Immersive Technology Penetrates Reality

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On the surface, the concept of reality is easy to understand. The world around us is all we see, all we feel in a given space. Reality is simply what exists.

However, with the proliferation of the Internet of Things (IoT), smart devices, and 5G, the premise of reality has changed from constant, predictable surroundings to a continuously-evolving real and virtual experience. Of course, we see and feel the physical reality, which is only part of the story. **Physical reality is balanced by immersive/extended reality (XR)**, adding and creating new experiences.

Immersive realities have three principal types:

- Virtual reality (VR) – An entirely simulated environment that lets the user feel immersed in a digital-only world.
- Augmented reality (AR) –The enhancement of the physical environment by adding digital images and experiences. Users frequently experience AR through smartphone cameras.
- Mixed reality (MR) –The interaction between physical and digital objects. MR uses the strengths and benefits of both AR and VR to optimize user experience.

The primary technology that delivers an immersive user experience is an XR headset. Computational and processing elements, actuators, sensors, and other components are within the XR devices. These components link the two worlds together and enable transformative applications to benefit humanity. Examples of XR usages include creating human and social benefits such as safe, simulated social interactions for children and aiding in treating ailments ranging from phobias to pain and anxiety. Along with the clear healthcare benefits, XR also improves human convenience through smart cities and connected streetlights, aids in space travel, and thousands of other applications in between.

The intersection of the virtual and physical worlds can change humanity for the better. The following reviews each type of XR and outlines the roles played by the relevant signal chain components that enable this transformative technology.

Immersive Tech Frames of Reference

It is worth defining the frames of reference of immersive tech to understand the signal chain and how relevant processing elements help deliver the experience.

Physical Reality

The world around us provides feedback to set the guardrails of what the user can expect.

Virtual Reality (VR)

Virtual reality provides its operator with a fully immersive experience, simulating as many of the five senses as possible.

Augmented Reality (AR)

AR adds virtual elements to the physical realm to enhance what users see and add functionality or features.

Mixed Reality (MR)

MR makes it possible to have an interaction of the two instead of the digital elements simply overlaying the physical ones.

Technical Signal Chain Components

Like the supply chain for sourcing materials, the signal chain comprises the network and order of components that provide the XR experience.

Processing Power/Thermal Management

The more intensive the display, the higher the power requirement needed to supply the digital features. Integrating power-dense thermal management and processors ensures the technology will not distract from the immersive experience. In addition, the system must sufficiently cool the increasing processing load to protect the user from equipment failure, especially during medical and human-care applications. The data center cooling market is helping drive processing and chip cooling solutions that can help XR.

Visual Display/Illumination

Having a display with an illumination strategy that lets the user's vision transition from real to virtual (and back) provides the transformative experience the user seeks. In addition, increasingly high-resolution cameras offer more realistic experiences.

Connectivity

The amount of data providing realistic environments will only increase as the system transmits more data to the user. The high speed and decreased lag of 5G will propel XR into applications where technology's real-time response to user behavior is non-negotiable. In addition, the widescale rollout of 5G enables decoupled data analysis from a central hub to process more of the data at the device level (the edge). Edge processing reduces data travel time and distance.

Motion Tracking

Sensors collect data from the environment, and actuators record and transmit the human response. Autonomous vehicle technology is pulling the development of both, especially sensors. For accurate interaction of the physical and digital environments, sensors must create a precise map of the physical space, and the actuators must transmit the person's action as intended.

Product Spotlight: TDK PowerHap™ Piezo Actuator

Collecting the data to accurately map the physical reality space provides a canvas on which design engineers can create the virtual elements. A denser physical reality matrix increases the degree of freedom the designers can access, creating subtle, life-like interactions that the user responds to with natural movements and impressions. The high-performing data processing fully immerses the user in the experience. And with any human-machine interface (HMI), high sensitivity and dynamic motion responsiveness enhance the XR user experience to make it feel like real life.

Transformative products combine both of these features for an optimal enhanced reality experience. One of the best product options

is the **TDK PowerHap™ Piezo Actuator**. The PowerHap leverages the piezoelectric effect, where an electrical charge is converted to a mechanical response. . This effect enables the PowerHap to provide haptic feedback with high acceleration, displacement and force to activate communication media and engage the user's tactile sensitivity. In addition, the actuator contains integrated sensing function to detect force in the form of touch. The force is a mechanical stress that generates an electrical charge that is linear in proportion to the amount of force applied.

The PowerHap incorporates multilayer piezo plates with copper inner electrodes. Copper's high electrical conductivity enables a relatively low operating voltage, 120V or below. In addition, these specific plates exhibit only minimal expansion in the z-axis with simultaneous contraction in the other two directions due to the piezoelectric effect, creating a constant volume. The piezo actuator also uses integrated cymbal features to amplify the magnitude of z-axis contraction up to 15 times the nominal value.

Product features that enable this type of high performance include large forces up to 20N, a wide displacement range between 35µm and 200µm, up to 15g acceleration with a 100g load, and are spatially, and energy-efficient. The PowerHap consumes a 26.0mm2 maximum footprint in the packaging envelope with a very low 2.4mm insertion height and consumes only between 1 and 8mJ of energy per cycle.

The PowerHap Piezo Actuator is ideal for augmented and virtual reality due to its small footprint, high sensitivity, and high-performance operation.

Conclusion

The benefits of the seamless integration of immersive technology are clear. This transformative technology movement improves entertainment and helps society by improving the products we develop, medical care and procedures, safety when traveling, and the quality and depth of education. Developments in the areas below will fuel this integration:

- Processing power and cooling from the data center industry
- Display and illumination led by smartphones and display manufacturers
- Connectivity led by 5G manufacturers and network service providers
- Motion tracking led by sensor and actuator electronics manufacturing

Each of these technologies risks limiting the growth of immersive technology. It will take combined efforts to develop and grow each segment to realize the exponential gains predicted by the market reports. But with the benefits available for humanity through improving extended reality, the rewards are worth the investment.