Project Plan Presentation

SmartSat™ AI Acceleration in Space

The Capstone Experience

Team Lockheed Martin Space

Susanne Constantakis
Benjamin Kavara
Josiah Klann
Kellen Lear

Department of Computer Science and Engineering
Michigan State University
Spring 2024
Project Sponsor Overview

• Lockheed Martin is a leading global aerospace, defense, and security company.
• Operates in four main segments: Aeronautics, Rotary and Mission Systems, Space, Missiles and Fire Control.
• Major Contractor for the U.S. DoD specializing in advanced technology systems, products, and services.
Project Functional Specifications

• SmartSat software integration and functionality for efficient software update and processing.
• Building on the previous capstone project and the developed accelerators for targeted testing.
• Develop test infrastructure for application verification and profiling on target hardware.
Project Design Specifications

• Development of a custom terminal within the PetaLinux environment, optimized for communication with the ZCU102 hardware.

• Creation of specialized script capable of automating the deployment of ML models tailored for benchmarking.

• Development of a script to record output data including performance metrics.

• Manage different models for image recognition and segmentation.
root@xilinx-zcu102-2020_2:~# The XKEYBOARD keymap compiler (xkbcomp) reports:
> Warning: Unsupported high keycode 372 for name <I372> ignored
> X11 cannot support keycodes above 255.
> This warning only shows for the first high keycode.
Errors from xkbcomp are not fatal to the X server
D-BUS per-session daemon address is: unix:abstract=/tmp/dbus-LgydUQ6N99, guid=elbd81205457d55d2e3f44cf65b81869
matchbox: Can't find a keycode for keysym 269025056
matchbox: ignoring key shortcut XF86Calendar=!$contacts

matchbox: Can't find a keycode for keysym 2809
matchbox: ignoring key shortcut telephone=!$dates

matchbox: Can't find a keycode for keysym 269025050
matchbox: ignoring key shortcut XF86Start=!matchbox-remote -desktop

dbus-daemon[984]: Activating service name='org.ally.atspi.Registry' requested by ':1.0' (uid=0 pid=980 comm="matchbox-panel --start-applets showdesktop, windows")
dbus-daemon[984]: Successfully activated service 'org.ally.atspi.Registry'
SpiRegistry daemon is running with well-known name - org.ally.atspi.Registry
[settings daemon] Forking. run with -n to prevent fork

root@xilinx-zcu102-2020_2:~#
Screen Mockup: Script Execution

Execute All AI Script

Input Folder Name: FolderName
Input Iteration Count: 3

Running: 100%

Data Collection Complete, please run display.py to see results
Screen Mockup: Results Display

<table>
<thead>
<tr>
<th>Average Model Runtime</th>
<th>Time(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 on System 1:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 2 on System 1:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 3 on System 1:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 1 on System 2:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 2 on System 2:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 3 on System 2:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 1 on System 3:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 2 on System 3:</td>
<td>123.4</td>
</tr>
<tr>
<td>Model 3 on System 3:</td>
<td>123.4</td>
</tr>
</tbody>
</table>

Do you wish to save these results to a Text File?(y/n): y
Enter Name of Text File you wish to save to: Demo
Screen Mockup: Optimal Results Menu

Optimal Hardware Component per Model

Input Name of text file: FileName.txt

Model 1 performs optimally on Hardware X
Model 2 performs optimally on Hardware X
Model 3 performs optimally on Hardware X
Model 4 performs optimally on Hardware X
Model 5 performs optimally on Hardware X
Project Technical Specifications

• Integration of TensorFlow models with VitisAI for optimized execution, enabling efficient benchmarking on Xilinx hardware platforms.

• Configuration of a custom PetaLinux system to facilitate communication and operation of AI applications.

• Utilization of the SmartSAT SDK environment, focusing on prototyping and testing.
Project System Architecture
Project System Components

• Hardware Platforms
  ▪ Xilinx ZCU102
  ▪ UDOO Bolt Gear
  ▪ AMD Jetson TX

• Software Platforms / Technologies
  ▪ Vitis AI
  ▪ PetaLinux OS
  ▪ SmartSat DSK
Project Risks

• Xilinx Hardware and non-commodity Embedded Systems
  ▪ Limited, convoluted, sometimes incorrect documentation
  ▪ Mitigation - Frequent communication with sponsors and more frequent team meetings to resolve issues

• Machine Learning
  ▪ No prior experience with ML. Will pose a challenge integrating with FPGA hardware
  ▪ Mitigation – Each develop our own small image recognition model

• Vitis AI
  ▪ Minimal documentation on Vitis, as well as a different workflow than typical software development
  ▪ Mitigation - The team immediately began research on Vitis documentation and will work with sponsors.
Questions?