Mi-V Virtual Summit Conference 2021

Key Takeaways From Porting A Computer Vision Application To The PolarFire SoC Icicle Kit

A Leading Provider of Smart, Connected and Secure Embedded Control Solutions

Presented by Alexander Wirthmueller

July 21, 2021

MPSI Technologies

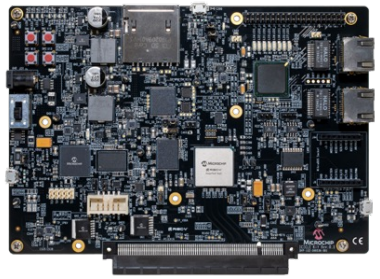
- **MPSI Technologies is a start-up based in Munich, Germany**
- **It was founded in 2016 to promote innovative ways of getting embedded software projects done faster and with better code quality**
- **Founder's background: electrical engineering and photonics (lots of *very* specialized hardware)**

Timeline:

- 2012-2016: Tasked to put a custom IR detector array to use in robotics research project; development of code generator to the side
- 2016-2018: Project becomes product Whiznium, covering wide range of embedded aspects, from FPGA's to Single Board Computers to Web User Interfaces
- 2018-2020: First revenue by applying Whiznium to customer projects
- 2020-today : Whiznium becomes Open Source project and use of the tool by external parties is encouraged

Whiznium: Leverage FPGA-SoC based hardware

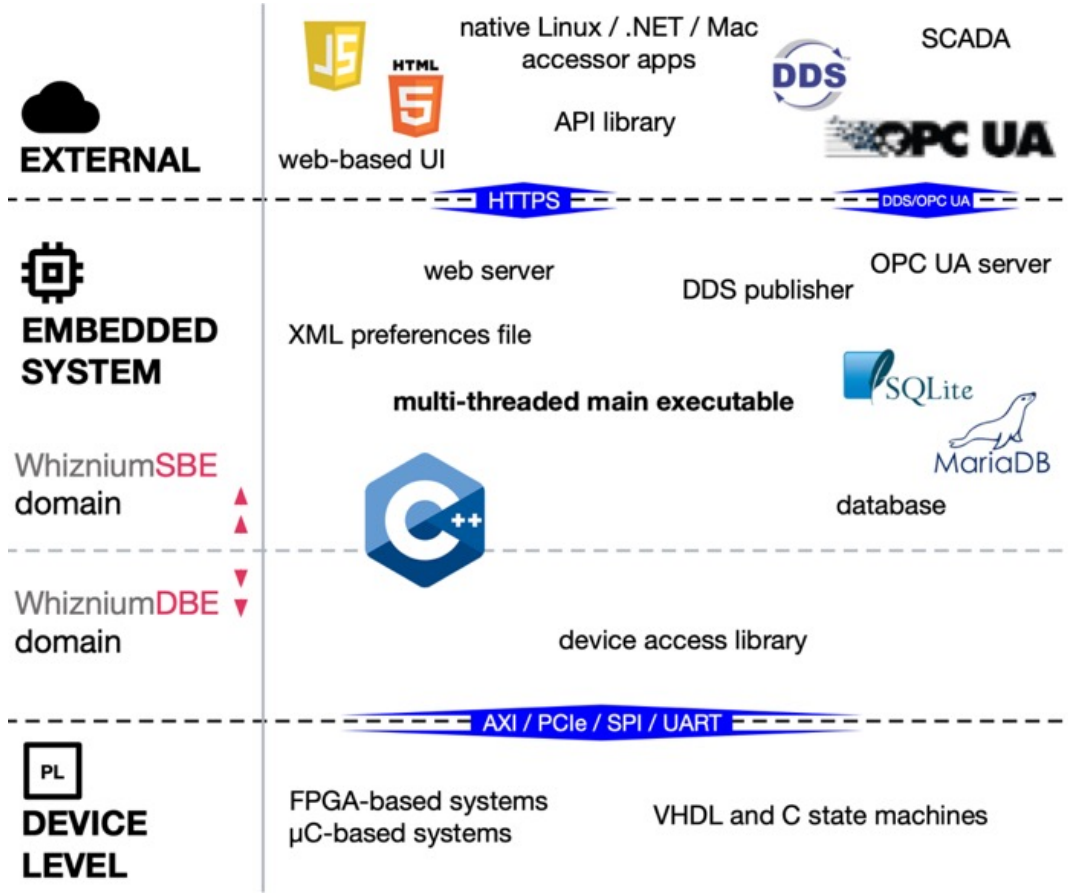
Microchip PolarFire® SoC Icicle Kit



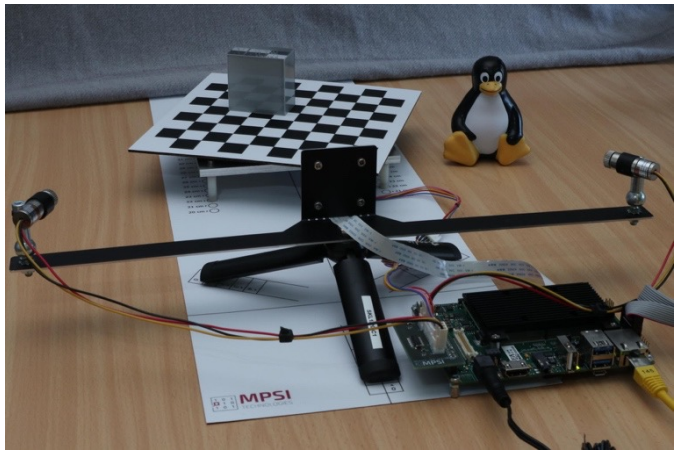
- Built around Microchip's PolarFire® SoC
  - quad-core 64-bit RISC-V CPU
  - NV-PL fabric with LE's, RAM and DSP's
- 2GB LPDDR4 RAM
- eMMC/SD permanent storage
- PCIe/Ethernet/USB/UART/CAN/SPI/I2C connectivity

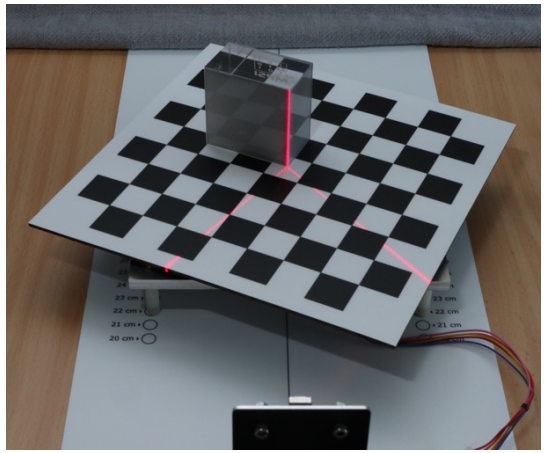
- Ready to run Embedded Linux

Software Development with Whiznium



Whiznium onboarding: Tabletop 3D laser scanner

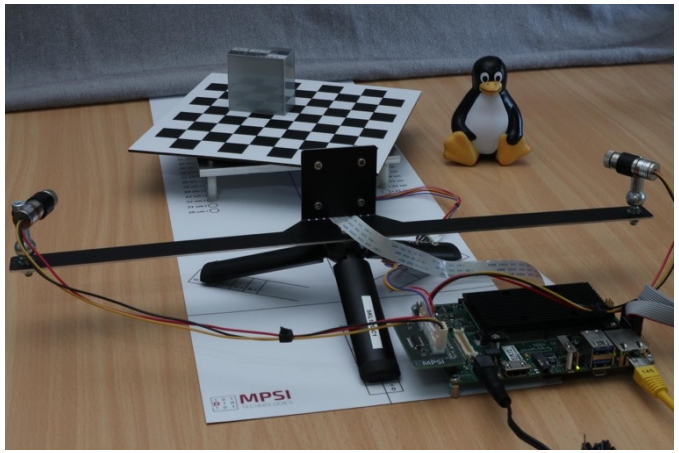


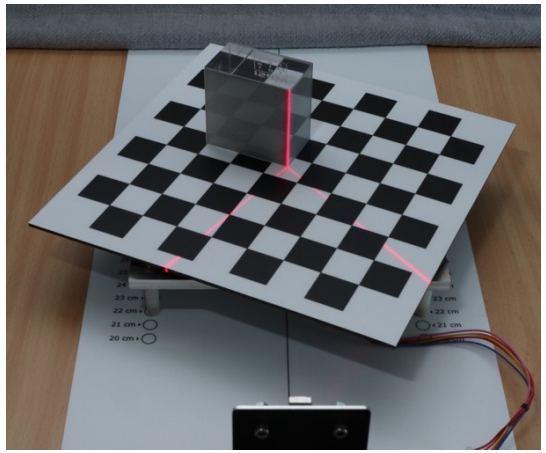


- ✓ Turntable driven by stepper motor
- ✓ Tripod-mounted camera + laser holder
- ✓ OV5640 five megapixels camera
- ✓ Two intensity-modulated red line lasers

NXP® i.MX6	Xilinx Zynq®	Microchip PolarFire® SoC	Intel Cyclone® V
- Toradex Apalis CoM on Ixora carrier board - Quad ARM Cortex-A9 (32-bit) - No FPGA	- Digilent® Cora Z7 development board - Dual ARM Cortex-A9 (32-bit) - SRAM-based FPGA	- Microchip® PolarFire SoC Icicle kit - Quad RISC-V (64-bit) - Flash-based FPGA	- Aries Embedded MCV SoM eval. Platform - Dual ARM Cortex-A9 (32-bit) - SRAM-based FPGA

Whiznium onboarding: Tabletop 3D laser scanner





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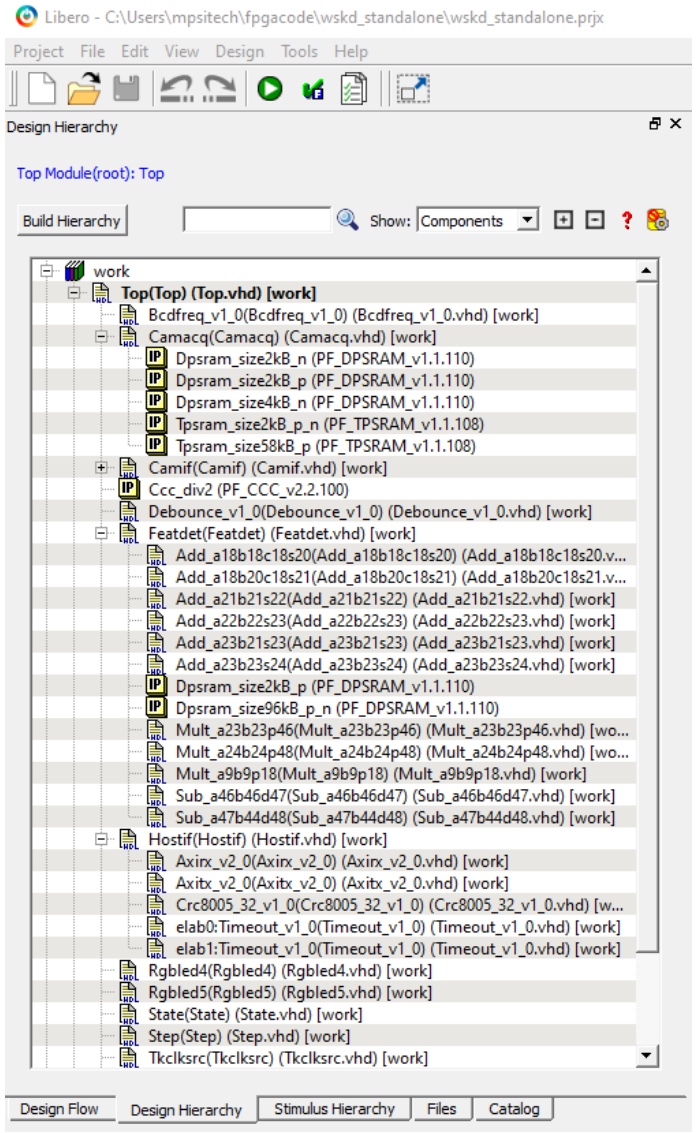
FPGA image processing: Libero® SoC workflow



Steps for Libero SoC:

- **Start out from existing (Zynq) VHDL code**
- **Replace e.g. DSP and memory primitives**
- **Re-write constraints file**

Step for System Builder:

- **Define MSS to allow for comms across AXI**

Conclusion:

- Straightforward port of RTL code
- Intuitive Libero SoC design flow
- MSS configuration greatly helped by tutorial series

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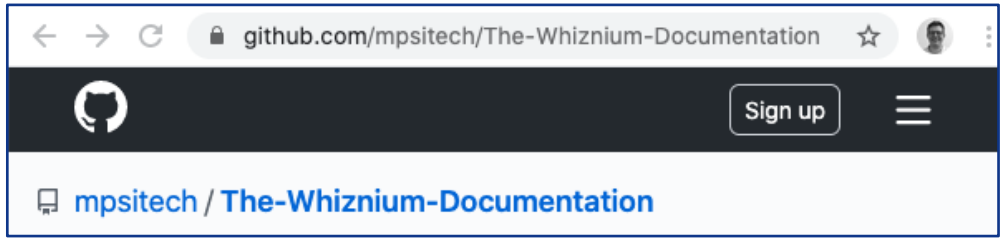
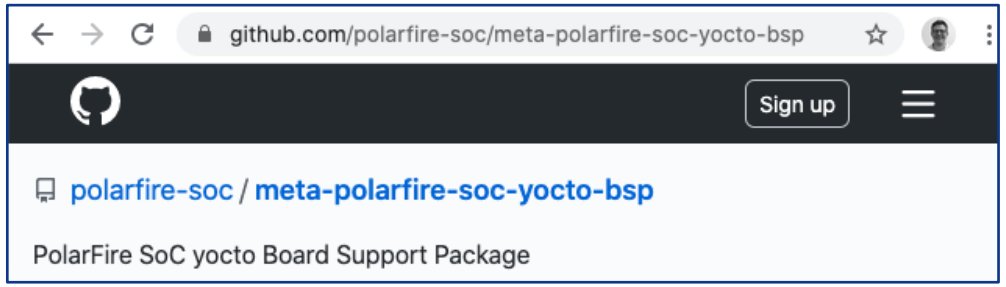
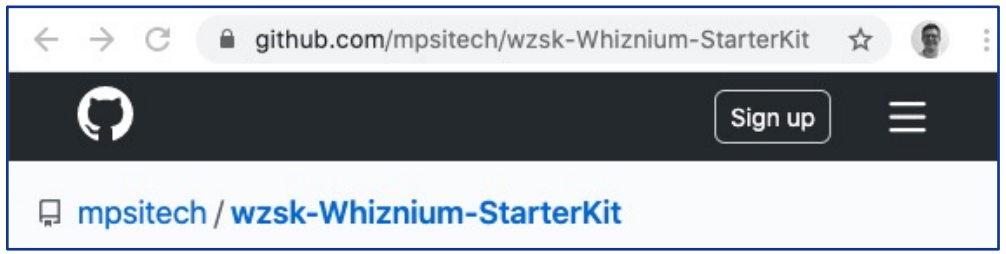
Embedded Linux with the Yocto® project







- Ingredients:
- Instructions from MPSI's GitHub account
- Microchip's Yocto BSP for the Icicle kit
- Custom device driver for PS-PL interconnect
- BitBake as part of the Yocto® project
- Cross-platform tabletop 3D laser scanner sources

```
root@icicle-kit-es:~# uname -a
Linux icicle-kit-es 5.6.16 #1 SMP Tue May 4 17:53:06 UTC 2021 riscv64 riscv64 riscv64 GNU/Linux
```

Conclusion:

- Except for custom driver, no adaptations required (!)

Tabletop 3D laser scanner: Software impressions

```
root@icicle-kit-es:~/whiznium/bin/wzskcmbd# ./Wzskcmbd
Welcome to Whiznium StarterKit v1.0.5!
        starting 4 job processor threads ... {19255, 19256, 19257, 19258} success
        starting 1 operation processor threads ... {19259} success
        starting application server ... success
        starting OPC UA server ... success
Initialization complete.

Wzskcmbd >> showJobs
        + RootWzsk (1)
                - JobWzskSrcV4l2/SRV (2)
                - JobWzskSrcSysinfo/SRV (3)
                - JobWzskSrcFpga/SRV (4)
                + JobWzskIprTrace/SRV (5)
                        - JobWzskActLaser/CLI (6)
                        - JobWzskSrcV4l2/CLI (7)
                + JobWzskIprCorner/SRV (8)
                        - JobWzskSrcV4l2/CLI (9)
                + JobWzskIprAngle/SRV (10)
                        - JobWzskIprCorner/CLI (11)
                - JobWzskActServo/SRV (12)
                - JobWzskActLaser/SRV (13)
                + JobWzskActExposure/SRV (14)
                        - JobWzskSrcV4l2/CLI (15)
                + JobWzskAcqPtcloud/SRV (16)
                        - JobWzskIprTrace/CLI (17)
                        - JobWzskActServo/CLI (18)
                + JobWzskAcqPreview/SRV (19)
                        - JobWzskSrcV4l2/CLI (20)
                + JobWzskAcqFpgapvw/SRV (21)
                        - JobWzskSrcFpga/CLI (22)
                + JobWzskAcqFpgaflg/SRV (23)
                        - JobWzskSrcFpga/CLI (24)
                + M2msessWzsk (25)
                        - JobWzskSrcSysinfo/CLI (26)
                        - JobWzskIprTrace/CLI (27)
                        - JobWzskIprCorner/CLI (28)
                        - JobWzskActServo/CLI (29)
                        - JobWzskActExposure/CLI (30)
                        - JobWzskActLaser/CLI (31)
                        - JobWzskAcqPtcloud/CLI (32)
                        - JobWzskAcqPreview/CLI (33)

Wzskcmbd >>
```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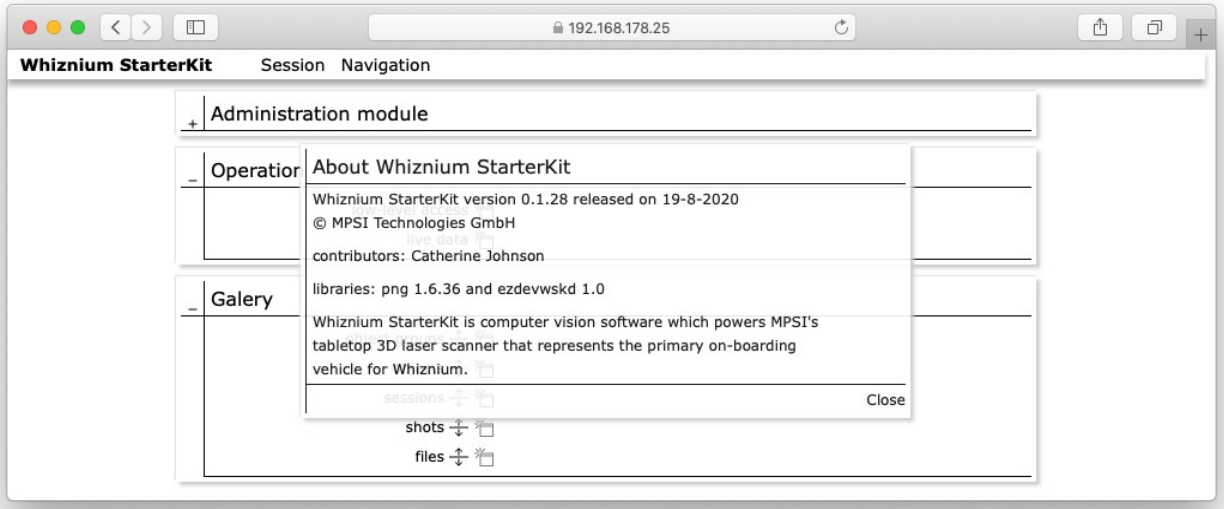

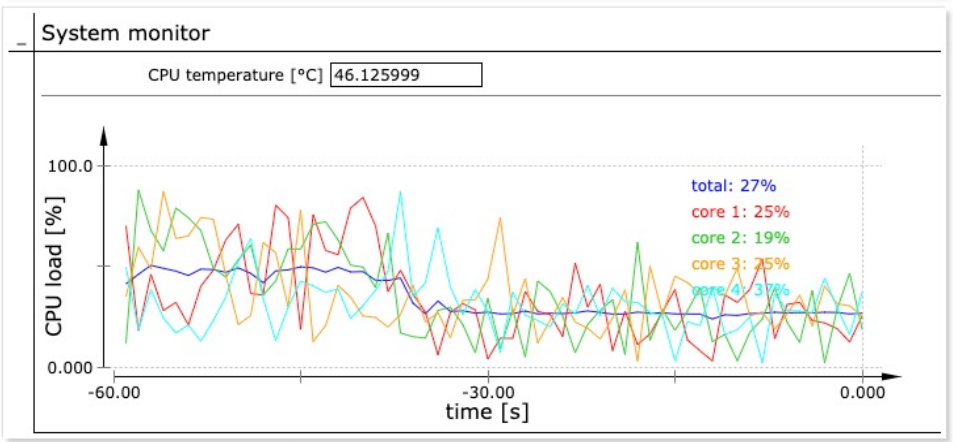

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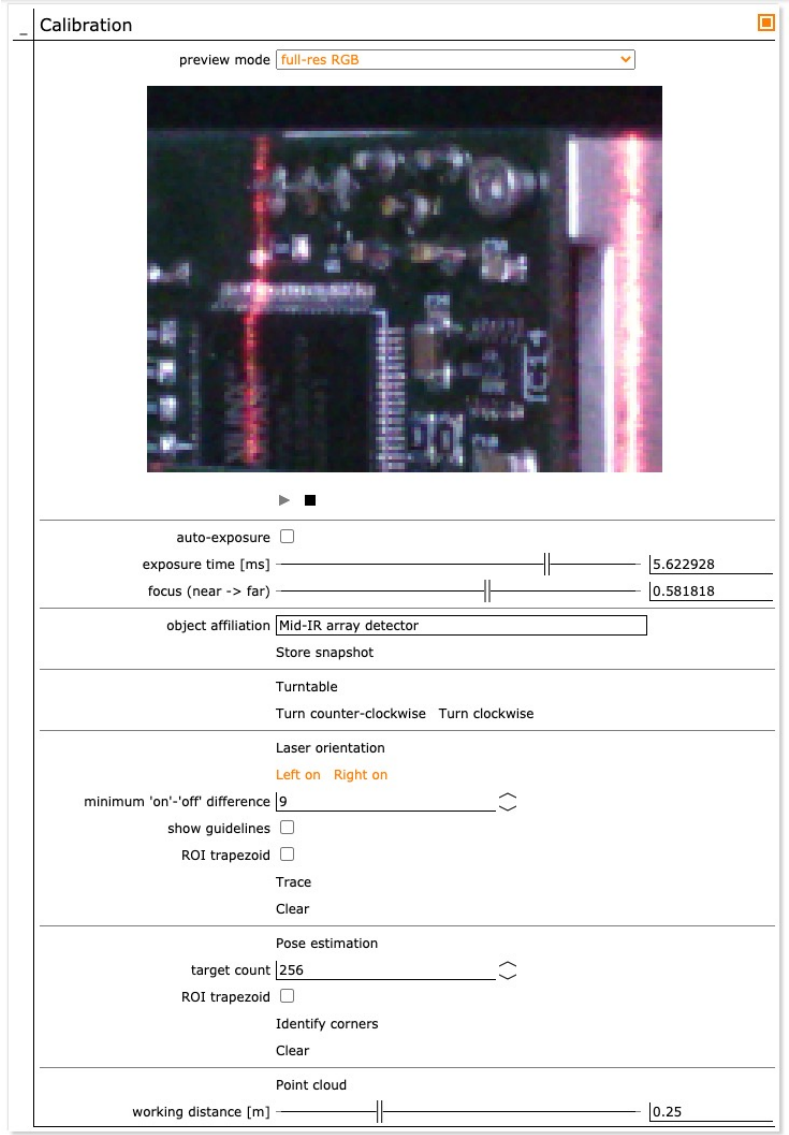

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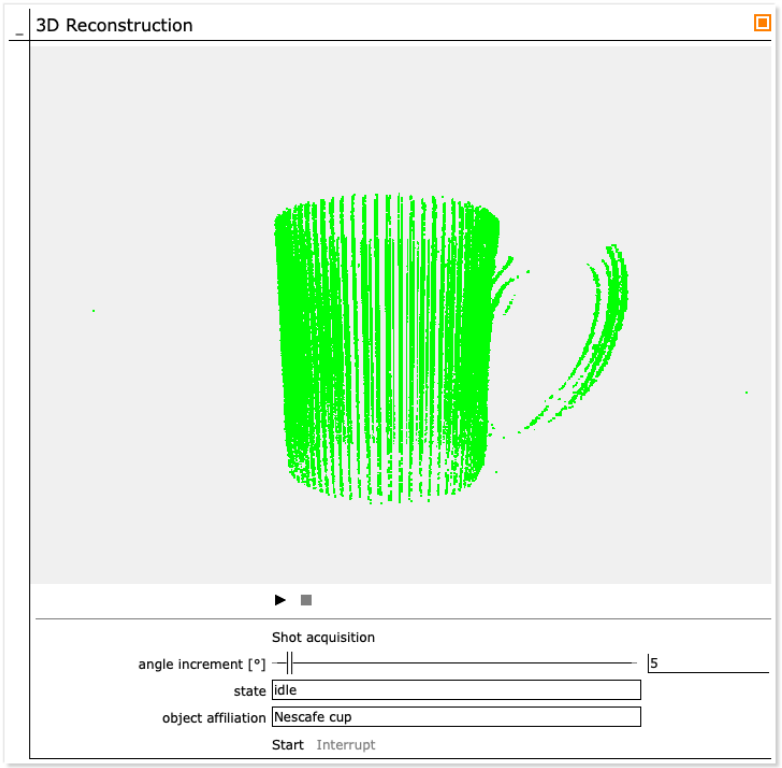

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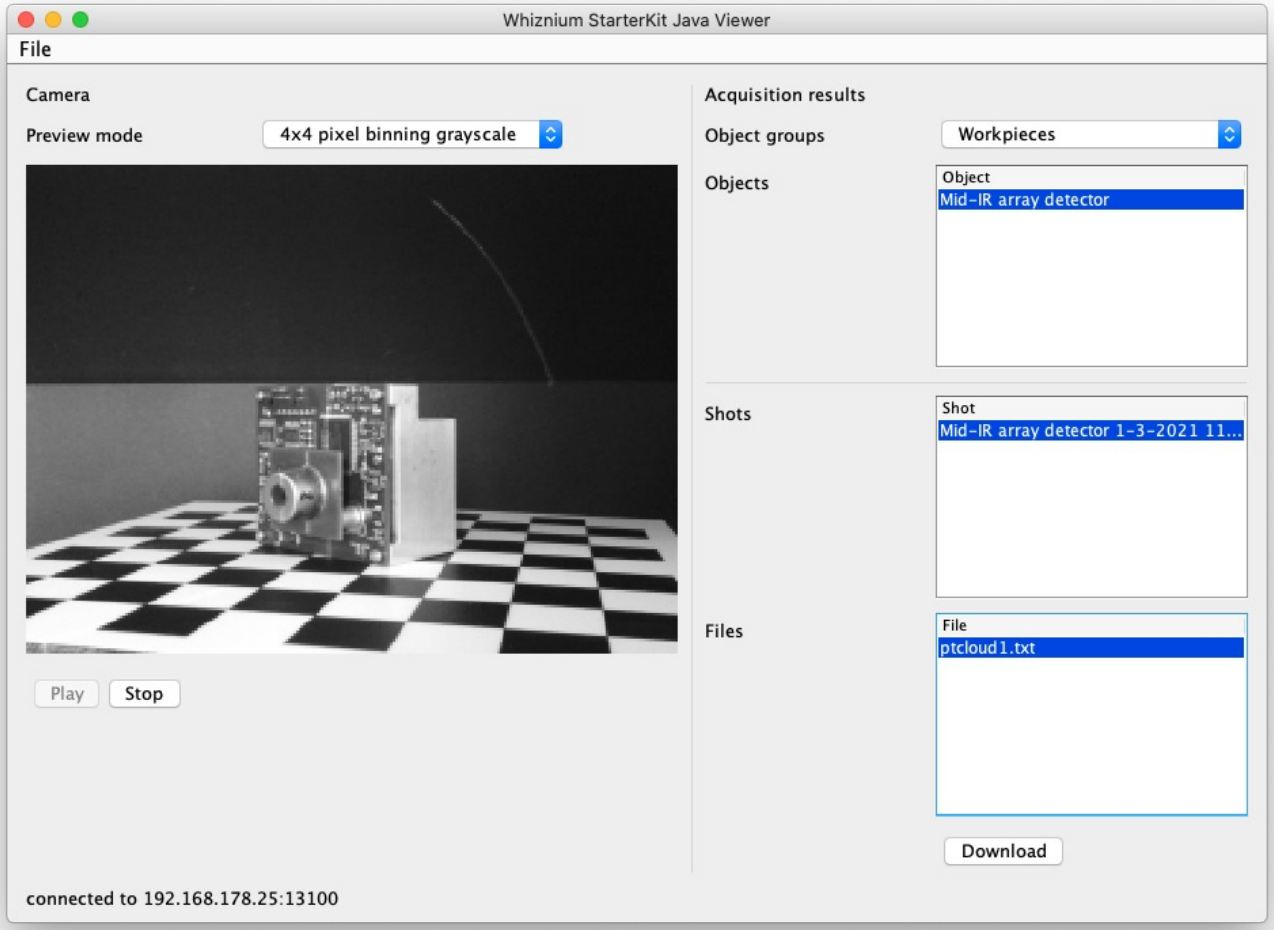

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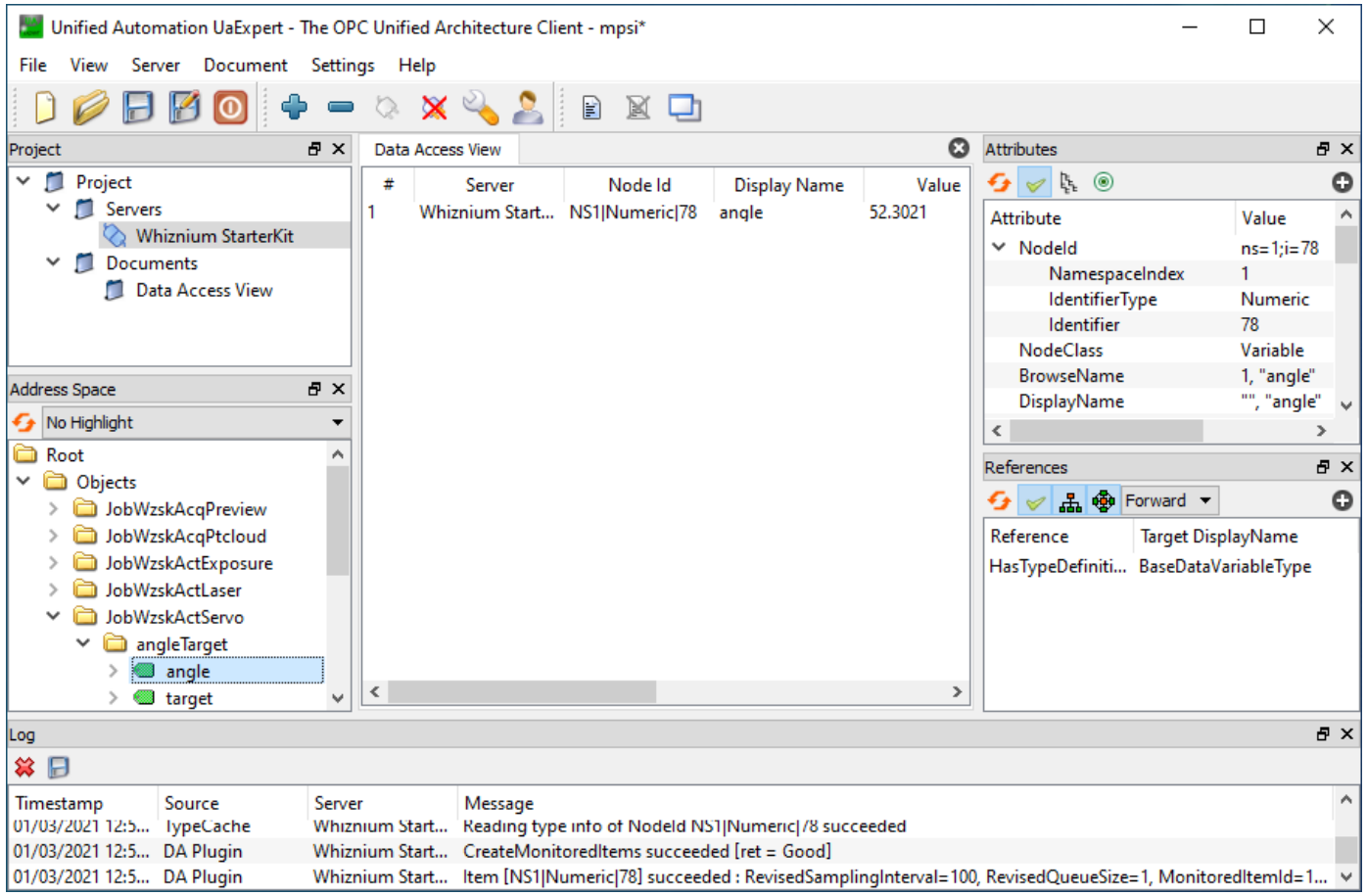

Thank You

Get in touch: contact@mpsitechnologies.com