Various measurement approaches exist for detecting the positions and movements of people. For challenging location detection tasks in building automation, electronic control or safety systems, image sensors offer greater potential than simple passive sensors. The diverse range of possible applications are leading to ever more powerful optical systems, such as embedded solutions with intelligent, programmable sensors.

Against this backdrop, Fraunhofer IIS/EAS has developed an energy-efficient system for activity detection using image sensor systems-on-chip with multimodal, texture-based image sequence processing. This enables robust, spatially resolved detection of movements and gestures without the need to output image data. In other words, there is no violation of privacy. The data obtained can serve as the basis for scene analyses or motion tracking, for example. The approach is expanded with a multi-sensor platform for improved building control that encompasses various measurement values in order to give optimal consideration to comfort parameters.

Your Benefits

- Detection of the location and intensity of human activity within a defined area
- Output of real image data suppressed by algorithms (privacy)
- Also functional in high-contrast or low-light situations
- Differentiation between people and moving objects by means of self-learning system
- Definition of focal regions and classification of events by software (region editor) developed in-house
- Low power consumption (< 100 mW)
- Optimization of the total system costs
Activity Detection with Image Sensors

The approach taken by Fraunhofer IIS/EAS is based on robust texture-based, multimodal algorithms for motion detection and location. An image sensor system-on-chip (SoC) was implemented for extremely low-power data processing. Alongside the low energy consumption, “privacy by design” played a fundamental role in the development of the SoC. The derivation of area-based object features (texture) at the level of the image sensor SoC allows for maximum protection of privacy. Because no real image data is output, it is not possible to visually recognize individuals. The requirements for additional hardware are also minimized, which lowers the overall costs.

In comparison, passive infrared motion detectors (PIR sensors) are only able to detect that a movement is occurring, not what type of movement it is or where exactly it is taking place. The spatial resolution could conceivably be improved by combining multiple PIR sensors, but the tracking of individuals in order to derive a position and movement pattern is not possible. By contrast, the image sensor hardware developed at Fraunhofer IIS/EAS and the implemented software contain algorithms that have been adapted for this purpose. These algorithms allow textures to be detected and classified independently of the lighting and with useful spatial and temporal resolution. For example, people can be automatically differentiated from equipment that is displaying motion or engaging in movement (televisions, fans, etc.).

Implementation Variants

Fraunhofer IIS/EAS offers its presence detection solution for various implementation levels. Each of these levels can be expanded with software modules for detecting the number of independent objects, the position and direction of movement as well as the entering or exiting of defined regions. The hardware can be networked via Ethernet, Zigbee or Bluetooth.

- **Software solution for existing camera systems**
  - Image capture via
    - Network streaming or
    - External cameras (USB, GigE Vision)
  - Image processing via
    - Software on a standard PC
    - Parameterization via Web interface or network packets

- **System based on an integrated camera unit**
  - Image capture via
    - Integrated camera module with lens
  - Image processing via
    - FPGA system with embedded ARM
    - Parameterization via Web interface or network packets

- **System based on image sensor system-on-chip**
  - Image capture via
    - Integrated HDR image sensor system-on-chip with lens
  - Image processing via
    - Image sensor SoC and ARM microcontroller
    - Parameterization via Web interface or network packets

Examples of Output from the Software Solution

Left: Demonstration of the region editor on an external camera image
  (green = active / red = inactive)
Right: Display of the activities in the image field (sensor output)