MetaVR™ Virtual Reality Scene Generator™ (VRSG™) features significant enhancements to the simulation of an infrared (IR) sensor. Working jointly with Technology Service Corporation (TSC), MetaVR has developed an advanced physics-based IR sensor modeling capability that is included in VRSG at no additional cost.

The key feature of the IR capability is the real-time computation of the IR sensor image directly from the visual scene, with no offline precomputation or data storage requirements. This real-time model combines automatic material classification of visual RGB imagery, and a physics-based IR radiance and sensor model.

MetaVR VRSG is capable of rendering vast geographic expanses of high-resolution geospecific imagery, such as MetaVR’s Continental USA plus AK and HI (CONUS ++) 3D terrain at 1 meter-per-pixel color resolution. Material classified representations of such large and high-resolution areas are generally not available nor are they practical to acquire. The technology developed by MetaVR and TSC solves the classification problem.

Our process uses pixel-shader technology to convert the per-pixel filtered visual spectrum RGB color into its component materials, which are then used by the physics-based IR model to compute IR radiance and sensor display intensity. The physics-based model takes full account of the local environment, time of day, and sensor characteristics. The result is a physically accurate sensor scene derived from a visual spectrum database.

As shown in an example on the next page, the higher the resolution of the visual database, the more accurate the IR profile for that database.

The only offline processing requires the user to create a classification palette for supervised material classification by associating up to 5 RGB colors with physical materials from the VRSG/RealIR material database. Using the per-pixel material properties and the real-time parameters derived from environmental conditions, a per-pixel radiance raster image is computed for each video frame, as would be seen by an actual thermal sensor.

This radiance image is processed in real-time by including blurring, noise, and Automatic Gain Control (AGC). The AGC process maps the radiance range into a display dynamic range, and can be disabled by the user if manual level and gain controls are to be used. The AGC process uses a histogram analysis of the radiance image to determine an appropriate display dynamic range for the scene. (A more efficient implementation of AGC is in VRSG version 6, which takes advantage of DirectX 11 compute shaders.) Sensor noise is automatically computed as a function of the display’s dynamic range.

Geotypical content, such as 3D culture and moving objects, can be mapped directly to material codes using an external file that associates texture names with material codes. The geospecific and geotypical content use the same underlying physics model, resulting in a consistent rendering of the scene.

A 24-hour cycle IR view in VRSG, showing the thermal progression starting at 12:00 midnight.
With imagery at this resolution, you can create a physics-based IR profile of the terrain with a high degree of realism. Using the IR Setup utility that is delivered with VRSG, you can describe the sensor’s spectral response within its waveband of interest, train the material classifier, and specify the environmental characteristics that influence the appearance of the IR scene. The material classification process automatically generates material attribution from visual spectrum colors. This means that the higher the resolution of the visual database, the more accurate the IR profile.

This final example below is from 2 cm per-pixel resolution terrain, built with 2 cm imagery collected by the MetaVRC small UAS of the Prospect Square area of Yuma Proving Ground, AZ.

Examples of sensor simulation
The following VRSG image shows MetaVR’s Afghanistan village 3D terrain at midnight. Notice the warmer vegetation and the cooler asphalt road and concrete structures. The cooler 3D structures are difficult to discern as they have cooled to an even temperature and blend into the background.

This next VRSG image shows the same area in the afternoon, after the sun has heated up the asphalt road and the stucco sides of the buildings. The vegetation is cooler than the concrete and asphalt structures heated by the sun. This example illustrates thermal inversion.

Compiling high-resolution imagery of an area of interest with accurate satellite elevation data or other digital elevation models (DEMs) results in a highly realistic geospecific synthetic environment with a physically accurate sensor scene.

The next example is from a geospecific terrain database of a desert rural area built built from 2.5 cm per-pixel imagery and 10 meter per-pixel elevation data. The 2.5 cm imagery was collected by MetaVR’s small UAS, the MetaVRC.

The resulting terrain tiles were compiled with MetaVR’s Terrain Tools for Esri© ArcGIS® at 2.5 cm per-pixel resolution, which can be rendered in VRSG at 60 Hz.

For more information, contact sales@metavr.com or scan the QR code to your mobile device.

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