater hardware and software complex

Customer

AET Entertainment Technologies is a developer and supplier of animatronics (robotic models) and stage sets for trade and entertainment centers, theme parks, water parks and museums.

Objective

Development of a hardware and software complex used to control a 5D movie theater and create 5D video clips.

Solution

1. Platform Design Requirements

Equipment operation features

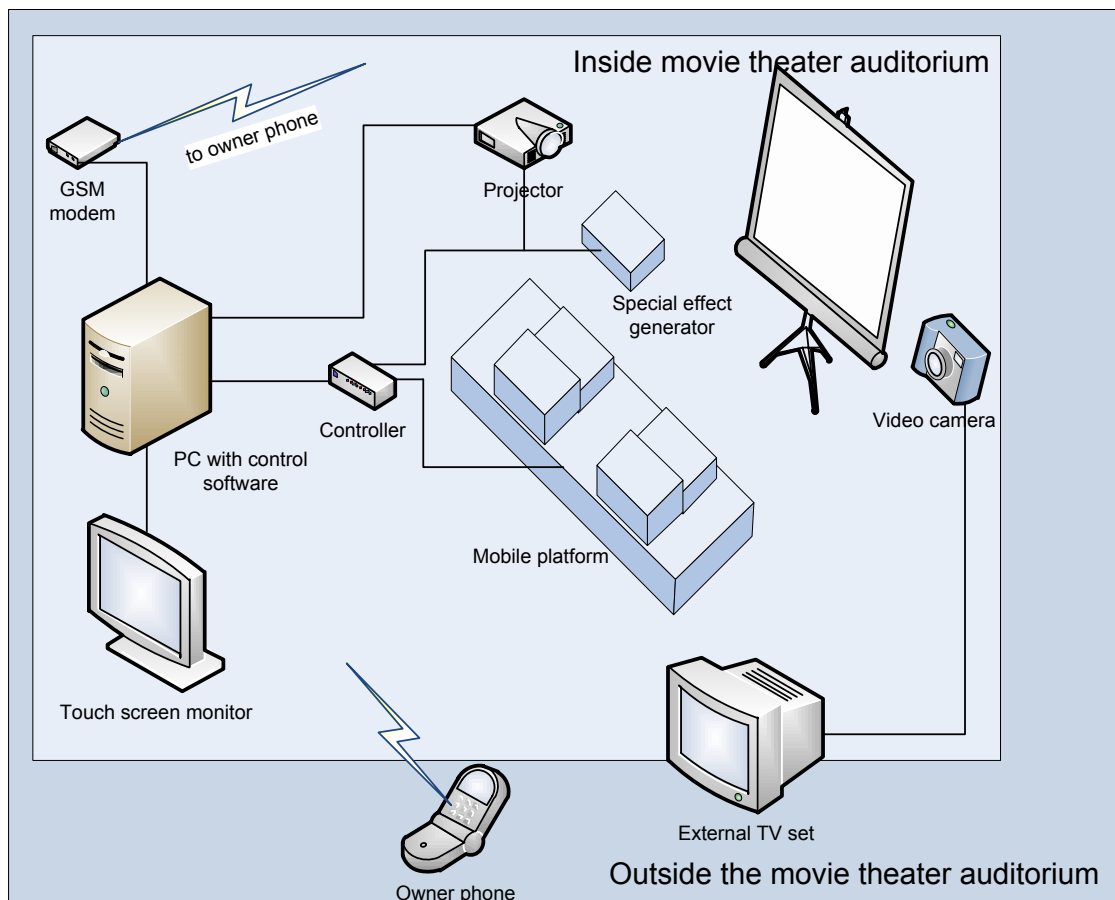
- Powered by Windows 7
- Precise positioning of seats regardless of visitors' weight
- Control of six special effects ("splash", "wind", "snow", etc.)
- The possibility of increasing the number of simultaneously controlled platforms
- Control of the movie theater using a touch screen
- The ability to perform basic diagnostics of the equipment

Licensing and control

- Counting the number of viewers per session
- Filming and mapping the audience on an external screen during the session
- Encryption of platform control commands
- The possibility of licensing the equipment for a limited period with reference to the customer, with further blocking of the equipment after the expiration of the license

- Licensing 5D clips with reference to the equipment, with further blocking of clips after the expiration of the license
- Keeping record of playing 5D clips
- Sending an SMS message with the total number of viewers per day, at the end of the movie theater operation

2. Concept



The proposed solution includes the following modules:

- Software for controlling the movie theater is installed on the PC and performs the function of controlling platforms and playing 5D clips
- Controllers, which manage the electric motors of mobile platforms and special effects generators, are connected to the PC over the RS-422 junction

- Software for creating 5D clips and tying them to the movie theater (not part of the movie theater); in this case the required positions of the platforms are set using a standard joystick

3. Circuit Design

The controller is based on the Cortex™-M3 STM32F103 microprocessor and the Spartan3A series FPGA for processing signals from encoders and generating control signals for real-time frequency converters. The PC and the controllers are connected through the RS-422 interface, which ensures interference immunity during the operation of the motors. Control of 220V effects is implemented on an anti-interference relay. The use of relays helps switch high-voltage power of up to 2 kW.

Also, the microprocessor collects data from the visitor counters made as optocouplers. The board is fitted with fuses for protection against possible overloads and incorrect connections. The PCB is designed to meet the security requirements since it carries life-threatening voltage.

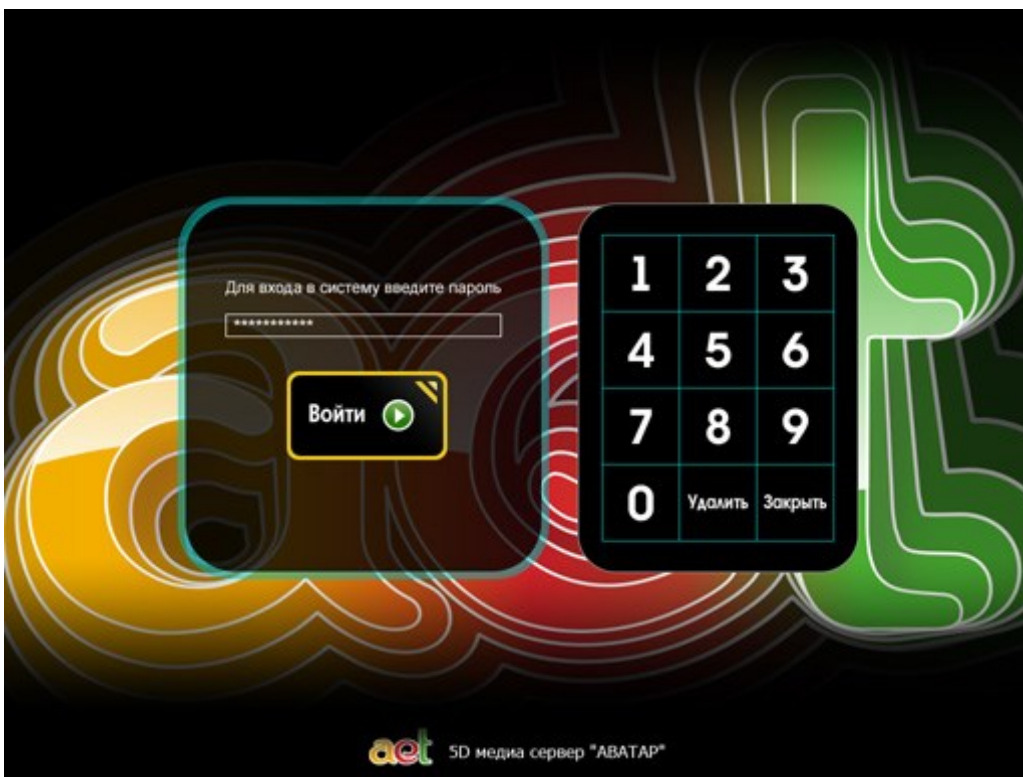
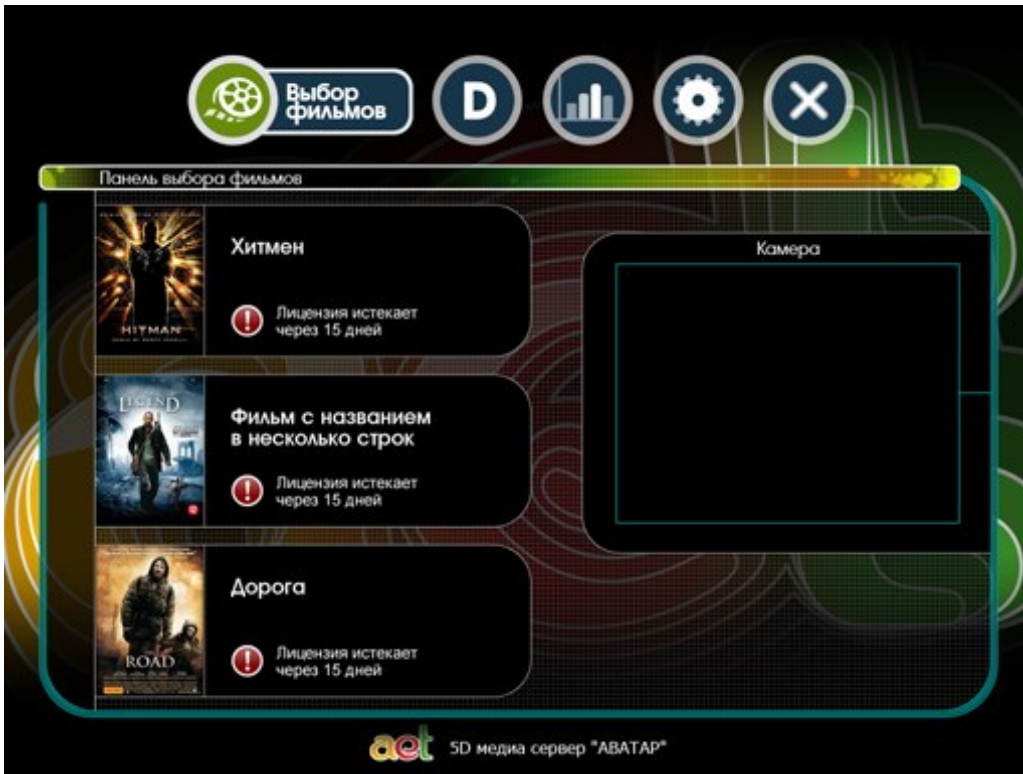
The optical isolation of the inputs helps prevent FPGA failure in case of a frequency converter malfunction or an incorrect connection. The circuit is designed using a modern elements base.

4. Software

The 5D movie theater software is implemented using the Qt 4.7 cross-platform library and OpenCV 2.1, an open-source image processing module.

5. User Interface

- An ergonomic and functional finger-controlled design of the movie theater software
- Support for resolutions, such as XGA (1024x768) and FullHD (1920x1080)



Advantages

- Two seats for viewers on a mobile platform, which helps minimize differences in viewers' sensations
- Each mobile platform is equipped with three independently controlled electric motors; it ensures a high dynamic performance of the platform on all axes
- Control of six and more special effects is available
- Cascade connection of mobile platform controllers, which helps simply increase the capacity of the auditorium and keep the number of connecting cables to a minimum
- A diagnostic system, which does not allow a user to start playing 5D clips in case of a blocking malfunction
- A license control system with protection against unauthorized access
- Password protection against unauthorized access to the control software

Technologies	Qt 4.7, OpenCV 2.1
Programming languages	C++
Development tools	MS Visual Studio, Qt Creator, Qt Linguist
Project managements tools	Redmine, Subversion