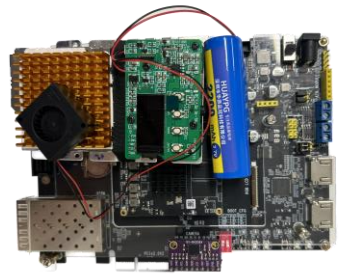
[Public]

A Real-time Continuous Projection Calibration Platform Based on ZYNQ7015

Zeyu Fang, Wenbo Huang,Nuo Yi
Nanjing University,Jiangsu Province

OpenHW2024

AMD



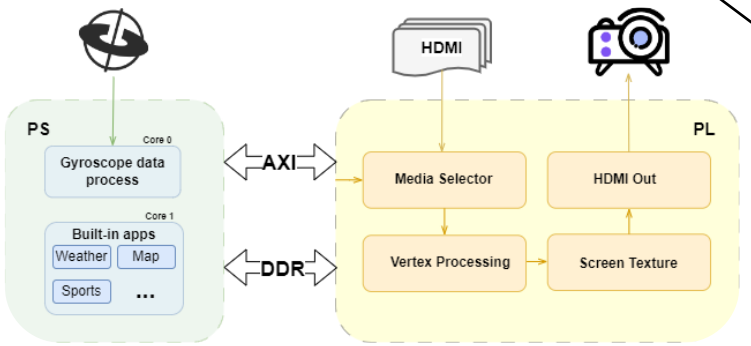
On board test by AMD ZYNQ7015

INTRODUCTION

Traditional projector correction relies on manual adjustments based on fixed scenes or employs image recognition through resampling of distorted images ,or utilizes point cloud sampling. However, the high complexity of these algorithms makes it difficult to achieve low-latency projection real-time correction on miniaturized devices with limited computational power.

The invention proposes a gyroscope-based method and system for real-time projection correction, ensuring accurate image alignment regardless of projector orientation. The system uses gyroscope data and projection plane type to calculate and apply a correction matrix in real time.

Our system has key technical features as below:
1. System Real-time Performance: The FPGA platform achieves a 18ms for 1280x720 resolution images utilizing Gyroscope-based real-time projection correction based on ZYNQ7015.
2. High energy efficiency: The platform supports high-resolution rendering with low latency and consuming less power than CPUs and GPUs.



System Architecture

PS terminal：
1. Obtain real-time device orientation with BNO085 gyroscope.
2.The task scheduler selects different built-in app tasks for output based on the gyroscope angle.
PL terminal：
1. Perform matrix correction calculations on the PL,with the characteristics of low latency and high resolution.

CREATIVE DESING

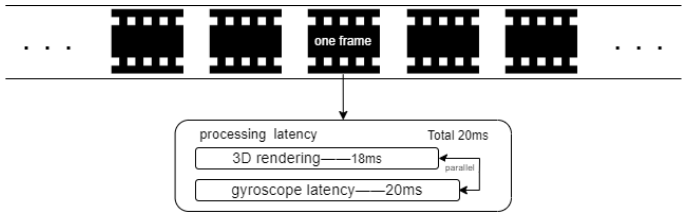
Creative Design

1. Gyroscope:Innovatively applying gyroscopes to projection correction.
2. Algorithm Improvement:The correction algorithm achieves an impressive O(1) time complexity, ensuring rapid and efficient performance regardless of the input size.
2. FPGA Parallelization: Enhances performance through efficient matrix and image processing.
3. Hybrid Display Innovation: Allows any surface to act as a screen and enabling “projection onto anything”,and utilizing projectors to achieve the integration of projection images with the real world.

RESULT

Algorithmic Improvement: Traditional image processing algorithms, such as resampling, image recognition and correction algorithms, and point cloud sampling algorithms, all have a time complexity greater than O(n), where n is the number of pixels or the number of points in the point cloud.The correction matrix method utilizes gyroscope angles for image adjustment, offering an impressively low O(1) time complexity. This makes it particularly effective for high-resolution images.

Reduced Latency: By utilizing FPGA acceleration in conjunction with gyroscope-based algorithms,and due to the superiority of these algorithms, the latency is significantly reduced to just 18.43ms.



This real-time projection correction tech can be used in many situations, allowing any surface to act as a screen and enabling “projection onto anything.” The platform has a wide range of applications, including but not limited to smart flashlights, intelligent car lights, home projection equipment,etc.