Towards a RISC-V Educational HW Lab

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An ARM-based Educational HW Lab

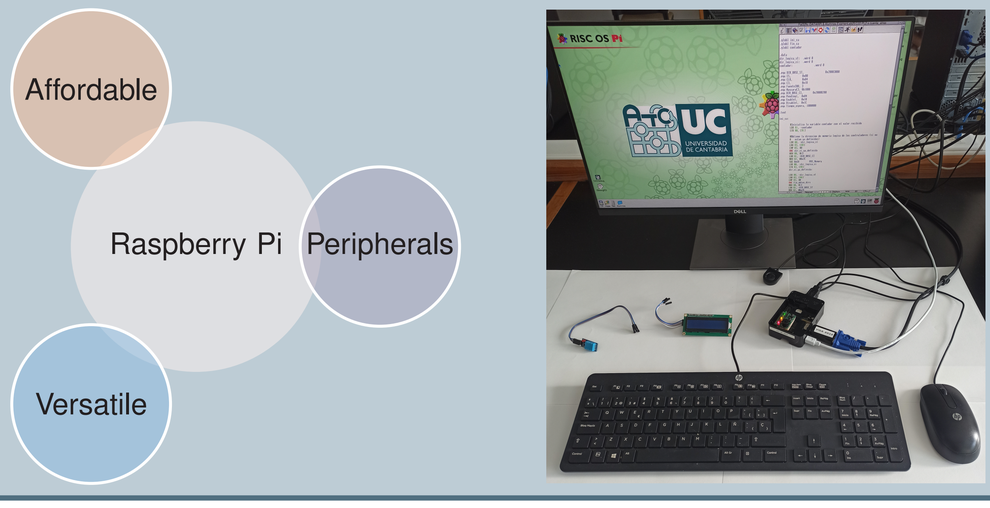
Motivating the students

Basic CPU architecture concepts are hard to engage with

Using physical devices helps to understand how Hardware works

→ An autonomous lab setup based on physical devices **motivates students**

A Raspberry Pi-based HW Setup

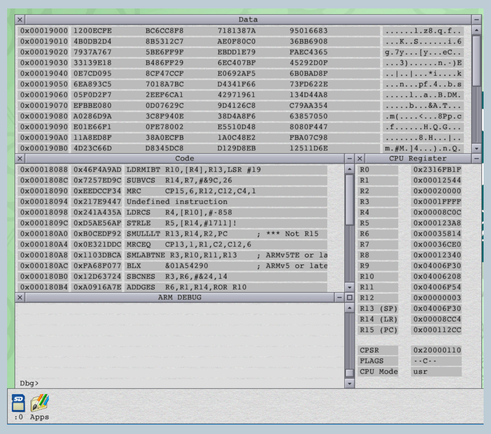


RISC OS/UCDebug

GUI and simplified **peripheral management** is crucial for an initial approach to HW

RISC OS: ARM-developed OS with easy HW access

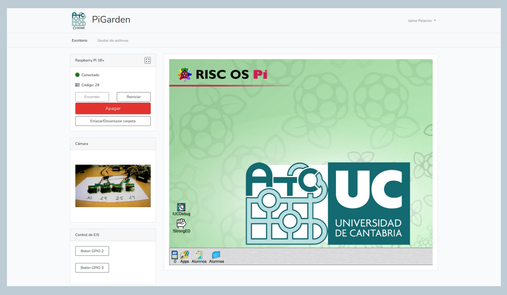
UCDebug: in-house developed tool capable of debugging interrupt handlers

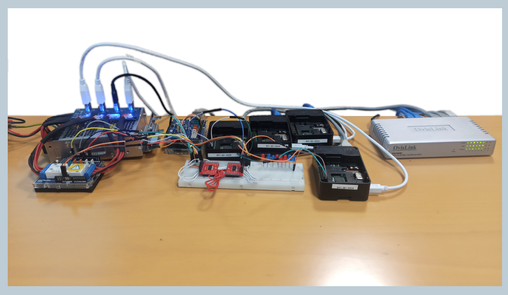


PiGARDEN: remote access to Raspberry Pi lab

Pi boards are currently difficult to acquire. PiGARDEN offers:

- Handling of GPIO pins
- Live stream of the peripherals
- Easy file sharing with boards
- Board allocation in time slots



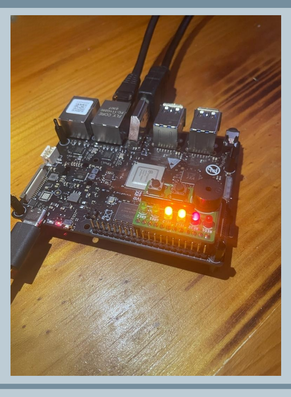


Towards RISC-V

RISC-V Boards

SiFive VisionFive

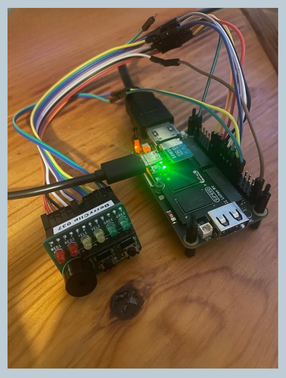
Main Specs:
- CPU: StarFive JH7110 (RV64GC)
- RAM: 4GB / 8GB LPDDR4
- Storage: FLASH + SD slot + MVNe
- Conectivity: 4xUSBs + HDMI + 2xRJ45
- GPIO: 40 pins
- Price: 65$ - 85$



Board summary/Evaluation: easy to setup, complete CPU user manual, better performance, same GPIO pinout as Raspberry Pi

Sipeed Lichee RV

Main Specs:
- CPU: CPU: Allwinner D1 - Alibaba Xuantie C906 (RV64GCV)
- RAM: 512MB / 1GB DDR3
- Storage: FLASH + SD slot
- Conectivity: USB + HDMI
- GPIO: 40 pins
- Price: 25$ - 45$



Board summary/Evaluation: easy to setup, complete and easy to read CPU manual, good quality-price ratio, accessible, small size

SW environments

Operating Systems and development software

Linux-based distros available for both boards: Debian & Ubuntu (official)
- Distro images with GUI, which enables an autonomous setup without an external PC
- Images of newer versions of Linux kernel without GUI
  ⇒ Board communication through ssh

GNU development tools available for both boards:
- `gcc` to generate executable files (compile/link phases)
- `gdb` to debug user-generated programs

Completed goals

- Driver to control GPIO as a kernel module
- Communication interface via IOCTL to make use of the GPIO from user space (adds overhead due to ioctl cost)
- Driver test programs with simple peripheral devices

Next steps

- Recompiling Linux kernel to add a system call to map physical addresses into user space
  ⇒ Manage peripheral controllers directly from user programs
- Testing other OS's such as Haiku OS; currently testing ports to VisionFive2

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Conclusions

OS availability for RISC-V has risen as the ISA garners interest and adoption, although OS support varies between devices. The VisionFive and Lichee RV boards support general Linux distros, such as Debian or Fedora, and purpose-built platforms such as Tina7 or Waft8.
Early results show promise: the boards are capable of running a modern OS autonomously and our tests on managing peripheral devices have been succesful. Our next step is to find the desired SW features in an OS that can be booted in a RISC-V board.