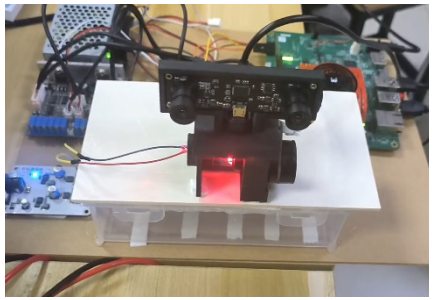
FPGA-Based Vision and Laser Pest Control System

Zhang Yaokang, Zhang Yun, You Xukun
Nanjing University of Posts and Telecommunications

OpenHW2024

AMD



On board test by AMD KV260

INTRODUCTION

Laser pest control system is an environmentally friendly, pollution-free, intelligent pest eradication solution, aligning with the principles of **smart agriculture** and **sustainable development**.

The system consists of binocular camera, high-precision DAC , laser galvanometer system, the image recognition and depth calculation deployed on Kria KV260.

The system can **identify insect species** and **drive high-power lasers** for pest eradication

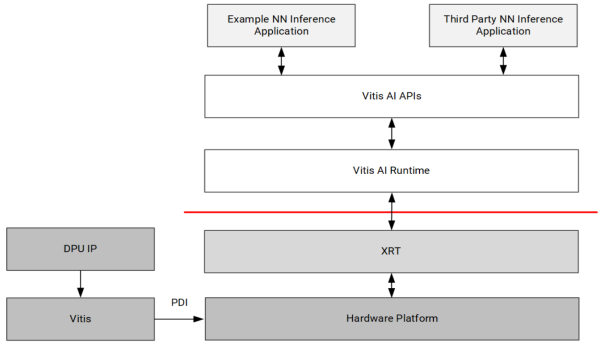
Key technical issues addressed:

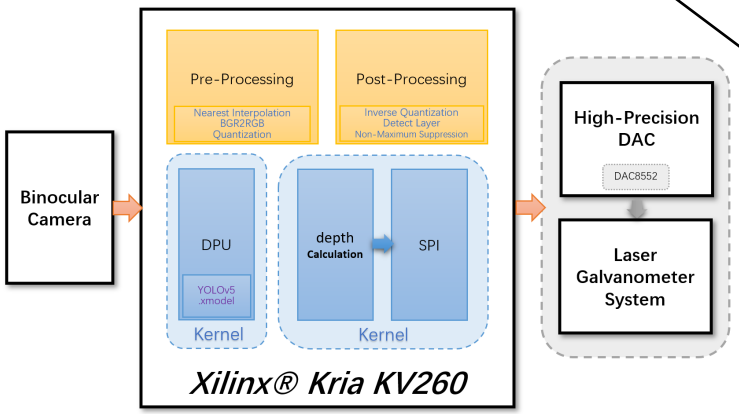
1.Quantified and compiled Yolov5 **CNN model** with Vitis AI.

2.Developed a hardware platform featuring custom-designed **depth calculation** IP core and SPI IP core.

3.Integrated the DPUCZDX8G IP core into the hardware platform via Vitis to accelerate CNN inference.

4.Implemented a laser galvanometer system driven by self-designed high-precision DAC module.





Xilinx® Kria KV260

Kria KV260

primarily has two functions:

1.Using the DPU to accelerate the quantized and compiled YOLOv5 model (.xmodel). It also includes ported model preprocessing and postprocessing.

2.Utilizing the FPGA for deep computation and converting the spatial information of pests into angular information, which is output via SPI.

External Devices

1.Binocular camera provides spatial depth information to determine the location of pests.

2.16-bit high-precision, low-temperature-drift DAC (DAC8552) operates via SPI.

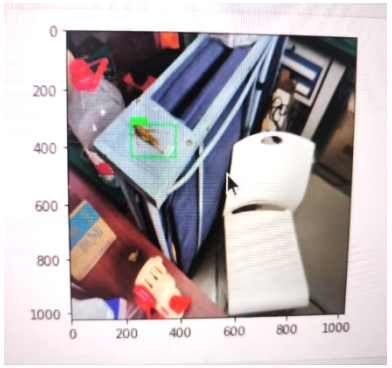
3.Laser galvanometer system accurately controls laser direction through multiple reflections.

CREATIVE DESING

RESULT

The completed system can accurately identify insects, calculate the location of pests, and direct a laser to target them.

The DPU-accelerated model achieves an inference speed of up to 30 FPS, with spatial calculation errors less than 1 cm, and the laser can precisely hit the insects.



In conclusion, the laser pest control system has achieved the intended functionality. Leveraging the flexibility and scalability of FPGA, this "visual recognition + control" model can be easily applied to a wider range of agricultural and industrial fields.