

Hull Pixelbot Project



Summary

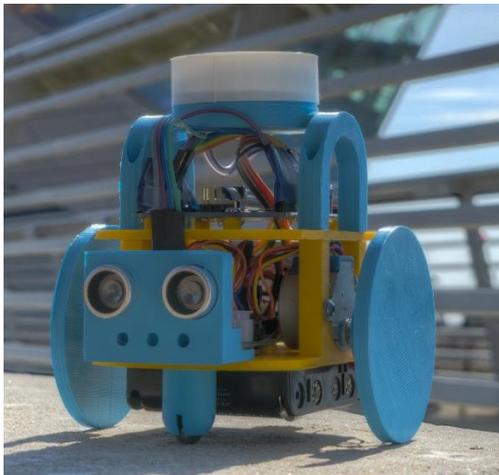
The Hull Pixelbot project was created to provide the Hardware Group at c4di with a project for hardware and software development. It has grown into a connected platform for embedded development powered by an innovative operating system which makes it easy to create connected IoT (Internet of Things) devices.

All the software and hardware elements have been made open source and are freely available. The platform has been used as the basis of a number of teaching events and work is continuing on a STEM (Science Technology Engineering and Mathematics) text which uses the Hull Pixelbot as the underlying platform.

The aims of the project are:

- create an ultra-low cost platform for engagement with programming for individual development and large scale events
- build an embedded robotic operating system which is extensible and connectable
- create high quality teaching materials based on the hardware and software platforms

The Hull Pixelbot platform and HulIOS



Creating physical devices is a great way to learn. The **Hull Pixelbot** grew out of a recognition of this, aiming to provide a platform that is simple to use, easy to extend and, above all, cheap to engage with. The hardware required to create the base platform can be purchased for around ten pounds.

The chassis components can be 3D printed or laser cut from perspex, although the electronics can be mounted on any physical platform.

The base device can be extended with sensors, a coloured pixel, sound output and a network connectivity, with none of the extensions costing more than five pounds.

The robot platform can be programmed using the C++ language, but to ease development an embedded robot operating system, **HulIOS** has been developed for the robots.

HulIOS provides simple, Python based, scripting commands that are executed and stored directly on the robot.

Students can use the editor (shown on the right) program to create and deploy programs.

HulIOS has been designed to be easy to understand and extend, so that developers can learn advanced software design concepts by studying the source code with the aim of adding language features and hardware connections.

```
# turn and run
begin
forever
  green
  d = @distance
  if d < 100:
    red
    turn 180
    move 100
end
```

Internet Connectivity

It costs around five pounds to turn a Hull Pixelbot into an internet cloud connected device. HullOS programs can be deployed into the robot using an internet connection making it possible to remotely control and program the robot via a network connection.

The program deployment has been implemented and used as the basis of a number of successful events where attendees were able to interact with the robot in a variety of ways:

- attendees programmed the robot using a web interface (shown on the right)
- attendees interacted with a "chatbot" that conducted a quiz with the attendee and allowed them to control the robot if they entered correct answers
- a group of robots was controlled to perform a choreographed dance routine

The robots interact with the server using the Message Queue Telemetry Transport (MQTT) protocol. The server used is a Microsoft Azure Internet of Things hub which hosts an ASP .NET web host and chatbot.

Robot: Oddwheels

Controller: Fred

Your program code

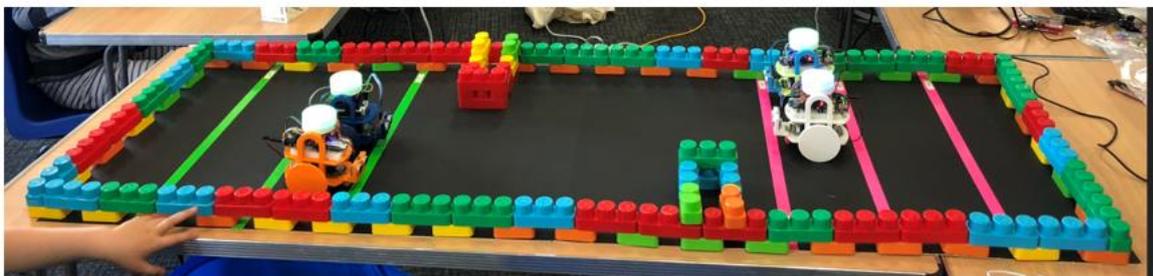
```
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Send the program to the robot

Run the robot

Stop the robot

ROBOT RUMBLE



More events are planned in the future, including one where groups take part in "Robot Rumbles", programming teams of robots to occupy territory.

Progress to Date

A number of Hull Pixelbots have been built and used at events involving age ranges from 8 years to 80, to universal acclaim. Hull Pixelbot robot kits have also been the basis of "Build a robot in a day" events which have been very successful. There are now robot platform designs available in 3D printed form which have been used by robot builders to make their own robots. There is also a laser cut robot design which can be used to mass produce robots.

Future plans

The development of the robot platform is an ongoing process. Future plans include:

- The release of a robot kit on Tindie for sale
- Completion of a text book that teaches robotics and electronics using the Hull Pixelbot
- Organising a number of "Robot Rumbles"
- Ongoing promotion of "Build a robot in a day" events
- Further development of the hardware and software to reflect new technologies, for example LoRa (Low Powered Radio) connectivity.

Hull Pixelbot FAQs

Why is it called the Hull Pixelbot?

It is a robot, from Hull, and it carries a coloured pixel on top. Next question.

Why does the robot have a pixel on the top?

The pixel contains 12 individual lights that can be controlled by from HullIOS. These can be used to indicate status, give the robot a personality (one of the HullIOS commands is "angry") and let you take cool pictures of the lights. Also, we had to have the pixel on the top so it could be called a Pixelbot.

What hardware are you using?

The robot uses an Arduino Uno (chosen because it is cheap) to run HullIOS and drive the robot hardware. The network connection uses a Wemos D1 Mini (chosen because it is cheap) to provide the network connectivity. The motors are stepper drivers actually intended for use moving vents in air conditioners(chosen because...oh, you know by now). The total hardware cost for the electronics is around ten pounds. A full parts list is on the Hull Pixelbot repository.

Do I have to make a robot?

No. The HullIOS system provides an easy way of controlling any device connected to an Arduino processor. HullIOS is designed to make it easy to add new peripherals and integrate them into the language, so that you can use it to power any cloud-connected device.

What software are you using?

The HullIOS is written in C++ and will run on any Arduino compatible platform. The Wemos network connection software is also written in C++. The server software is written in C# as are the Hull Pixelbot choreography software and HullIOS editor. There is also a version of the HullIOS editor written in Python.

What computers will the Hull Pixelbot work with?

The Arduino program editor is available for Windows PC, Apple Mac and Linux platform, including Raspberry Pi. The server software can be developed on Windows PC and Apple Mac. The Python HullIOS editor will work on Windows PC, Apple Mac and Linux platform, including Raspberry Pi.

How is the robot powered?

The robot is powered from 5 x AA batteries. These give several hours of use when connected to a network. It rather depends on how many pixels that you turn on...A rechargeable battery pack can be used instead.

What cloud services do you use?

The software uses Microsoft Azure cloud resources. These are readily available to students. The software could easily be adapted to use other servers if required.

Why did you do this?

I wanted a device that would make it as easy to create and deploy behaviours to an embedded device while learning programming. I thought a robot with a pixel on it would be cute, and I wanted to explore the social aspects of getting large numbers of robots (and their owners) together to make things happen.

Links

Hull Pixelbot web site:	http://hullpixelbot.com/
Hull Pixelbot pictures:	https://www.flickr.com/gp/robertmiles/gk184G
Open source Hull Pixelbot repository:	https://github.com/HullPixelbot
Hull Pixelbot videos – Hull Pixelbot Parade	https://youtu.be/6K1MSUy3iAg
Hull Pixelbot videos – Hull Pixelbot Robot Rampage	https://youtu.be/uglpg7PVldI
Hull Pixelbot videos – Pixelbot Pixel drawing	https://youtu.be/i7XpCK2SThQ
Hull Pixelbot Chatbot	http://hpb.host/QuizHome.html
Hull Pixelbot Robot Rumble	http://hullpixelbotcontroller.azurewebsites.net/
Rob Miles Hull Pixelbot posts	http://www.robmiles.com/journal?category=HullPixelBot