PC-based technology controls entertainment applications and kinetic digital signage

Highly precise motion control and synchronization

Simtec Group specializes in custom-tailored motion simulator systems. Founder and Managing Director Bernd Kaugmann used his extensive flight simulator expertise to enter the market for automobile component testing systems and entertainment applications. Today, simulator systems from Simtec can be found in entertainment parks, 4D theaters and museums around the world. With its development of Screenflite®, Simtec has entered the digital signage field as well. Resembling a kinetic piece of art, the media information system catches people's attention in airport terminals, train stations or shopping malls – precisely automated with PC-based control from Beckhoff.

To control the smaller motors that rotate the screens, Simtec uses compact drive technology from Beckhoff, the EL7201 servo terminals with One Cable Technology.
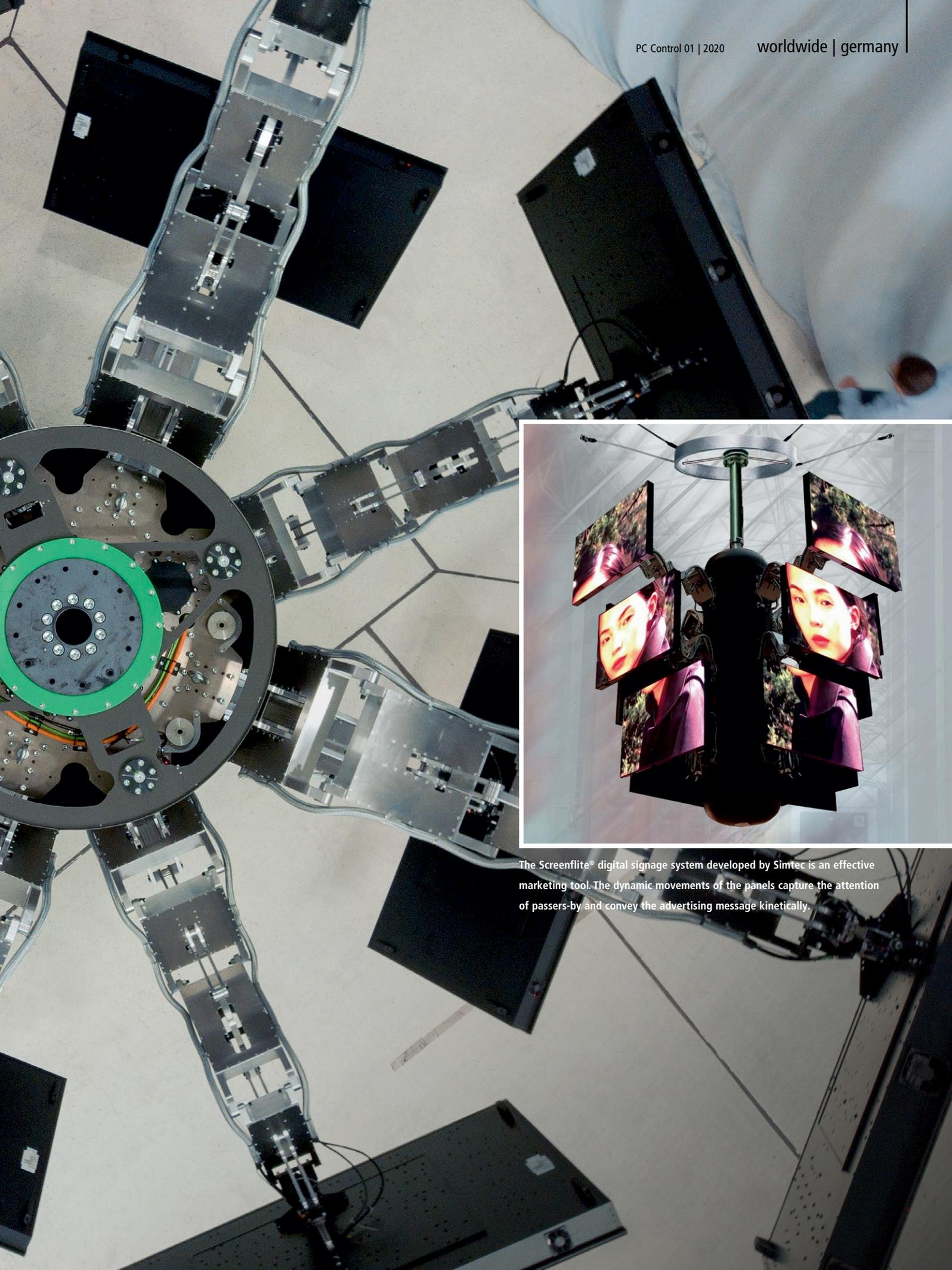
The Screenflite® digital signage system developed by Simtec is an effective marketing tool. The dynamic movements of the panels capture the attention of passers-by and convey the advertising message kinetically.

The modular digital signage system consists of three circular rotating levels and weighs 5.3 tons. Each ring holds four LED screens that can be moved in and out by approximately 1.1 meters and rotated with or against each other as desired.

The LED screens can be dynamically combined and separated again to form a wide range of shapes with two, three, four and six displays.

Over time, the development and manufacture of custom-tailored simulator systems for the entertainment industry has become Simtex Systems' core business segment with the highest sales, with about 80% going to China. "The Expo 2010 in Shanghai was our entry into the Chinese market," says Andreas Stickel, Director Business Development at Simtec Systems GmbH. "As a result of our strong international growth, we expanded our production site in Braunschweig, Germany and set up a subsidiary in China in 2016," he adds.

New generation of the "Flying Theater"

Adding to the classic attractions of its Funride™ family of products which deliver a perfect simulation experience by combining visual and mechanical effects, Simtec has developed the next generation of indoor attractions with its Hexaflite® Flying Theater. The moving platform featuring six degrees of freedom is surrounded by a spherical projection screen with a diameter of up to 23 meters. After the spectators have taken their seats on the platform, it tilts into a vertical position so that the audience sits directly in front of the giant screen. "Each spectator's centered position in front of the screen ensures that they enjoy the same experience from every seat," says Andreas Stickel. Linear acceleration ranging from ±0.7 g and ±1 g and rotations of ±15 to 20 degrees around all axes and the perfect synchronization with the projected images and special effects generate a spectacular, highly dynamic flight-like experience that fully immerses the audience in the screen action.

The moving platform is controlled by a Beckhoff CX5140 Embedded PC with a multi-touch Control Panel and TwinCAT 3 automation software. EtherCAT is leveraged as a powerful communication system. "The nearly unlimited network expandability of EtherCAT and the high data transmission rate make it the ideal fieldbus system for such a large-scale project. EtherCAT branching makes any network topology possible. Simtec also takes advantage of the redundancy supported by EtherCAT," explains Christian Spoer, Team Leader Software Engineering. The complex safety solution for the motion system is based on approximately 100 digital TwinSAFE terminals in IP20 and local TwinSAFE I/O modules in IP65. Also in use are four EL6910 TwinSAFE Logic terminals that communicate with each other as well as with the higher-level CX5140. "The signal and interface diversity of the Beckhoff I/O modules also allows us to easily integrate the stage lighting control via DMX terminals and the compressed air measurement with appropriate measurement modules," explains Christian Spoer.

TwinCAT integrates customer-specific motion control expertise

Simtec has developed the closed-loop control technology for this application in-house in C++. The fact that TwinCAT 3 supports the C++ programming language was an additional plus. As a result, Simtec's entire motion control programming can be easily integrated into the TwinCAT 3 automation software and run in real time. The user interface of the Hexaflite® system is another proprietary Simtec solution developed in C++. "One of the great advantages of the Beckhoff technology is the ability of our visualization system to communicate easily with TwinCAT over ADS," emphasizes Andreas Stickel.

Digital signage interpreted kinetically

With its Screenflite® system, Simtec is now entering a new market. The modular media information system, which weighs 5.3 tons, consists of three circular rotating levels. Each ring holds four LED screens, each with a surface of 2 square meters, that can be moved approx. 1.1 meters in and out with scissor arms and rotated with or against each other. "Based on highly dynamic choreography, the LED screens move toward each other and separate again to form various combinations or shapes consisting of two, three, four or six screens in rapid order," is how Andres Stickel describes the kinetic system. "In addition, the flat screens on the upper and lower rings can tilt vertically. The mechanical design ensures that the screens don't collide with each other."

On each of the 12 screens, media content can be played in sync with the screens' motion. Since the motion sequences are determined through program-
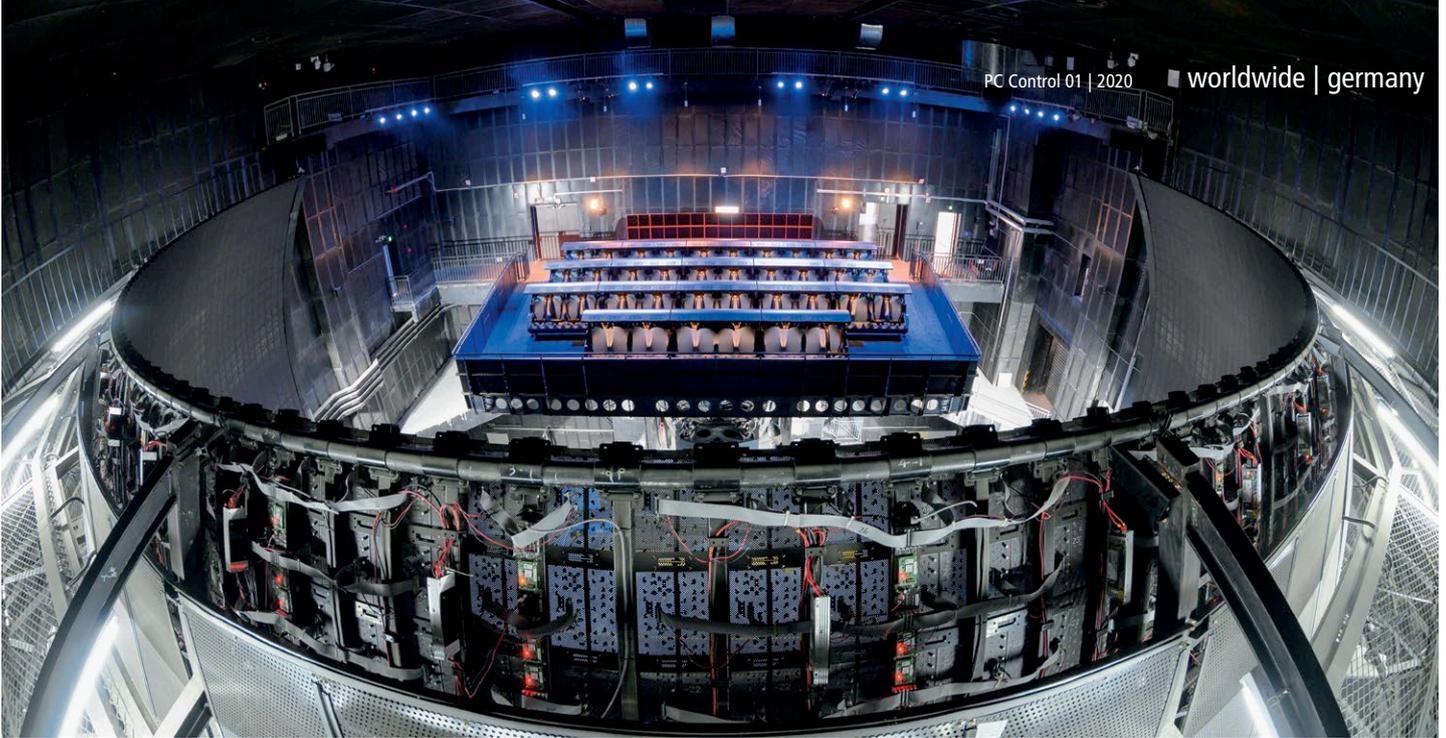
The Hexaflite® Flying Theater consists of a platform that is movable with six degrees of freedom and surrounded by a circular screen, resulting in a viewing angle that's 180 degrees horizontally and 110 degrees vertically.

ming, sequences in line with the system's 20 degrees of freedom are possible. "We have created nine different motion cycles for the Screenflite®," adds Andreas Stickel, "but the kinetics are freely programmable and can be adapted by the operator's content designer."

Kinetics require exceptionally precise drive control and perfect synchronization

"From a control perspective, the digital signage system is our most complex product," says Christian Spoer. The challenge lies in the precision of the different motion control speeds and the perfect synchronization. The three rings that move the LED screens via their scissor arms are not linked mechanically but communicate via Wi-Fi using TCP/IP (via ADS). Only the power and the emergency OFF signals are transmitted via slip rings.

Each ring uses an ultra-compact C6015 Industrial PC with an Intel Atom® quad-core processor that functions as an EtherCAT master to control the movements of the four LED screens. Because of their high performance, one of these IPCs is able to handle the synchronization of all three rings over Wi-Fi. "The ultra-compact design of the C6015, which measures only 82 x 82 x 40 millimeters, is ideal for the small amount of space we have in the rotating shapes," explains Christian Spoer.

The motion control runs in a C++ module with a linked PLC project. "We programmed the axis control algorithms and the synchronization of the motion sequences in a C++ module that integrates seamlessly into TwinCAT 3. The TwinCAT NC library provides the closed-loop controller and profile generator," adds Christian Spoer.

To control all 27 PTP axes on the digital signage system's three levels, one- and two-channel EtherCAT servo drives from the AX5000 series with integrated safety functionality are used. And to control the smaller motors for rotating the monitors, Simtec uses EL7201 servo terminals with One Cable Technology

(OCT) connection because their compact design works perfectly in the limited space available.

Conclusion

Simtec has used control technology from Beckhoff in many of its projects. "We use the complete spectrum of Beckhoff control components in our media information system, from the Control Panel and Industrial PCs to I/O terminals and TwinCAT software. The option to employ both centralized and decentralized PC-based control technologies works great for our needs and is an important prerequisite for our applications. We also benefit from the broad range of terminals that Beckhoff offers. For example, by simply inserting a pressure measurement terminal into the I/O segment you can recognize a pressure drop in the system and take appropriate corrective action. And in addition to the high communication speed of EtherCAT, which is a prerequisite for the perfect synchronization of the screens, we also benefit from its diagnostic functions. Other benefits include the direct integration of C++ modules into TwinCAT 3 as well as the ability to run it on top of Visual Studio, which allows us to easily integrate Git for the version management," says Andreas Stickel, summarizing the many advantages of PC-based control.

More information:
www.simtec.de/en
www.beckhoff.com/stage