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AP068

FPGA Based Sensor Hub For VR|AR Application

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Outline

- Motivation
- Introduction
- Features
  1. Head Position Tracking
  2. Eye Tracking
  3. Stereo Vision
- Implementation
- Application

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Motivation

- New way to deliver content and experience
- Demand for affordability and portability
- Exponential growth of the industry
- Basic requirements for VR/AR
  - Head tracking
  - Stereoscopic displays
- Advance requirements
  - Eye tracking
  - Depth map

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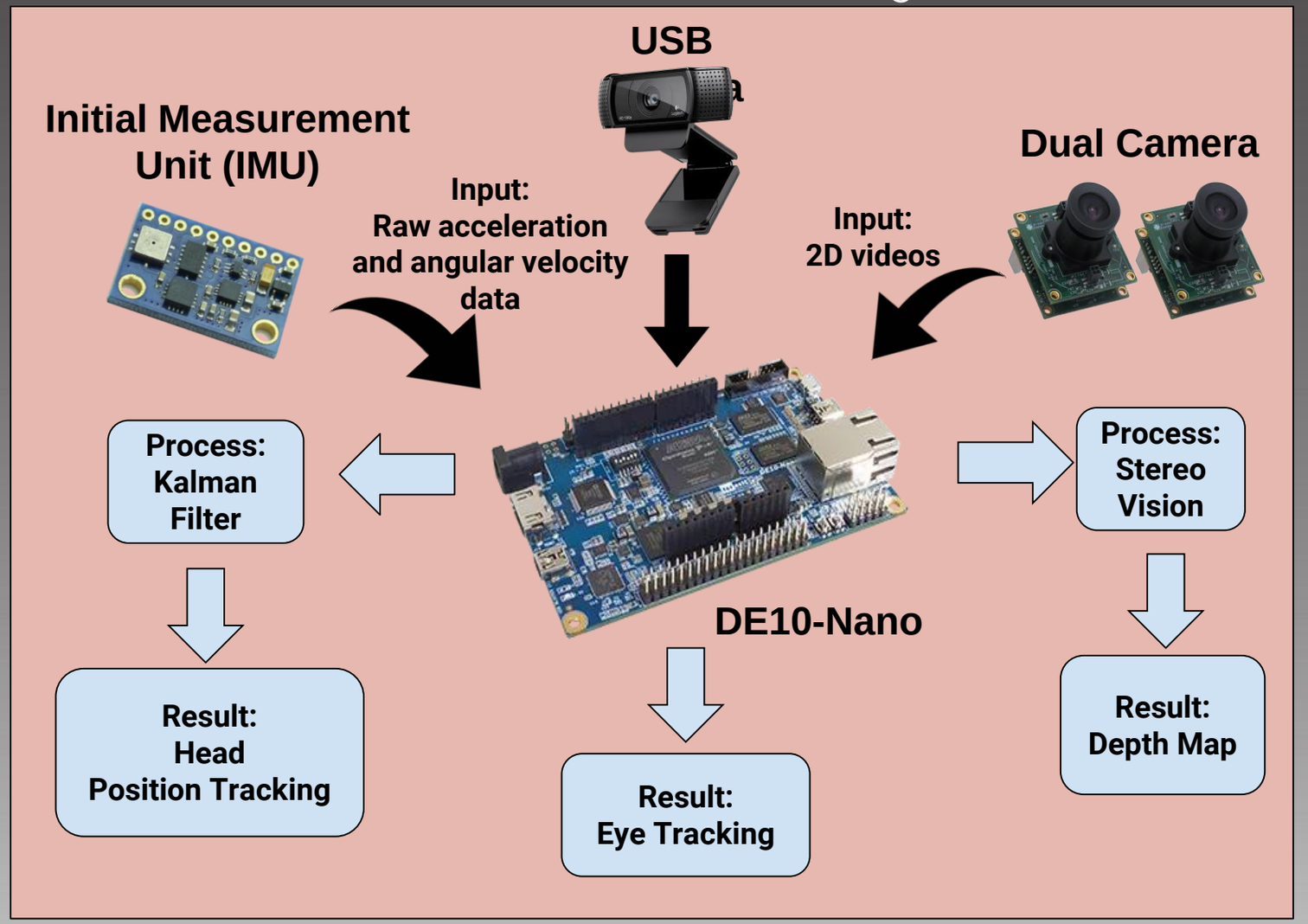
Introduction

- FPGA based sensor hub
- 3 main functions
  - Head Position Tracking
  - Stereo Vision
  - Eye Tracking

Headset Hardware Block Diagram



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Features - Head Position Tracking

- Track the direction where user's head is facing

- Vital data for VR/AR application
- Render specific portion of display based on head position
- Require extra low latency
  - Prevent dizziness
  - Better immersion

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Features - Stereo Vision

- Process dual camera images into 3D depth map

- Inside-out tracking
  - Positional tracking based on environment
  - Minimal setup and boundless field
- Realistic augmented/mixed reality
  - Environment aware application

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Features - Eye Tracking

- Determine eye position from video stream

- Foveated Rendering
  - Render only portion of the display based on the eye position data.
- Input Interface Device
  - Interaction and control by using eye movement

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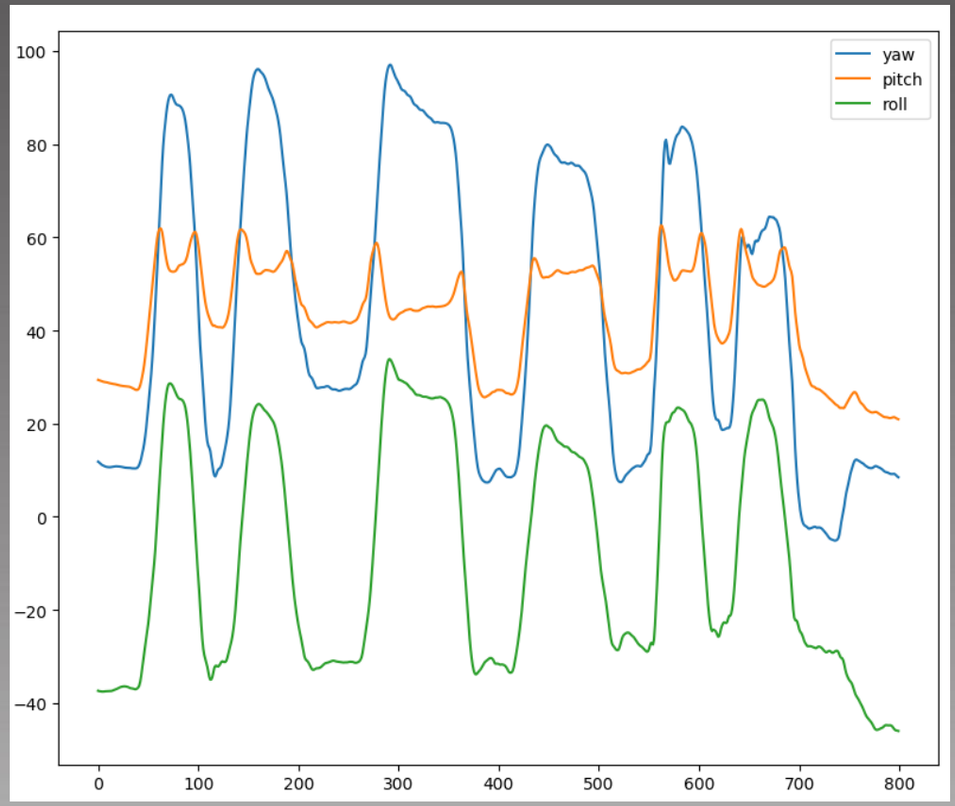
Head Position Tracking

- Kalman Filtering Algorithm
- Two stages
  - Time prediction
  - Measurement update
- Heavy computation
  - Large block of inputs
  - Complex matrix computation
- FPGA
  - Parallel computation ability
  - Computing resource available
  - Able to configured by end user when necessary



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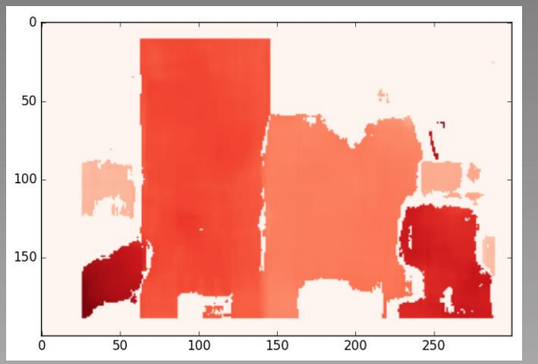
Stereo Vision

- Calibrate and rectify images
  - remove distortion
- Grey-scale conversion
- Stereo Matching
  - Sum of Absolute Difference (SAD) for cost aggregation
  - winner-take-all (WTA) for disparity selection
- Disparity Calculation
  - calculate depth from disparity



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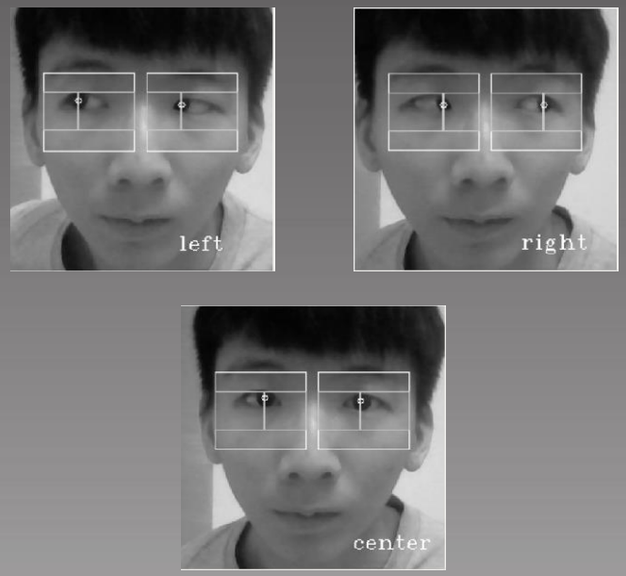
Eye Tracking

- Using Image Processing Approaches

- Face and Eye Detection
  - Classifier using Viola-Jones Algorithm
- Eye Centre Localisation
  - Image Gradient based



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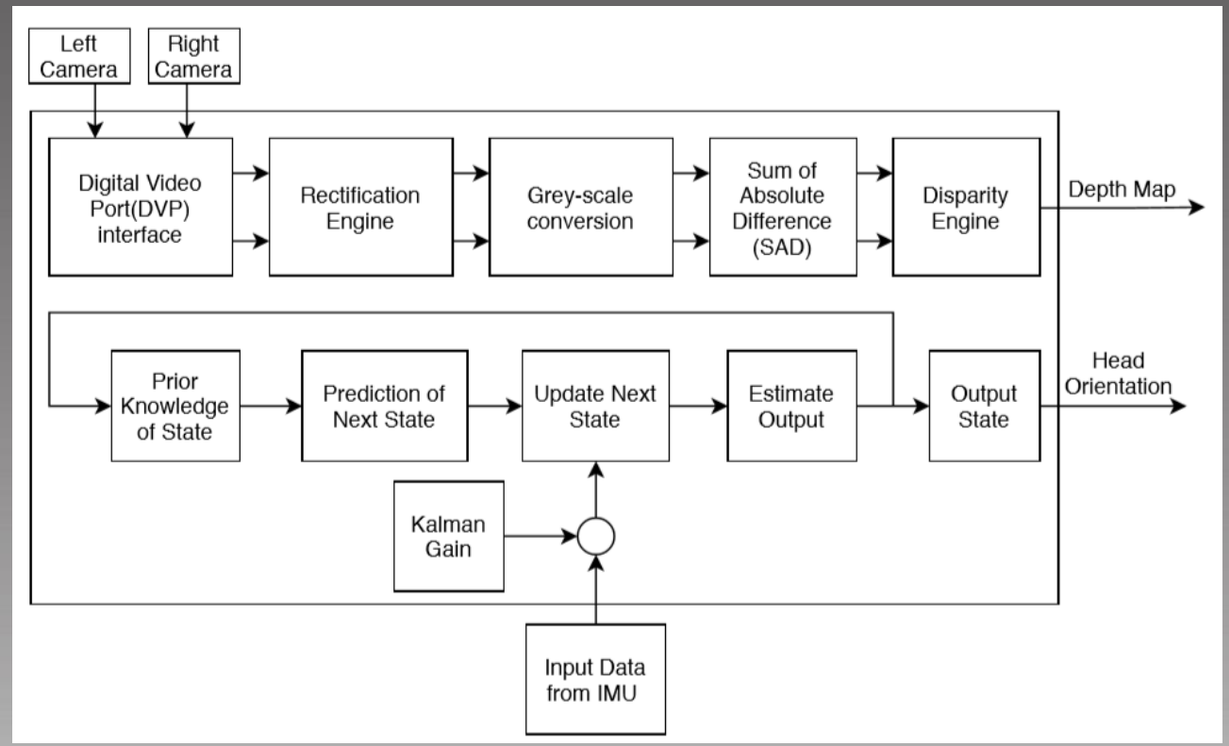
System Architecture

- Uses both FPGA and HPS
- FPGA
  - Head Position Tracking
  - Stereo Vision
- HPS
  - Eye Tracking



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Applications

- Lightweight, low power sensor hub
  - Integrated with head mounted display
- Provide API to facilitate reading of data from the sensor hub
- Provide hardware abstraction layer
  - Simplify application development for makers and developers

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