向中国中小公司
引入自动化

BRINGING AUTOMATION
IN THE SMALL ENTERPRICE IN CHINA

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中小企业自动化现状

Current status of automation in small and medium-sized enterprises

第一个问题

First question

- 为什么小公司没有机械臂将简单流程自动化？
- **Why are there no robotic arms in the small company to automate simple processes?**

答案：

Answers:

虽然生产机械臂的中国企业很多，但小公司没有机械臂的主要原因是：

- 高成本
- 需要聘请专业工程师
- 复杂操作系统壁垒（**LINUX**）
- 要执行的复杂动作的编程语言（**ROS**）难度大
- 难以适应小批量生产的变化
- 以及许多隐藏成本

Although there are many Chinese companies that produce robotic arms, the main causes are:

- High cost

- Requires the employment of specialized engineers

- Complex operating system (LINUX)

- Programming languages of complex actions to be carried out (ROS)

- Difficulty in adapting the changes for small production batches.

- Many hidden costs.

成本很高，是因为...

The cost is high because ...

- 市面上的机械臂通常使用在 LINUX 系统上运行的 ROS（机器人操作系统）软件
- ROS系统是美国的
- 管理软件需要大量投资才能与中国生产的工业机器人对接
- ROS比较复杂，必须使用LINUX操作系统中的功能
- LINUX的专业技术人员成本高，有经验技术人员很难找

Typically they use ROS (Robot Operating System) software which runs on LINUX systems.

The ROS system is US.

The management software required large investments to make it interfaceable with the industrial robot produced in China

ROS Is complex and must use the functions of the LINUX Operating System

LINUX's expert technicians cost a lot and are hard to find with experience

当前自动化操作系统

Current automation operating systems

什么是Linux？
What is Linux?

- 如今市面上有无数版本的 Linux
- Linux 是一个开源操作系统，定义为 TRUE REAL TIME（真正实现实时操作）
- 它用于需要实时功能的应用程序中

Today there are countless versions of Linux.

Linux is an OPEN SOURCE operating system defined TRUE REAL TIME.

It is used in applications, where the real time functions are required.

什么是Linux？
What is Linux?

- Linux 的众多版本往往互不兼容，而且更新非常频繁
- Linux 具有高度的可靠性，用于大型机和互联网服务器
- 因此，它用于必须运行连续性的工业自动化中

The countless versions of Linux are often not compatible with each other and are updated very frequently.

Linux has a high level of reliability and is used in mainframes and internet servers.

Consequently it is used in industrial automation where operational continuity is mandatory.

Linux 在机器人工业生产中无处不在
Linux is everywhere in robotic industrial production

在如图所示的自动化过程中，机器人必须全天24小时可靠且完美运行。不允许出现任何故障。最小的故障都会阻塞整个生产流程。而且有大量工程师参与监控和控制每个机器人以实现完美功能。

In an automation process like the one shown, everything must work perfectly and must be reliable to operate 24/7. No malfunctions are allowed. The smallest malfunction blocks the entire production process. A large number of engineers are involved in monitoring and controlling the perfect functioning of each individual robot.

但在小型企业中，高可靠性是必须的吗？

In the small business, high reliability is needed?

- 而小型企业需要的是一个易于编程和更新编程的灵活系统
- Linux 专家的成本是不可持续的
- 小批量生产，经常需要修改生产周期，因此需要修改机器人配置

In small businesses, you need a flexible system that is easy to program and reprogram.

The cost of a Linux expert is not sustainable.

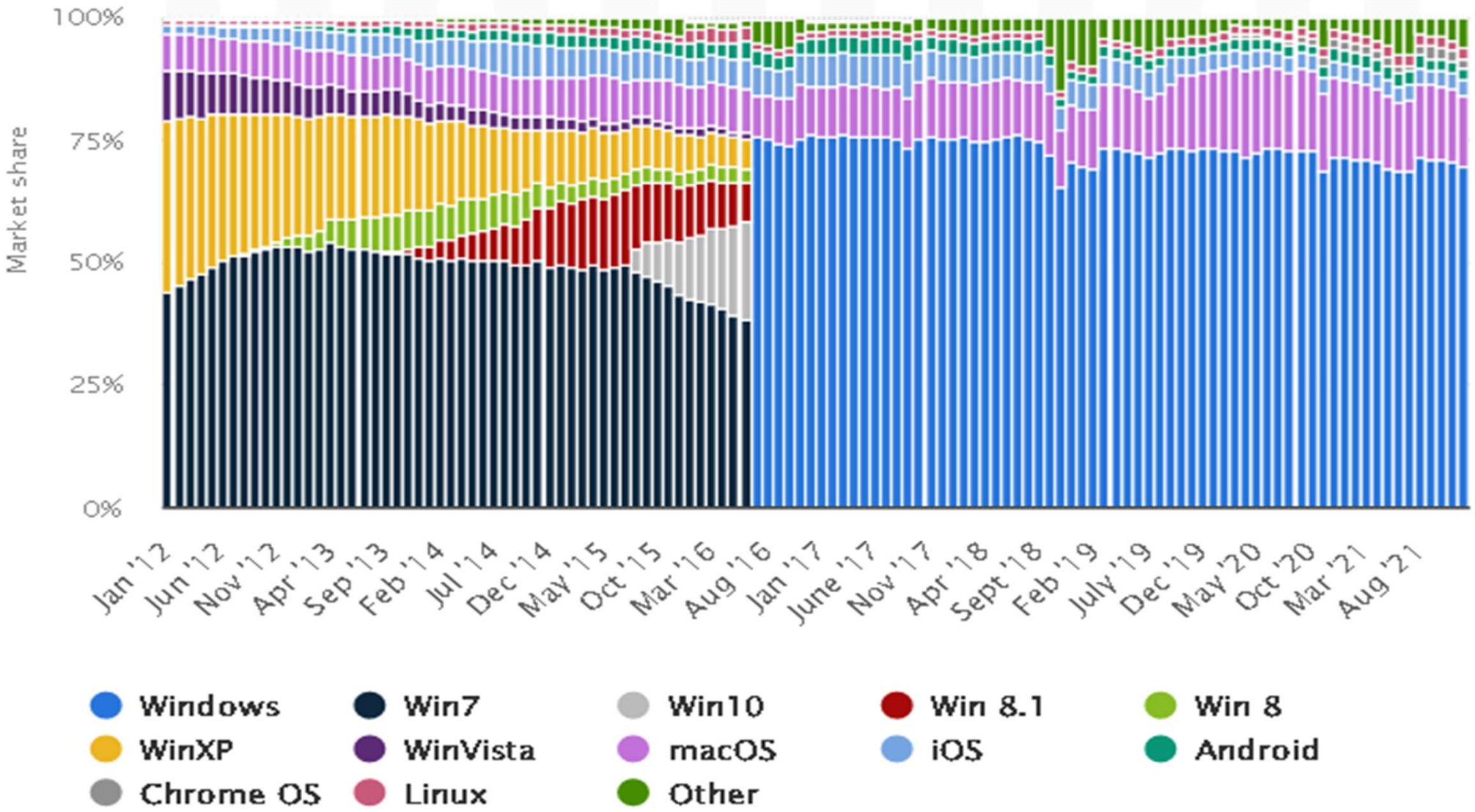
Small batches are produced, with frequent need to modify the production cycle and consequently the robot.

Theremino替代方案优势

The alternative Theremino System.
Advantages and benefits.

我们有替代方案

There is an alternative



Windows 操作系统是最广泛和最知名的操作系统。

The Windows operating system is the most widespread and well-known of all.

采用Win10系统
We use Windows 10

- **Windows** 是有史以来最常用的操作系统。
- 它使用现代处理器，程序执行速度很快，该速度足以驱动 **COBOT(**工业协作机器人**)** 作为 **LINUX / ROS** 的替代品。

Windows is the most used operating system ever.

With the modern processors available, the execution speed of the programs is high, this speed is more than enough to drive COBOT as an alternative to LINUX / ROS.

我们有替代方案
There is an alternative

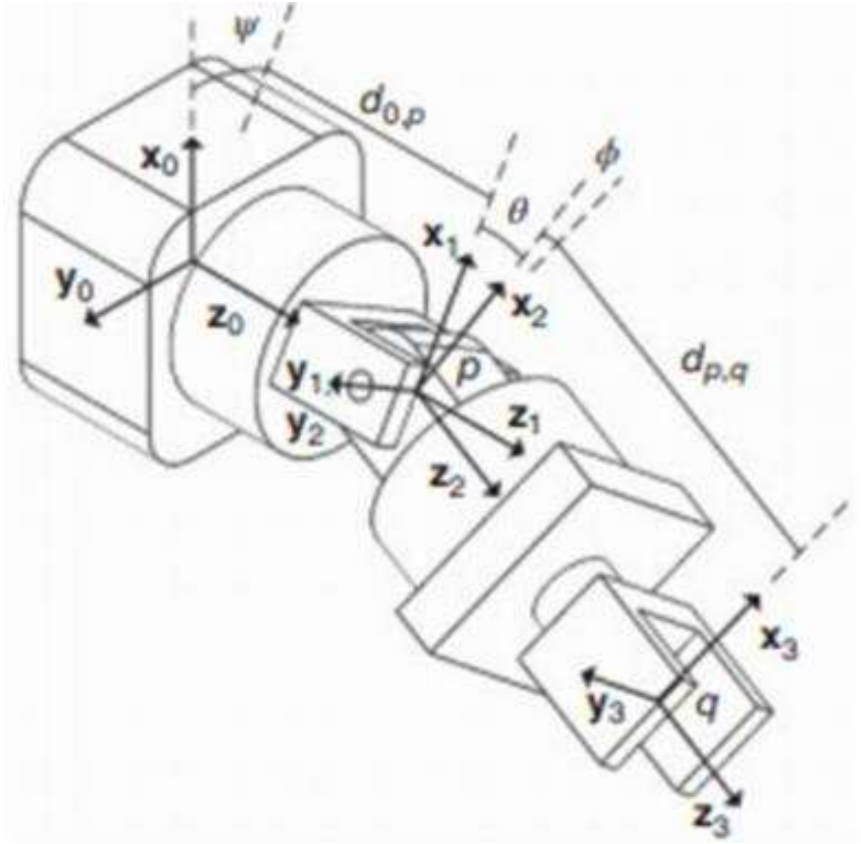
- 在所有中小型企业中，都有使用安装 **Windows** 系统的个人计算机
- 企业中也都有知道如何使用 **Excel**、**Word**、**Power Point**、**email**、网络浏览器的人的人，也会复制、粘贴并了解基本的几何和数学知识。

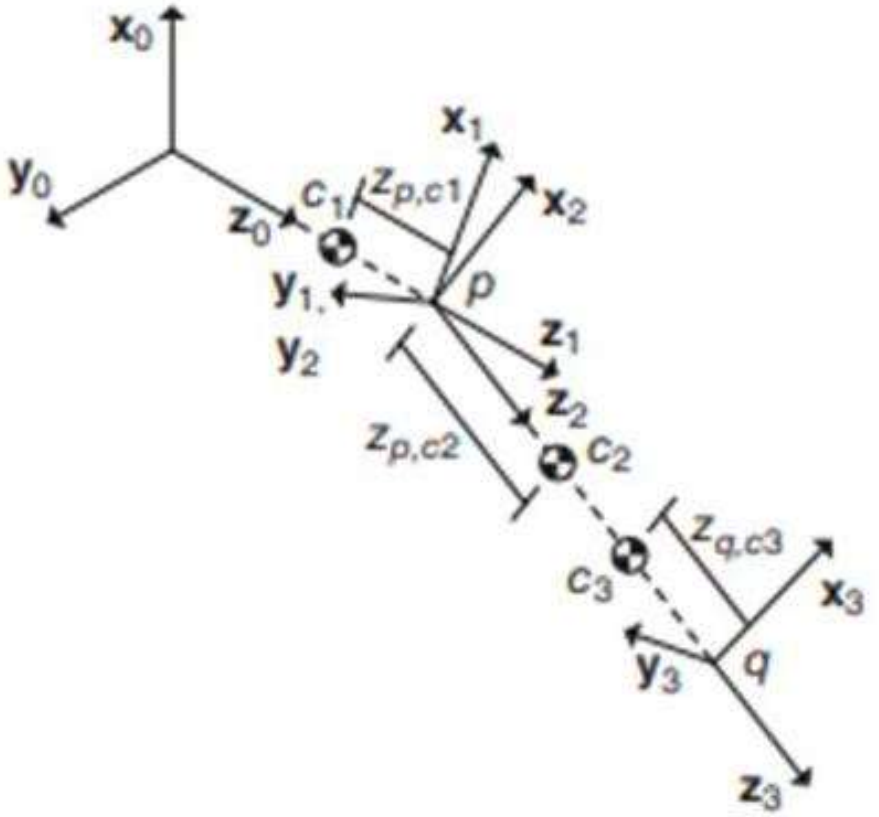
In all small and medium-sized businesses there are people who use a personal computer with Windows.

Those who know how to use Excel, Word, Power Point, web browser, email can copy, paste and know basic geometry and mathematics.

我们让机器人自动化变得简单

Now, language of automation is for specialized engineers





这种过于复杂的专业技能和知识，还是留给大公司的工程师吧！

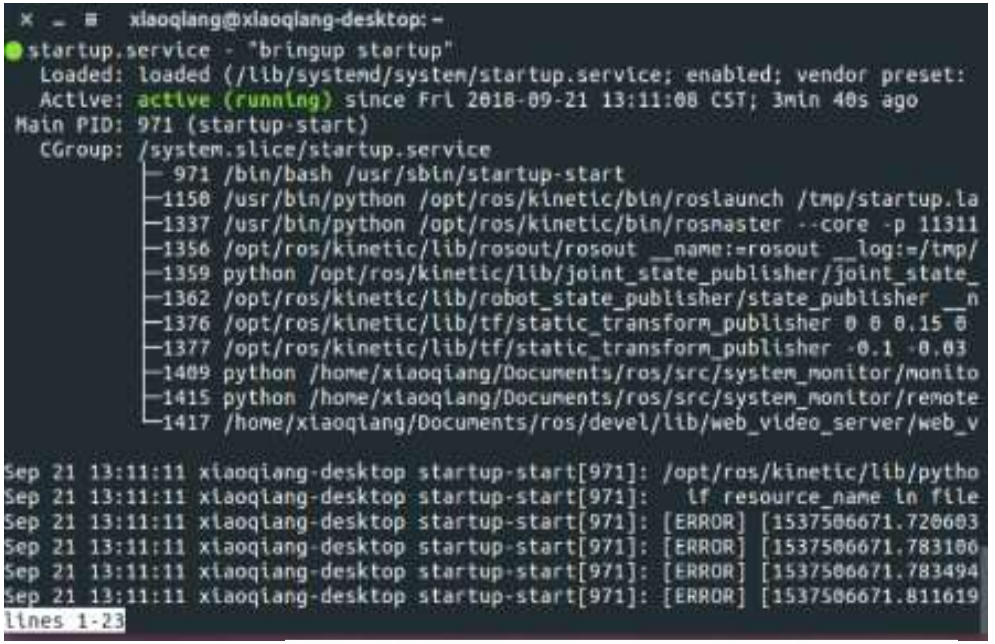
This type of expertise and knowledge, let's reserve it for engineers of large companies.

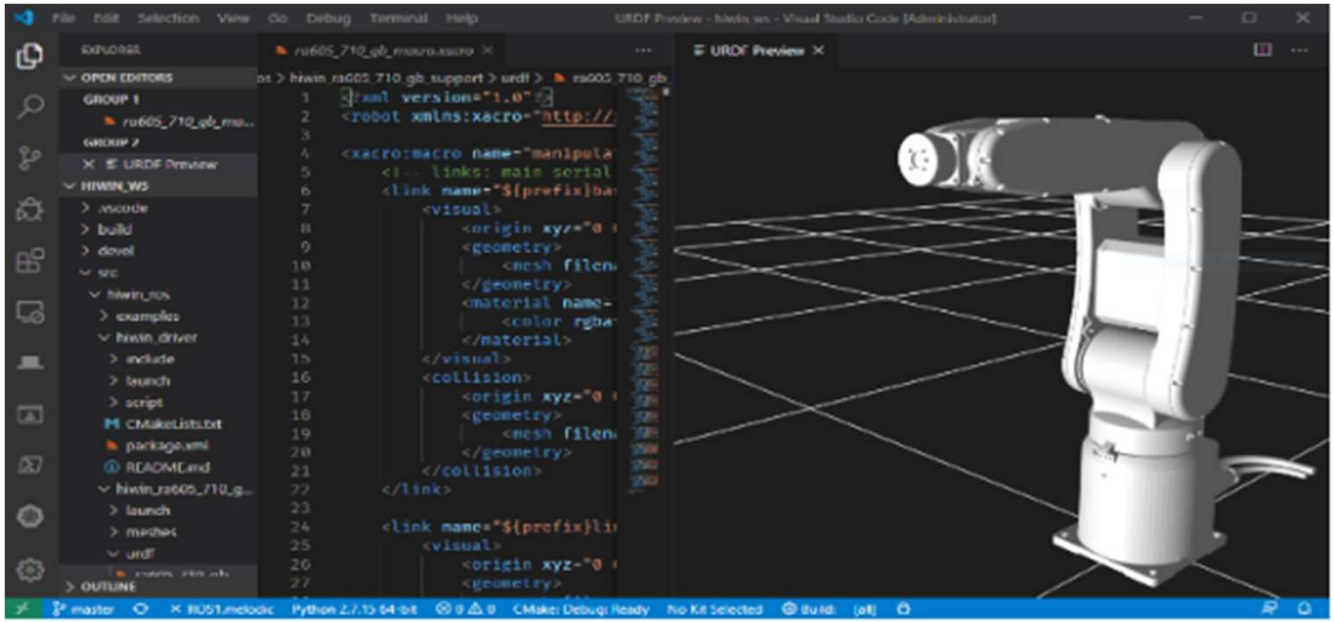
我们让机器人自动化变得简单
Now, language of automation is for specialized engineers

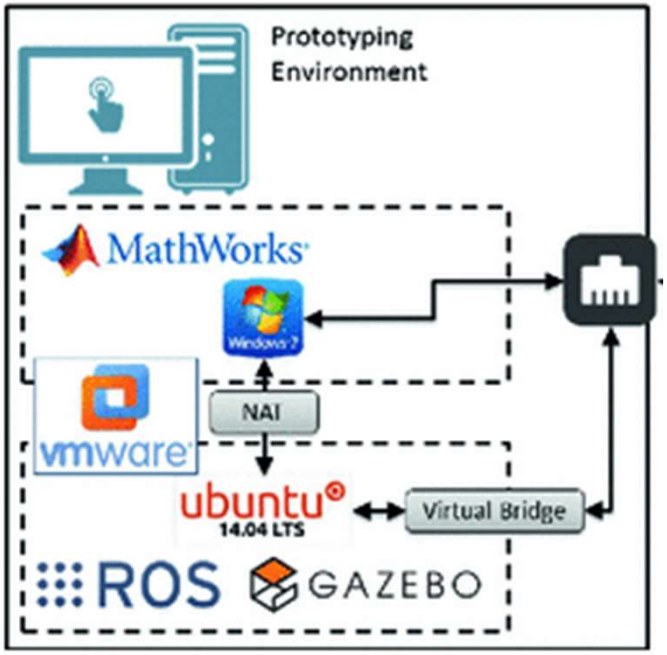
- 只有具有高水平教育、专业知识和经验的工程师才能处理这些软件工具，而且这些软件大多来自美国
- 只有机器人公司的专家知道如何最好地管理他们的机器人

Only engineers with a high level of education, expertise and experience can handle these software tools, mostly of US origin.

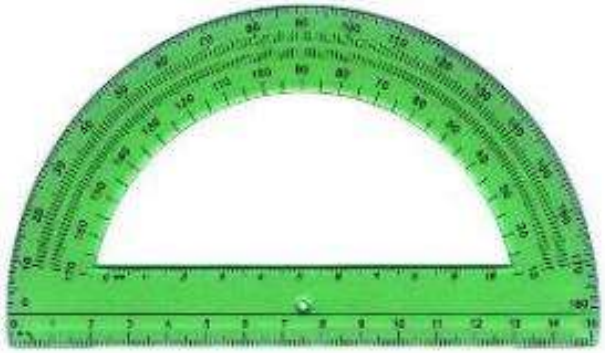
Only the expert of the companies that produce the robots know how to best manage their robots.

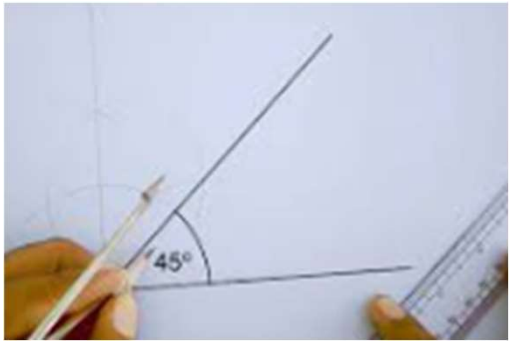






我们让机器人自动化变得简单
We make automation with robot simple





- 没有接受过高水平教育的人也知道角度和以毫米为单位的测量值
- 每个人都知道如何绘制 **45** 度角
- 这种类型的能力，再加上使用个人计算机的一般知识，任何人都会操作开源的 **THEREMINO** 系统对机械臂的运动进行编程

It is not necessary to have a high level of education to know angles and measurements in millimeters.

Everyone knows how to draw a 45 degree angle.

This type of competence, added to the normal experience of using a personal computer, allows you to program the movements of the robotic arm with the OPEN SOURCE THEREMINO system.

我们让机器人自动化变得直观
We make process automation intuitive

- 为了指导机器人进行动作，我们可以用手移动它。 在每个重要的位置点上，只需要按下一个按钮（或一个脚踏开关来解放你的双手），如图所示，每个点都能以角度值直接存储。

To instruct the robot in the movements to be made, we move it by hand. At each important point, you press a button (or a footswitch to have your hands free).

Each point is stored directly with values in angles, in a sequence as shown.

COB_SENTEL_DEMO

```
'  SENTEL DEMO SEQUENCE M
'          M1       M2
'╟──────────────────────
Move8 +000.000 +000.000
Move8 +044.781 +044.992
Move8 +089.998 -089.996
Move8 -135.004 -134.464
Move8 +179.895 -179.989
Move8 +000.000 +000.000
Move8 -179.992 +179.999
Move8 +159.996 -159.959
Move8 -117.023 -135.304
Move8 +179.974 +178.013
Move8 +000.000 +000.000
Move8 +175.021 +175.031
Move8 -112.994 -119.987
Move8 -135.025 +145.024
Move8 +135.018 +135.018
Move8 +059.994 -059.983
Move8 +089.995 +090.013
Move8 +000.000 +000.000
Move8 -179.984 +179.986
Move8 +159.991 -159.959
Move8 -117.017 -135.311
Move8 +179.967 +178.021
```

机器人与协作机器人有什么区别？

Robot – COBOT - what is the difference

- 机器人是一种经过编程的自动化机器，可以在没有人工控制的情况下执行重复性任务
- 协作机器人是一种人工智能机器人，可以与人类工人一起安全地执行任务。
- 当操作员靠近时，机器人会减速停止
- 即使与操作员发生最轻微的意外接触时，它也会立即停止

A robot is a programmed autonomous machine that performs a repetitive task without human control.

A COBOT is an artificially intelligent robot that performs tasks in conjunction with human workers safely.

When an operator approaches, the robot slows to a stop. At the slightest accidental contact with the operator, it stops immediately.

小型协作机器人
The small robot – COBOT

- 通常，市场上最小的 协作机器人的平均负载能力为 **3kg**
- 这是巨大的负载能力，能够提供足够支撑和可靠锚固
- **协作机器人**的重量通常在 **12** 到 **18** 公斤之间，因此需要有足够的支撑

Usually, the smallest COBOTs available on the market have an average load capacity of 3 kg.

This is an excessive load resulting in adequate support and solid anchoring.

Even the weight of a COBOT is typically between 12 and 18 kg, therefore it is necessary to have adequate and sold support.

我们为中小企业提供了全新的自动化方式
We offer a new way of automation for small businesses

- 东莞某公司正在开发一种创新的小型、强劲、低成本的关节电机
- 这种类型的电机非常适合构建适合负载约半公斤的，符合小型企业需求的协同机器人
- 希望其他公司能尽快制造出类似的联合电机，因为这类电机将打开巨大市场

A Dongguan company is developing an innovative small, powerful and economical joint motor.

This type of engine is perfect for building COBOTs suitable for the needs of small businesses with a load of about half a kg.

It is hoped that other companies will soon build similar joint motors, as the market that opens up is enormous.

小型机械臂
Small robot arm

- 东莞开发的机械臂原型机具有优良的机械和电子特性
- 使其成为一款优秀的小型机械臂。要成为协同机器人，需要添加一系列与安全处理和执行速度相关的更新以及全新的软件功能

The robotic arm prototype developed in Dongguang has excellent mechanical and electronic characteristics that allow it to be a good small robot arm. To become a COBOT, is needed to add a series of updates and new software functions related to safe handling and speed of execution.

我们对“小型协同机器人”的愿景

Our vision of the "small COBOT"

- 我们认为，一个**协同机器人**必须有 **7** 个关节电机才能简化机器人的动作，使它们尽可能地模拟人类动作
- 我们希望生成一个系统，为小型**协同机器人**的指令执行提供信息
- 首先，我们需要分发开源的 **协同机器人**管理软件以支持想要生产小型**协同机器人**的公司
- 在政府的支持下对感兴趣的公司组建起一个联盟

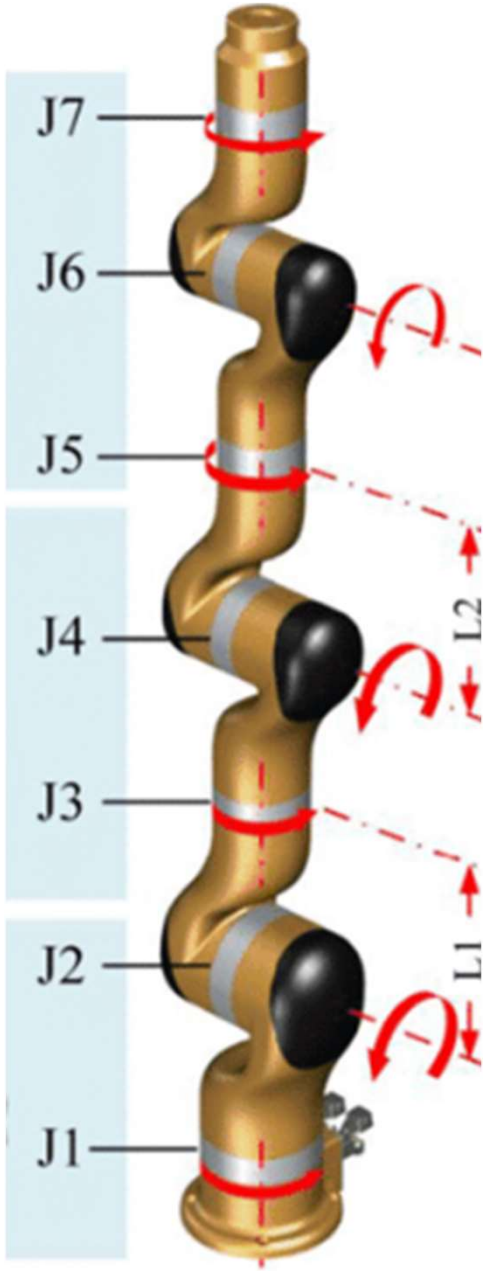
We believe that a COBOT must have 7 joint motors in order to simplify the robot's movements, making them more similar to human movements as possible.

We want to generate a system providing information for the implementation of small COBOTs.

First of all, the distribution of the OPEN SOURCE COBOT management software.

Supporting companies that want to produce small COBOTs.

Generate a consortium of interested companies, with the support of the Government.



原型

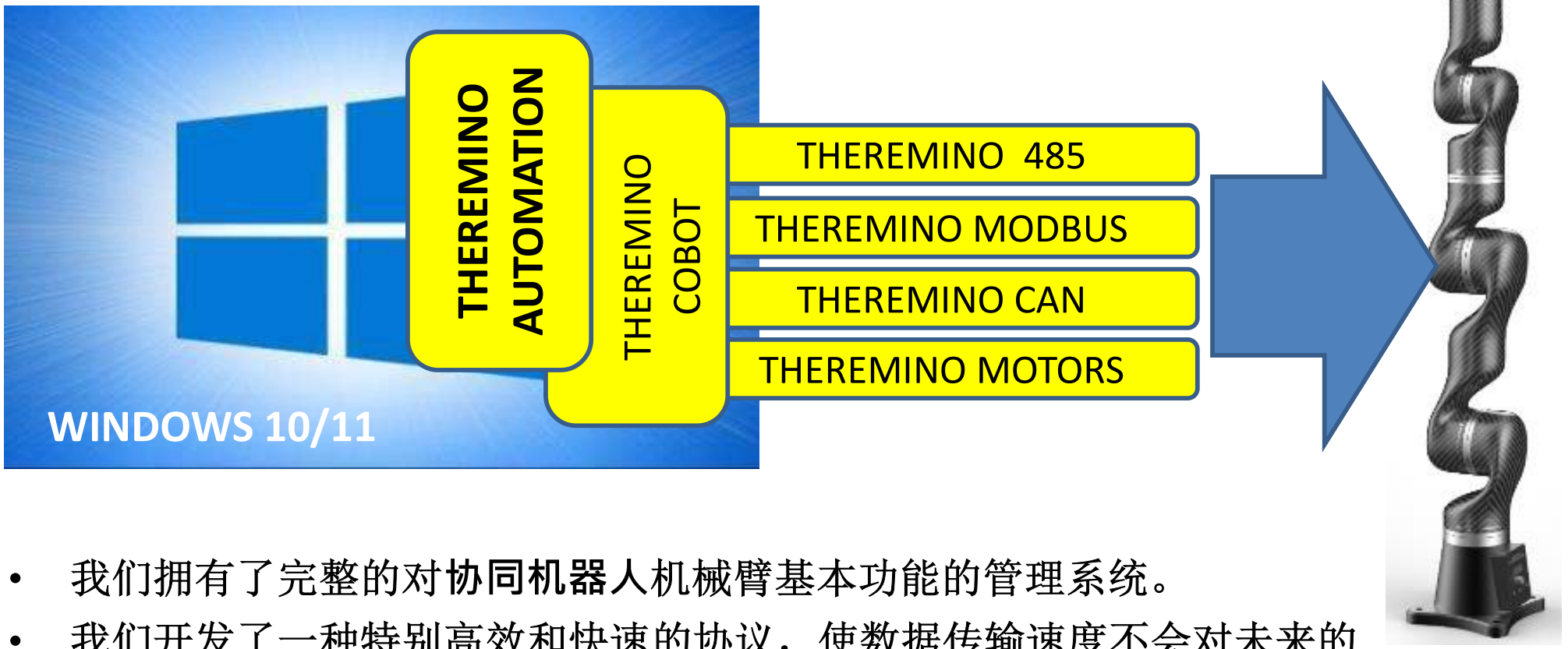
The prototype

机械臂原型

Some images of the robotic arm prototype

我们对“小型协同机器人”的愿景 - 软件方面

Our vision of the "small COBOT“, the software



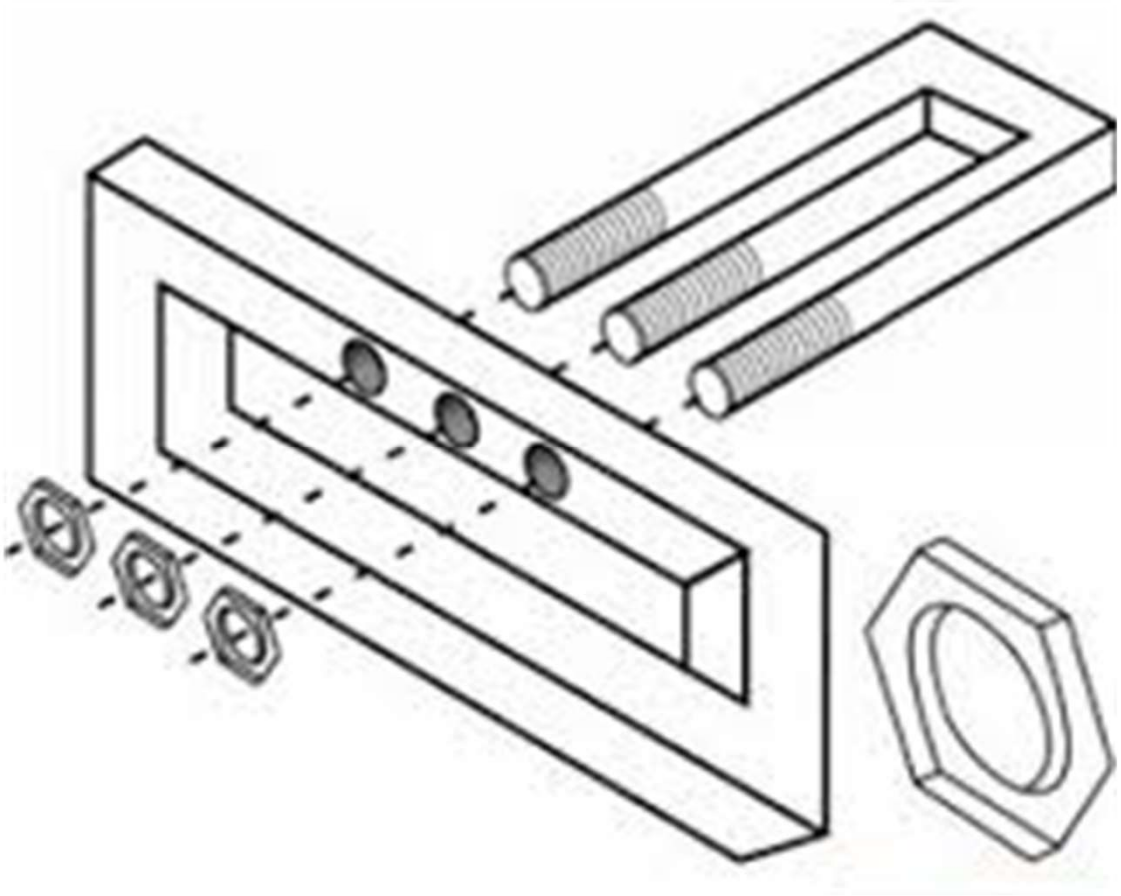
- 我们拥有了完整的对**协同机器人**机械臂基本功能的管理系统。
- 我们开发了一种特别高效和快速的协议，使数据传输速度不会对未来的应用造成任何问题。
- 我们支持当下应用最广的协议和任何开源内容

We have a complete management system of a COBOT robotic arm for elementary functions.

We have developed a particularly efficient and fast protocol, so that the data transfer speed does not cause problems for future applications.

We support the most popular protocols and everything in OPEN SOURCE.

开放系统的技术传播
Diffusion of technology with OPEN SYSTEM

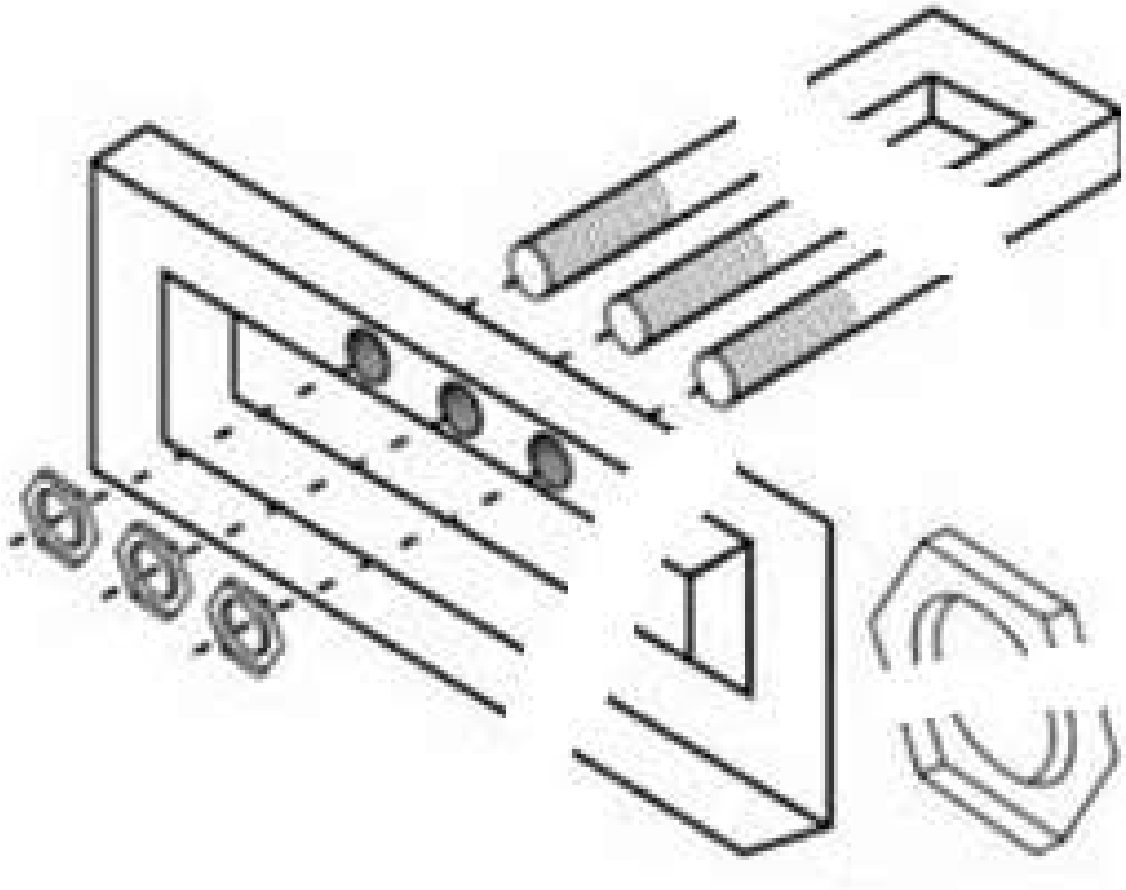


如果信息的传播不清晰或难以理解，就会发生这种情况：

If the dissemination of information is not clear and understandable, this happens:

开放系统的技术传播

The diffusion of the information need to be centralized

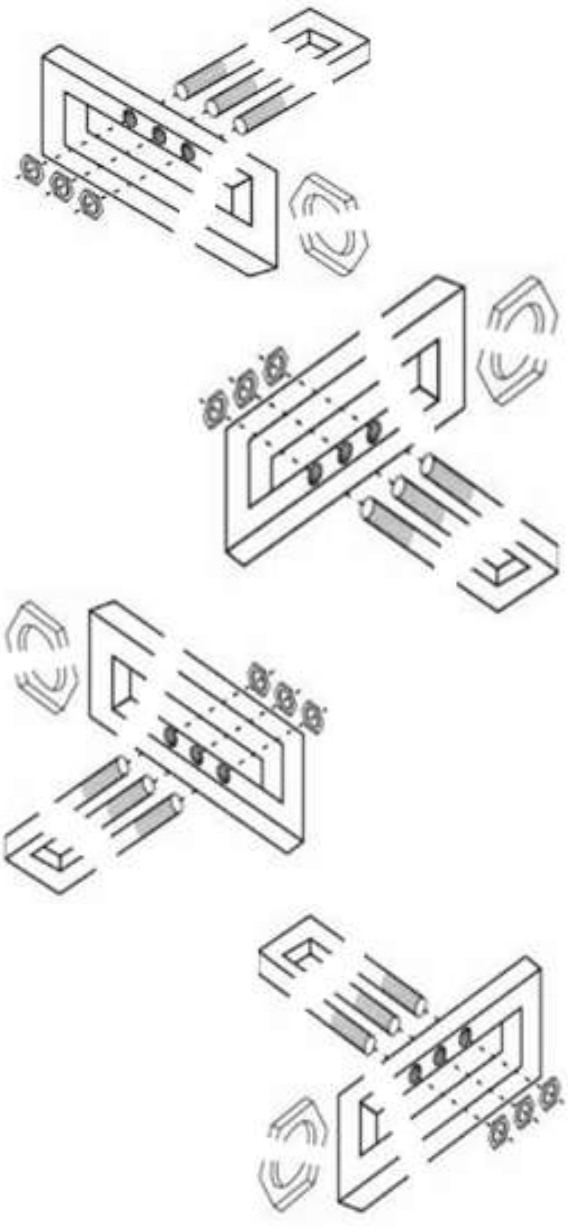


每部分的设计和构建都是正确的，但当我们尝试将所有部分放在一起时，不同方的利益会使的统一化和集成化变得复杂。

Every single part is correctly designed and built, but when we try to put all the parts together, unfortunately, different interests make the integration complex.

系统集成
The system integration

- 通过为小型企业设立**协同机器人**研发中心，可以产生一系列优势，包括降低开发、生产、安装和维护成本。
- 此外，使用相同的管理软件系统，不同公司生产的机械臂能够互相兼容。这对于使用**协同机器人**的公司来说将是很大的好处。
- 因此，每个制造公司都会转而专注于生产和质量改进。



By setting up an R&D center for COBOT for small businesses, a series of advantages are generated which reduce development, production, installation and maintenance costs.

Furthermore, using the same management software system, the robotic arms produced by different companies become compatible. This is a great advantage for companies that will use COBOT.

Consequently, each manufacturing company focuses on production and quality improvement.

我们想重现个人电脑发展的良好经验

We want to repeat the Personal Computer phenomenon

COMPAQ
hp
ASUS
DELL
SIEMENS
NEC
SONY
TOSHIBA
acer
FUJITSU

- **PC(**个人电脑**)**在全球范围内的成功归功于 **IBM** 在开源平台中交付完整项目，这一富有远见的举措
- 其详细且图文并茂的手册，具体解释了主板和所有其他外围设备的各个部分

The worldwide success for Personal Computers was due to IBM's foresight to deliver the complete project in OPEN SOURCE.

Detailed and well illustrated manuals to explain the various parts of the motherboard, motherboard, and all other peripherals.

Theremino团队成员介绍

Theremino team members introduction

Theremino团队成员介绍

Leonardo de Palo

- 意普智能科技（深圳）有限公司**CTO兼CEO**
- 计算机科学博士
- **40**余年深耕于工业自动化专家，曾任**IBM**工程师**10**余年
- 曾任多家大型企业自动化技术总监**CTO**
- 专攻研发，原型设计、机电、电子、固件和软件开发及测试；
- **Theremino**系统联合创始人。

- **CTO and CEO of SIRT Ltd.** (**S**henzhen **I**perMedia **R**obotics **T**ecnologies)
- **PhD in Computer Science**
- **More than 40 years of deep cultivation in industrial automation, and worked as an IBM engineer for more than 10 years**
- **Served as CTO of automation technology director of many large enterprises**
- **Specialize in research and development, prototyping, mechatronics, electronics, firmware and software development and testing;**
- **Co-founder of Theremino System.**

Theremino 系统 - 团队

Theremino System - Team

Ennio

数字图像、灯光、视频、声音和交互方面的艺术家。 他探索感知、社交互动和媒体传播。

Artist in digital images, light, video, sound and interactivity. He explores perception, social interaction and media communication.

Roberto

固件和软件开发专家。精通 C++、.Net、Mono、Windows、Linux 和 IOS。

Firmware and software development specialist. Proficient in C++, .Net, Mono, Windows, Linux and IOS.

Fabrizio

软件和固件开发专家，精通质量控制、网络、微控制器和外设。

Specialist in software and firmware development, proficient in quality control, network, microcontroller and peripherals.

Livio

在电子领域以及自 1981 年以来在编程领域进行了四十多年的实验、研究和专利。

More than forty years of experiments, research and patents in electronics and, since 1981, in the field of programming too.

意大利团队成员介绍

Theremino System - Team

Roberto

Theremino 亚洲协调员。
1988年在意大利成立 IperMedia Ltd.。
从事IT、多媒体控制器、AI和人机界面专家。
用于工业控制的 Theremino 系统的开发商。

Theremino Asia coordinator.
Founded IperMedia Ltd. in Italy in 1988.
Engaged in IT, multimedia controllers, AI and human interface expert.
Developer of Theremino Systems for industrial control.

Marco

化学和物理测量以及新原型解决方案的开发，以在实验研发项目的背景下交付。 “小事成就完美，但完美绝非小事”（米开朗基罗）

Chemical and physical measurement and development of new prototype solutions to the delivery in the context of experimental R&D projects.
“The little things make perfection, but perfection is no small thing” (Michelangelo)

Massimo

录音室专家。 从第一天起就沉迷于声音。 他的音乐之旅使他危险地走向了技术方面，使他的生活永远复杂化。

Recording Studio expert.
Addicted to sounds since his first days. His journey on music, brought him dangerously towards the technical side, complicating his life, for ever.

Gabriele

高科技聚合物专家、汽车和生物医学部门、工程和质量部门经理。 对电子、电信和创新技术充满热情。项目以及流行技术科学杂志和书籍的合作。

Technopolymer expert, manager of the automotive and biomedical sector, engineering and quality department. Passionate about electronics, telecommunications and innovative technologies. Collaboration on projects and popular technical science magazine and books.

中国团队成员介绍

Theremino System – Collaborators in China

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Joey

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大公坊国际加速器

Theremino系统发展历史

Theremino System Development History

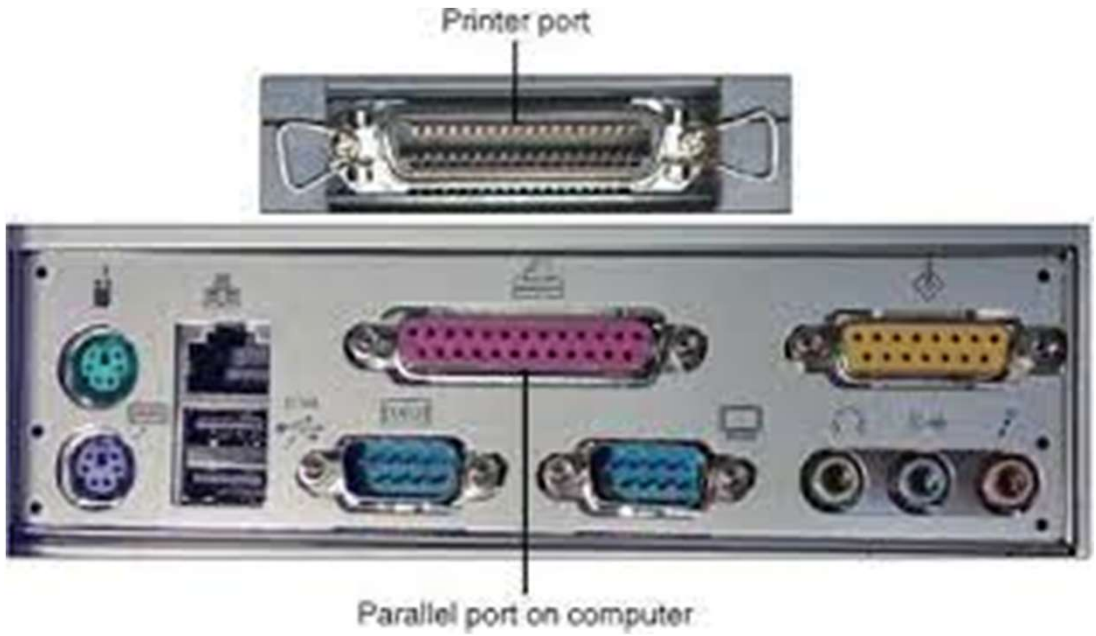
Theremino系统发展历史

Theremino System History

在当时，Windows 95 中引入了 USB 端口，事实上并行端口的终结已被颁布。迄今为止，PC 与传感器和执行器的连接非常简单和直观。8 位读写总线可用，每秒可传输数千字节。

With Windows 95 the USB port was introduced and in fact the end of the parallel port was decreed.

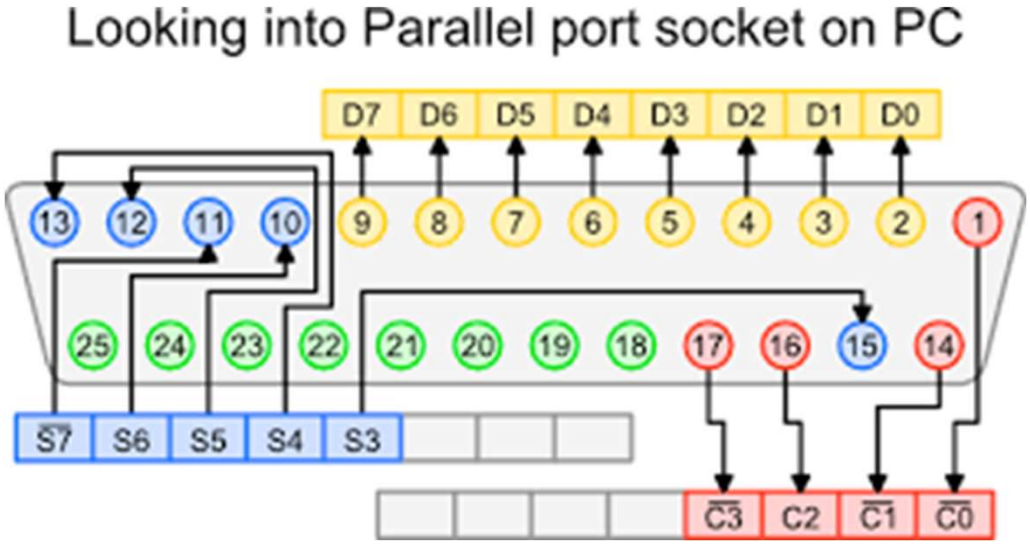
Up to that date, interfacing the PC with sensors and actuators was very simple and intuitive. An 8-bit read and write bus was available which could transfer thousands of bytes per second.



Theremino系统发展历史

History of Theremino System

整个 PC 接口开发人员开始研究新的 USB 1.0 标准，但在接口和识别操作系统方面遇到了巨大的困难。



The whole community of PC interface developers began studying the new USB 1.0 standard with enormous difficulties in interfacing and recognizing the operating system.

Theremino系统发展历史

Theremino System History

随着Windows 98SE的到来，USB 2.0也来了。 微软方面的情况有所改善，使用串行端口与传感器和适配器进行通信变得很普遍。

With the arrival of Windows 98SE, USB 2.0 also arrived. Things improved a bit on the Microsoft side, and it became common to use the serial port to communicate with sensors and adapters.

Theremino系统发展历史

Theremino System History

- 串行端口有速度限制，驱动步进电机或 ADC 转换器或复杂的接口是不够的。
- 此外，USB协议非常复杂，在官方文档中可以找到相互矛盾的信息。
- 解决这些问题，我们获得了来自 Microchip 芯片的帮助，该芯片在 HID 模式下集成了 USB2.0 堆栈。该芯片命名为PIC 24FJ64GB002。

The serial port has speed limits and to drive stepper motors or ADC converters or complex interfaces it is not enough.

Furthermore, the USB protocol is very complicated and contradictory information can be found in the official documentation.

A help to solve these problems comes from Microchip a chip with the integrated USB2.0 stack in HID mode. The chip is named PIC 24FJ64GB002.

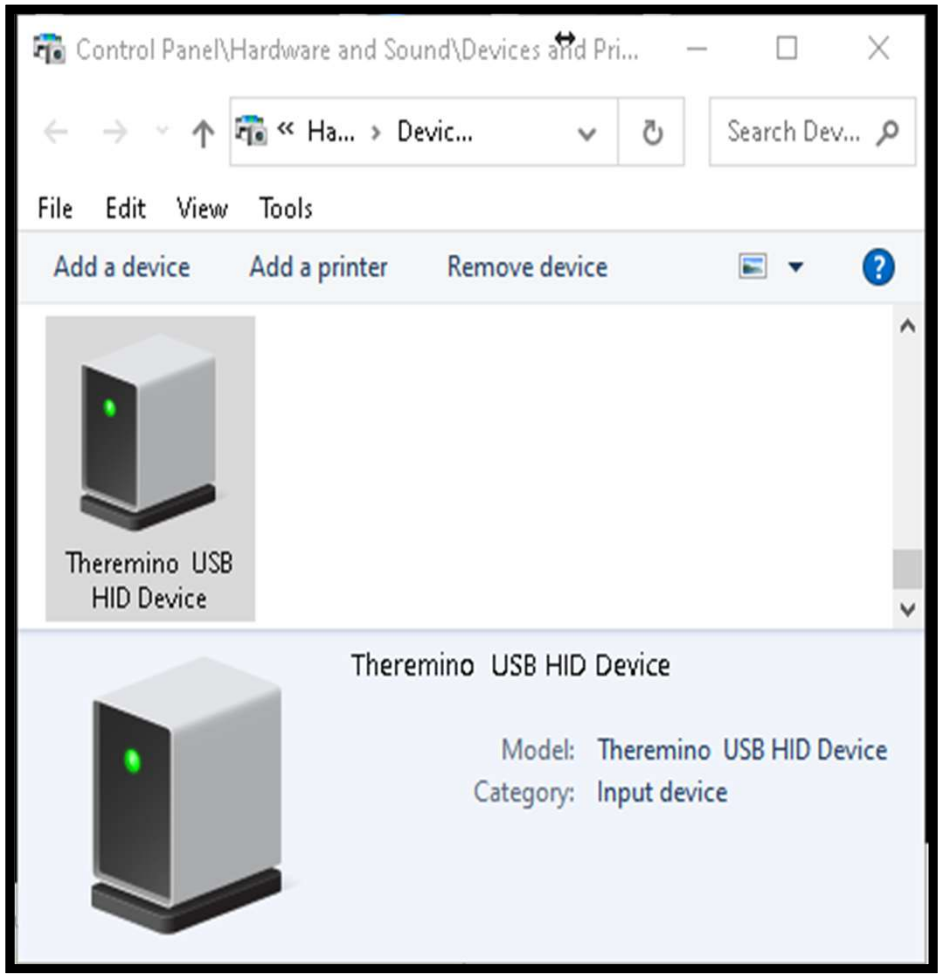
获得USB识别

- Microchip 从 USB 组织获得 VID 和供应商标识和产品标识 (VID)，并具有高速 HID 通信协议。
- 经协议，Microchip 客户可以使用该标识。
- 这使得 Windows 可以立即识别 THEREMINO MASTER，而无需安装任何特定的驱动程序。

Microchip obtains the VID and Vendor Identification and Product Identification (VID) from the USB organization and has the high-speed HID communication protocol.

The identification can be used by Microchip customers after an agreement.

This allows the THEREMINO MASTER to be recognized immediately by Windows without installing any specific driver.



PIC 24FJ64GB002

Microchip 的微控制器 PIC 24FJ64GB002 是一款功能强大的 16 位 MCU，具有 RISK 结构，因此非常快速和高效。 在内部，USB 部分的处理速度以 98 兆赫兹的频率运行。 但是用户手册非常冗杂，长达 352 页。

Microchip's microcontroller PIC 24FJ64GB002 is a powerful 16-bit MCU with RISC structure and therefore extremely fast and efficient. Inside, the processing speed in the USB section runs at a frequency of 98 Mega Hertz. The user manual has 352 pages.

PIC 24FJ64GB002 特性

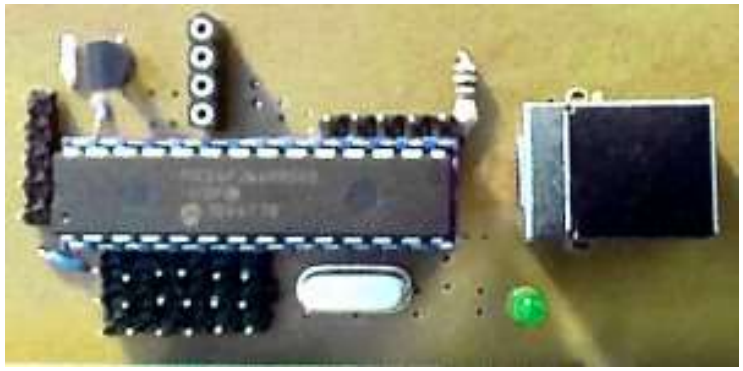
The PIC 24FJ64GB002 features

16 MIPS performance
16 x 16 Hardware Multiply, Single Cycle Execution
32-bit x 16-bit Hardware Divider
C Compiler Optimized Instruction Set
Internal oscillator support - 31 kHz to 8 MHz, up to 32 MHz with 4X PLL
On-chip LDO Voltage Regulator
JTAG Boundary Scan and Flash Memory Program Support
Fail-Safe Clock Monitor – allows safe shutdown if clock fails
Watchdog Timer with separate RC oscillator
eXtreme Low Power Managed ModesRun, Idle and Sleep modes
Deep sleep mode for lowest current consumption
Multiple, Switchable Clock Modes for Optimum Performance and Power Management
10-bit ADC, 13 channels, 500k samples per second
3 Analog comparators
2 UART Modules with LIN and IrDA® support, 4 Deep FIFO
2 SPI ™ Modules with 8 Deep FIFO
2 I2C™ Modules with Master and Slave Modes
Five 16-bit Timer Modules
Up to 5 Input Capture and 5 Output Compare / PWM,all with dedicated timers
Hardware RTCC, Real-Time Clock Calendar with Alarms
PMP, Parallel Master Port, with 16 Address Lines, and 8/16-bit Data
Peripheral Pin Select for remapping digital peripherals to I/O
Charge Time Measurement Unit (CTMU) for capacitive touch interface
Universal Serial Bus Features
USB v2.0 On-the-Go compliant
Dual role capable, can act as either Host or Device
Low speed(1.5Mb/s) and full speed(12 Mb/s) operation in host mode
Full speed USB operaiton in Device mode
Supports 32 endpoints
On-chip USB transceiver

Theremino系统发展历史

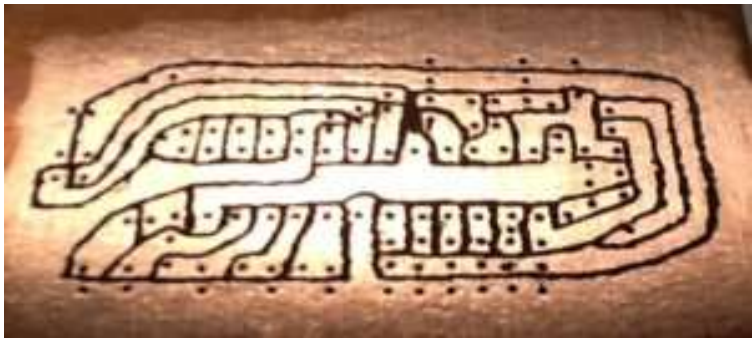
History of Theremino System

2012 年，不同领域的一组专家决定分享他们的经验和技能，以创建旨在简化和共享信息的开源THEREMINO 系统网站 www.theremino.org 和 Theremino 主板的第一个版本诞生了。



In 2012 a group of experts in different sectors decided to share their experiences and skills generating the OPEN SOURCE THEREMINO system aimed at simplifying and sharing information

The site www.theremino.org and the first version of the Theremino Master is born.



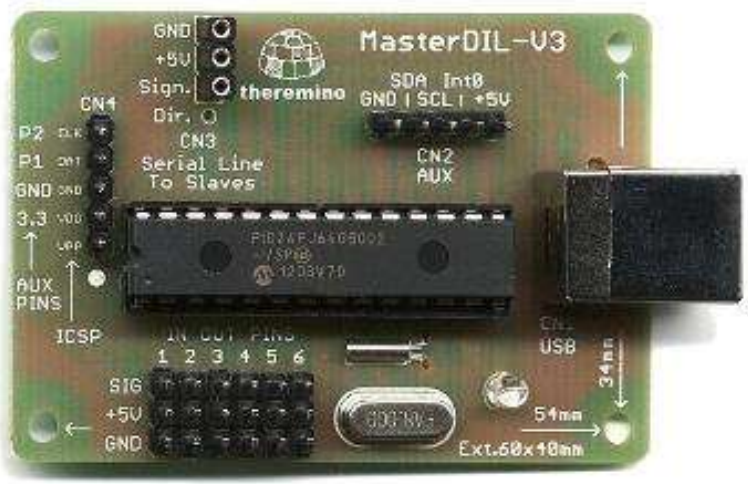
Theremino系统发展技术特点

Technical Features of Theremino System Development

主板

The Master

- 第一个商业版本是 V3，2016 年发布了 V5 版本，稳定可以管理 12 个输入和输出引脚。
- 接线图和固件，以及Gerber 文件可从网站 www.theremino.org 免费下载



The first commercial version was the V3, later in 2016 the V5 version was released, stable able to manage 12 input and output pins.

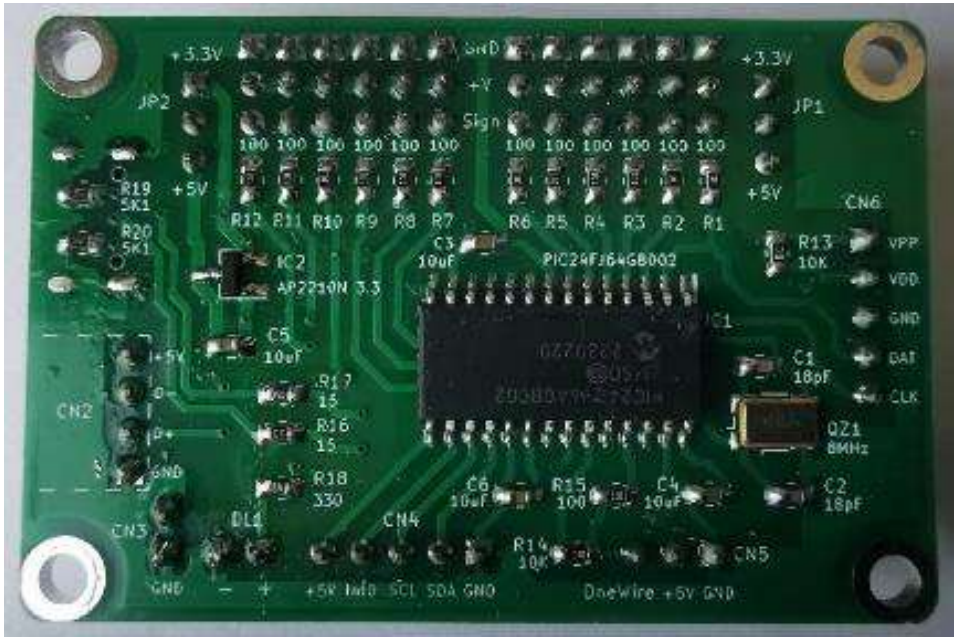
The wiring diagram and the firmware and Gerber files are freely downloadable from the website www.theremino.org

主板

The Master SMD-V1

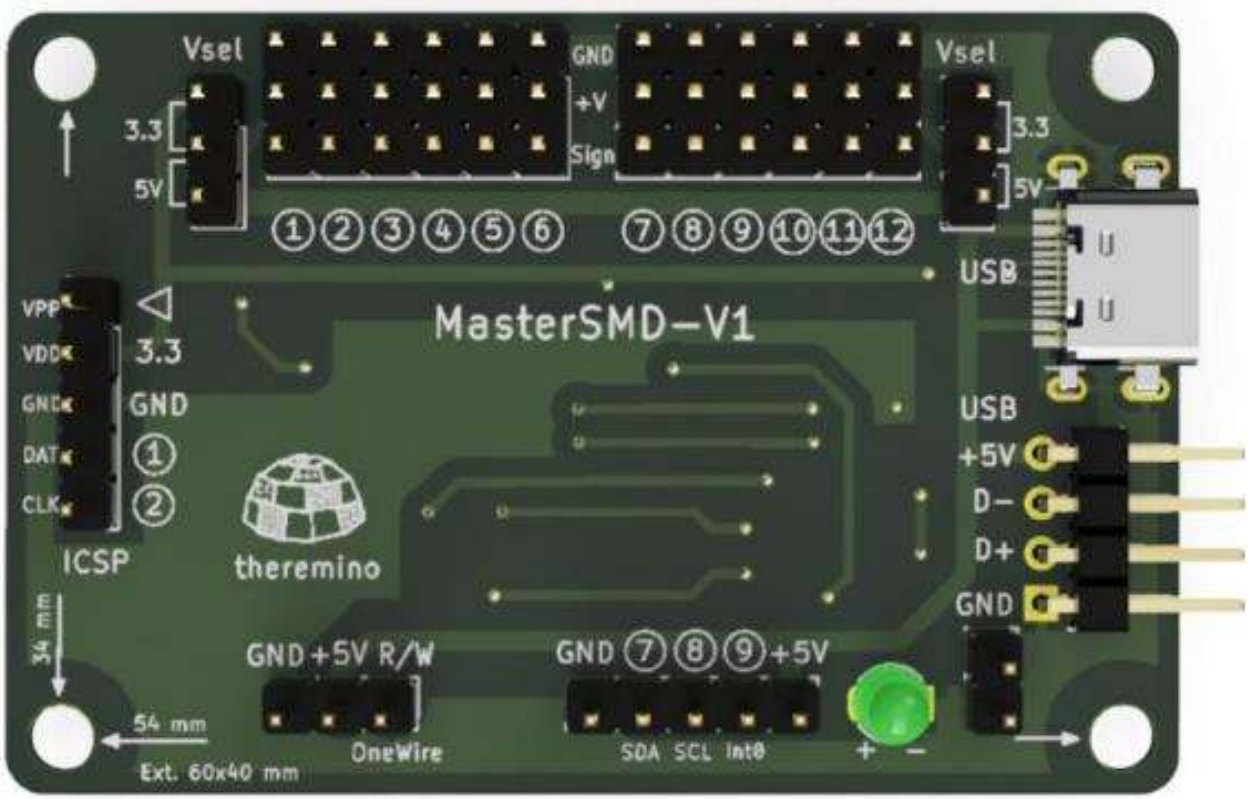
最近发布了一个新版本，以符合欧洲关于 USB 连接器的指令。 该 SMD 版本的板与之前的 DIL V5 版本基本相同，具有相同的应用和功能。 然而，有一些差异使得 SMD 版本使用起来更方便。

A new version has recently been released to comply with a European directive on USB connectors. This SMD version of the board is essentially identical to the previous DIL V5 version, with the same applications and features. However, there are some differences which make the SMD version more convenient to use.



主板

The Master SMD-V1



12 个 In Out Pin 连接器全部对齐，更容易连接电缆。

每个连接器还具有 GND 连接和电源输出。

每组六个连接器可设置为 3.3V 或 5V 传感器供电。

USB 连接器为 USB-C 类型。

添加 4 针公 USB。

添加了两个连接器来连接从站或 ADC24。

12 In Out Pin connectors are all aligned, making it easier to connect cables.

Each connector also has a GND connection and a power output.

Each group of six connectors can be set to power 3.3V or 5V sensors.

The USB connector is of the USB-C type.

Added 4-pin male USB.

Added two connectors to connect the Slaves or ADC24.

插槽系统
The SLOTS

- 硬件接口的分辨率只有连接传感器和执行器所需的一半。
- 再次使用标准 USB 协议，困难是巨大的。
- Theremino 团队决定重写 USB 协议, 引入邮槽的概念。
- 邮槽是存放信件、发票、报纸、广告等的地方。 每个信封包含不同的数据。
- 有 1000 个可读取的插槽和 1000 个可写入的插槽，它们在 Windows 和 Master 之间不断高速交换。
- 操作槽只有两条指令：
- **variable = Slot (nn)**
- **Slot (nn) = variable**

The resolution of the hardware interface is only half of the need to connect sensors and actuators.

Using the standard USB protocol, once again, the difficulties were enormous.

The theremino team decides to rewrite the USB protocol, introducing the concept of mail slots.

Mail slots are the place where letters, invoices, newspapers, advertisements, etc. are deposited. Each envelope contains different data.

There are 1000 slots to read and 1000 to write which are continuously exchanged at high speed between Windows and the Master.

There are only two instructions for manipulating slots:

variable = Slot (nn)

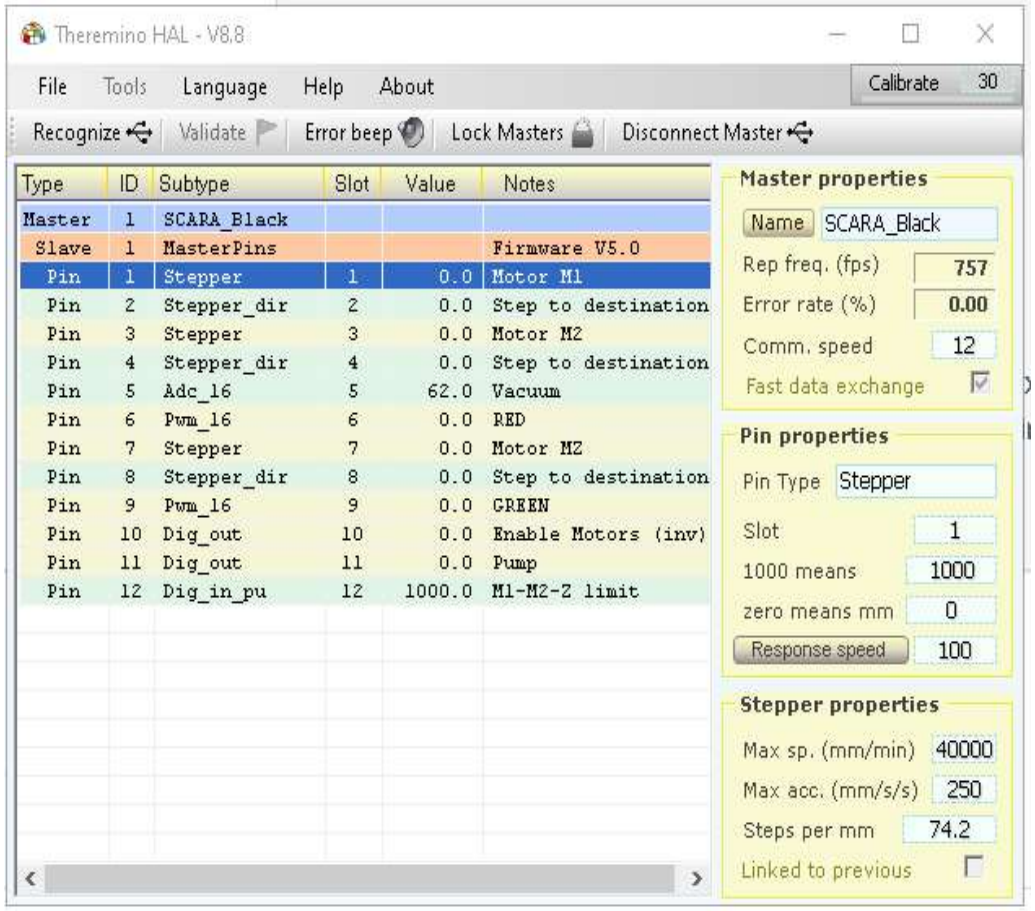
Slot (nn) = variable

软件模块: HAL(硬件抽象层)

The software modules: The “HAL”

HAL（硬件抽象层）模块负责与主站协作的电气接口和信号处理功能，以及通过 HID 模式下的 USB 和外部组件与 PC 进行通信。 它通常通过 USB 2.0 每秒传输超过 700 帧。

The HAL (Hardware Abstraction Layer) module takes care of electrical interfacing and signal processing functions in collaboration with the Master, as well as communication with the PC via USB in HID mode and with external components. It typically transfers over 700 frames per second over USB 2.0.

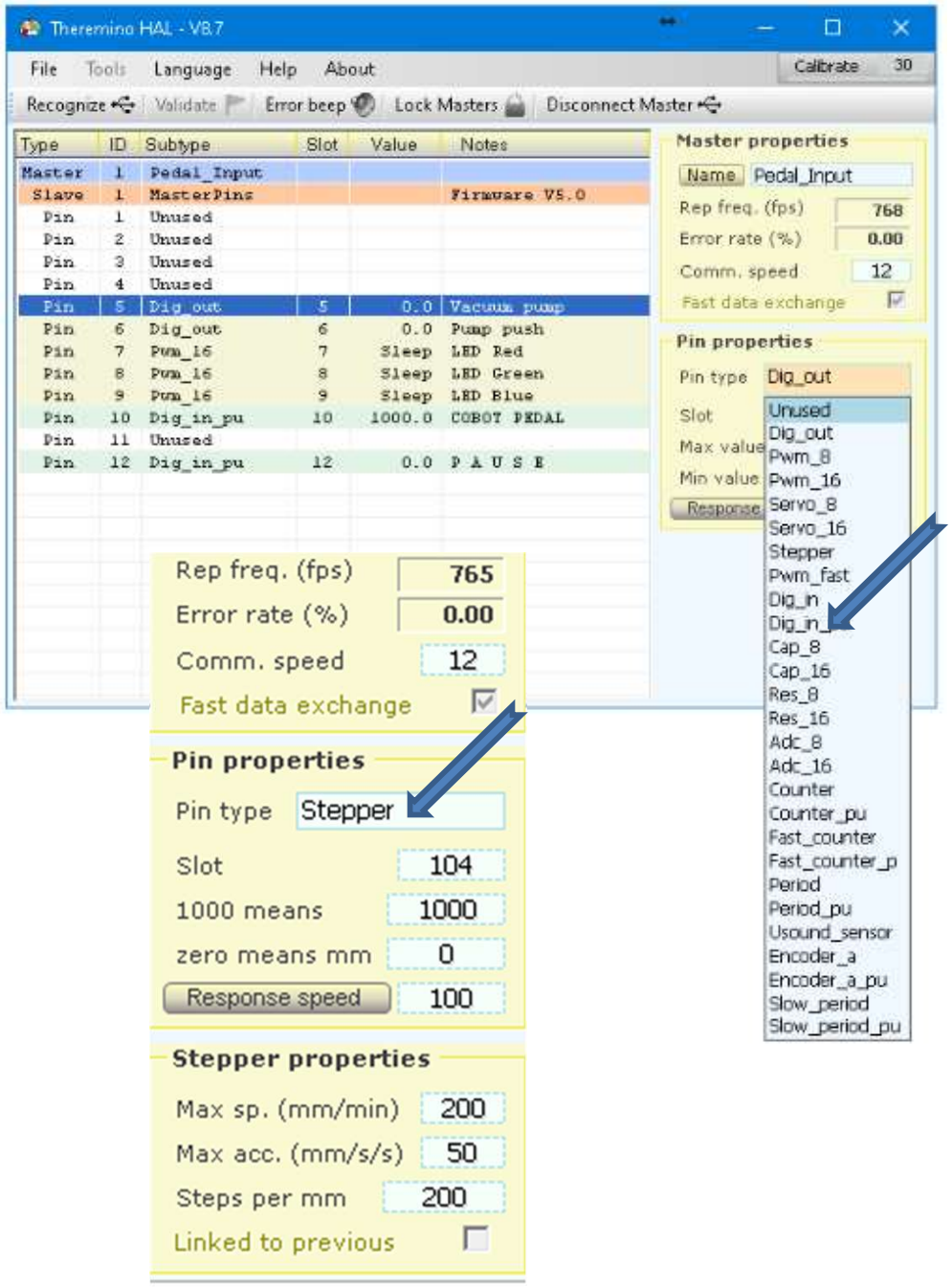


输入/输出引脚简单配置

The easy configuration of the I/O pins

称为 HAL（硬件抽象层）的软件模块允许以简化的方式将硬件功能分配给外部引脚并设置它们的参数。 目前有 26 种可能的配置，每种配置都可以有特定的设置。 例如，对于步进电机，我们有最大速度、加速度和每毫米的步数以及旋转方向。

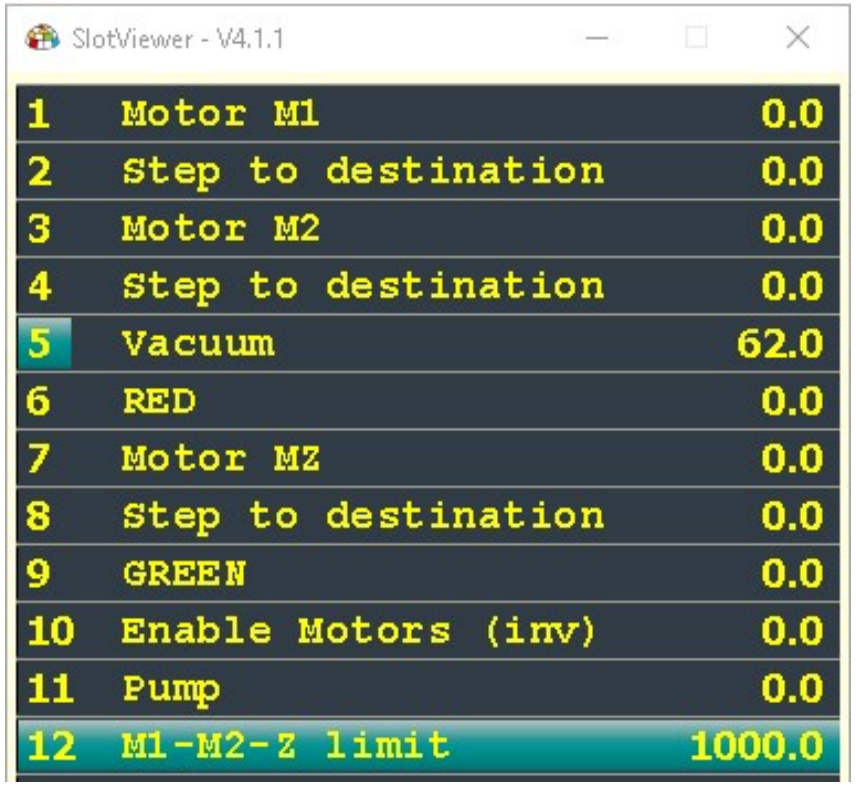
The software module called HAL (Hardware Abstraction Layer) allows in a simplified way to assign the hardware functions to the external pins and to set their parameters. Currently there are 26 possible configurations, and each configuration can have a specific set up. For example, for the stepper motor we have the maximum speed, the acceleration and the steps per millimeter and the direction of rotation.



软件模块:“插槽显示器”

The software modules: The “Slot Viewer”

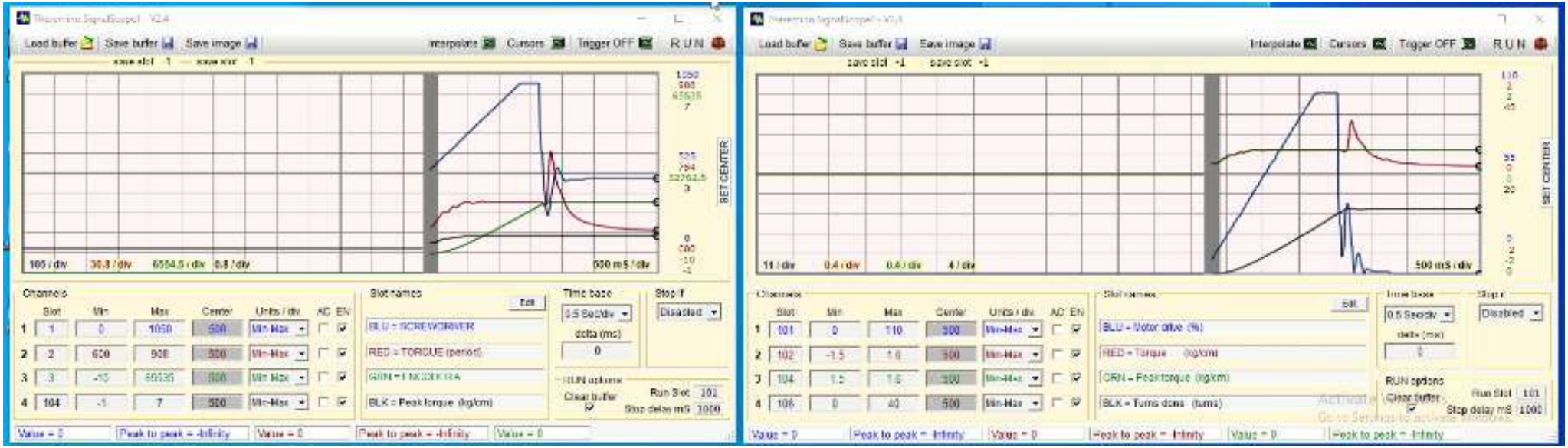
- “插槽显示器”模块可让您实时查看插槽状态。
- 插槽是硬件抽象层模块与 Windows 环境中的应用程序之间通信的简化版本。
- 通过这个模块，可以实时干预插槽的内容。



The "SlotViewer" module allows you to view the status of the slots in real time.
Slots are a simplified version of the communication between the HAL module and the applications in a Windows environment.
Through this module it is possible to intervene in real time on the contents of the slots.

软件模块: “信号显示器”

The software modules: The “SignalScope”



- “信号显示器”可以实时查看插槽的状态，就像逻辑分析仪或示波器一样。
- 这些插槽是硬件抽象层模块与 Windows 环境中的应用程序之间的通信协议的重新设计和简化版本。该模块具有存储波形和历史的功能。

The "SignalScope" allows you to view the status of the slots in real time, like a logic analyzer or oscilloscope.

The slots are a redesigned and simplified version of the communication protocol between the HAL module and the application in a Windows environment. This module has functions for storing the waveform and history.

其他Theremino系统应用

Theremino other applications

我们在官网记录了所有Theremino系统的应用，其中一些是完全创新的。全部严格开源。

www.theremino.com/zh/applications。

On a web page we have reported all the applications, some totally innovative.

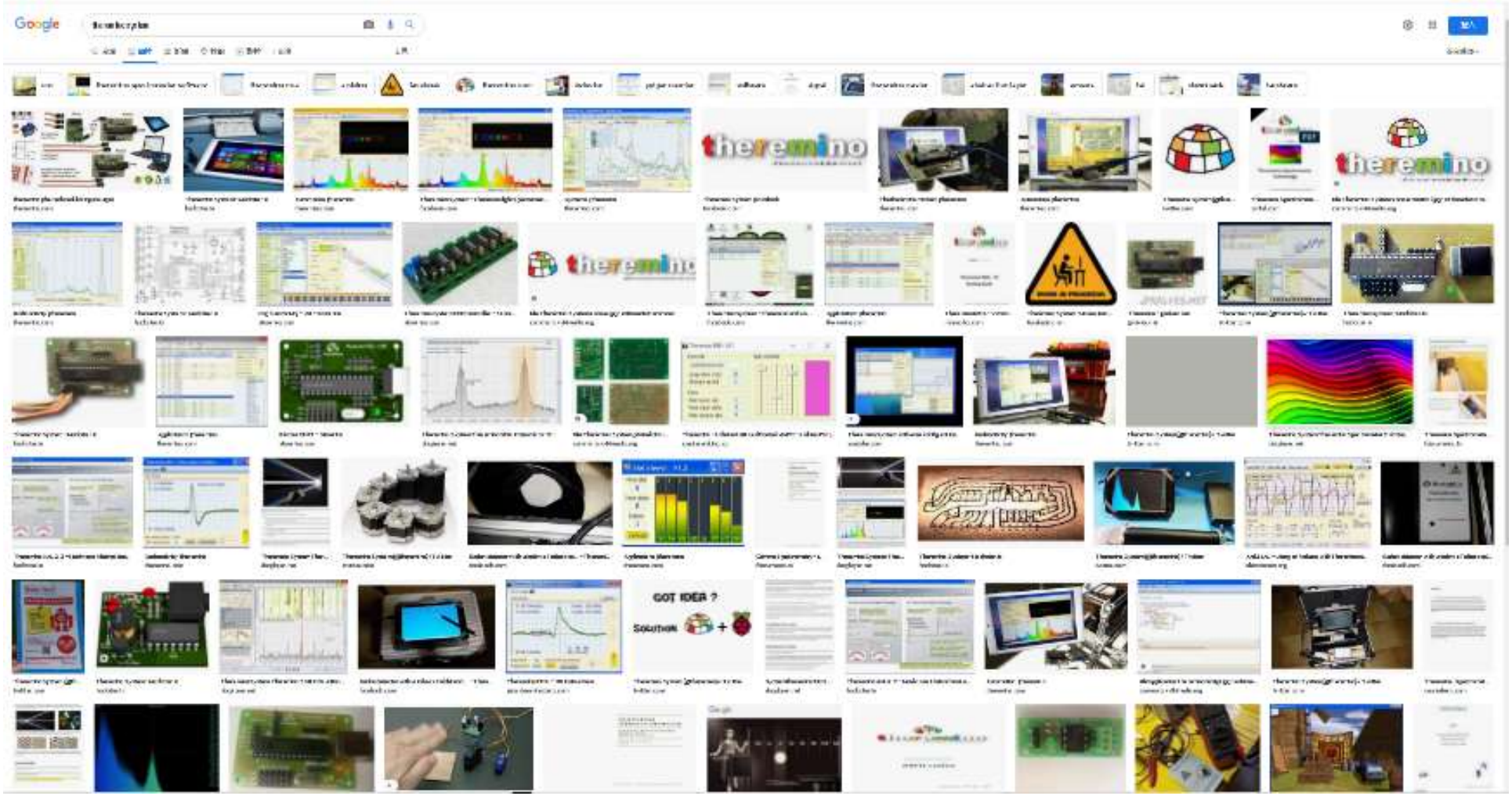
All strictly OPEN SOURCE.

www.theremino.com/en/applications

其他Theremino系统应用

…Theremino还有许多其他应用案例

… and much more.



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