Osaamista
ja oivallusta
tulevaisuuden
tekemiseen

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XYPlotter

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Smart Systems

Embedded Systems Project

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Contents

1 Intro

The main goal for this project was to accomplish a working solution to draw with the XY-Plotter using LPCXpresso 1549 microcontroller. This project was done for the Embedded Systems Project course. This project employed three students.

2 Hardware

2.1 LPCXpresso 1549

The LPCXpresso 1549 Cortex-M3 is a low budget microcontroller from NXP. The LPC1549 is an ARM-based developments platform. The microcontroller was chosen by the course teacher for this project.

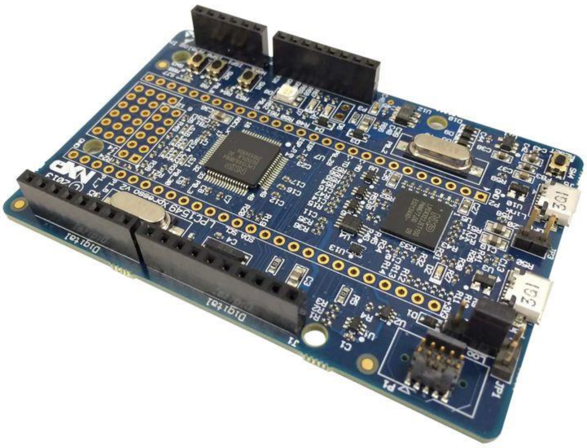

Figure 1: Picture of the LPC1549

LPC1549 comes with 72MHz processor, 36kb of ram and 256kb of flash. Addition to that you send signals via USB, UART, SPI, I2C, ADC and of course GPIO.

> “LPCXpresso is an end-to-end solution enabling embedded engineers to develop their applications from initial evaluation to final production.” - NXP

2.2 XYPlotter

XYPlotter is a robot kit provided by the Makeblock company. XYPlotter is used to move a pen or other drawing instruments to create artwork on a flat surface. It can also be used as a laser engraver.

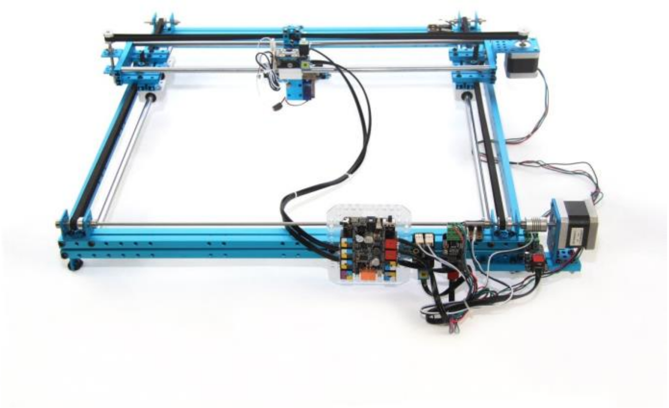

Figure 2: Makeblock's XYPlotter

The XYPlotter uses stepper motors to move in the XY-axis and can be controlled by sending pulses from the microcontroller. Limit switches are used to stop overflowing from the surface and activation stops the motors. Pen is controlled by a servo motor which lifts the pen from the paper. The laser engraver was supported in this plotter and can be used. The laser is a diode laser and can burn pictures to paper.

2.3 Signal Capture Board

Signal capture board was used to test the plotter via simulator application. Project was made during the Covid-19 pandemic which meant there was limited access to the plotters.

3 Software

3.1 FreeRTOS

Helping the development side of the project was provided but the FreeRTOS project. FreeRTOS is a real-time operating system kernel distributed under the MIT License. FreeRTOS library is small and simple and easy to use and provides all the necessary functionalities for example: multithreading and tasks, mutexes, semaphores, timers etc.

3.2 mDraw

mDraw is a piece of software by the Makeblock company used for many drawing projects. mDraw can digest SVG images and provide the gcode for the specific image. The commands are parsed by the software that was written for this project.

```
M10
G28
G1 X-0.50 Y101.50 A0
M1 90
G1 X149.50 Y101.50 A0
G1 X149.50 Y1.41 A0
G1 X-0.50 Y1.41 A0
G1 X-0.50 Y101.50 A0
```

Figure 3: Example output from mDraw

After getting the code from mDraw it was parsed by the software and according instructions were passed to the according pieces of hardware.

GCode	Inputs	Description
M10	-	Start command
M1	y	Set pen position
M4	power	Change laser power
G1	x, y	Go to position
G28	-	Go to origin

3.3 Software

The whole software was written in C/C++. FreeRTOS library and standard libraries offered much help in the making process. First plan we had drafted looked something like this.

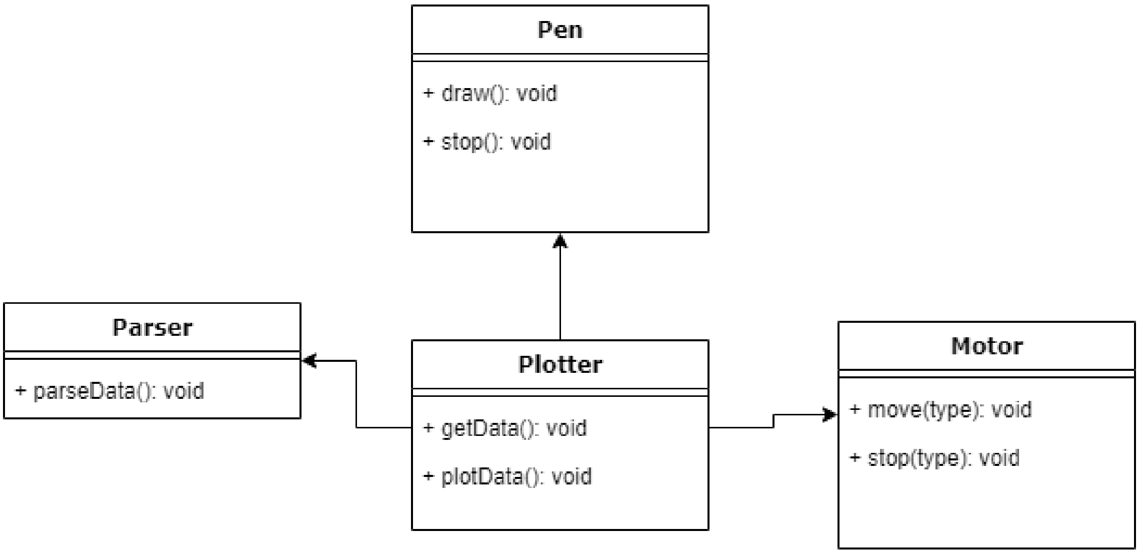

Figure 4: Object diagram

We followed the plan quite a lot, but some changes needed to be made while we learned new things. We needed to add more classes to convert UART input to string and add some more functionality to other classes. Some classes were added from other assignments to help the project.

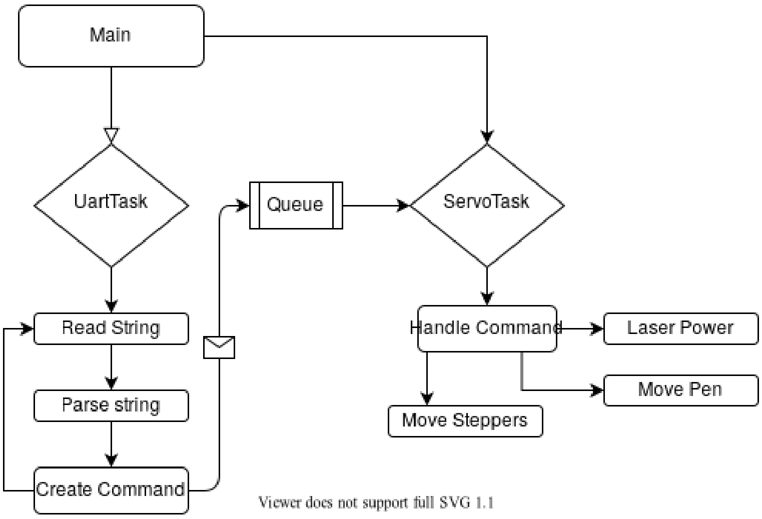

Figure 5: Flowchart

3.4 CI/CD

We enabled automatic cppcheck runs via the GitHub actions to provide us with continuous feedback from the code. Each commit would trigger the action and a cppcheck report would be committed to the repository.

4 Outcome

The project turned out to be a success even though there were not many chances to try out the actual plotter. Simulator offered a solid alternative to development platform. The project enables successful control over the XYPlotter and can produce pretty accurate drawings.

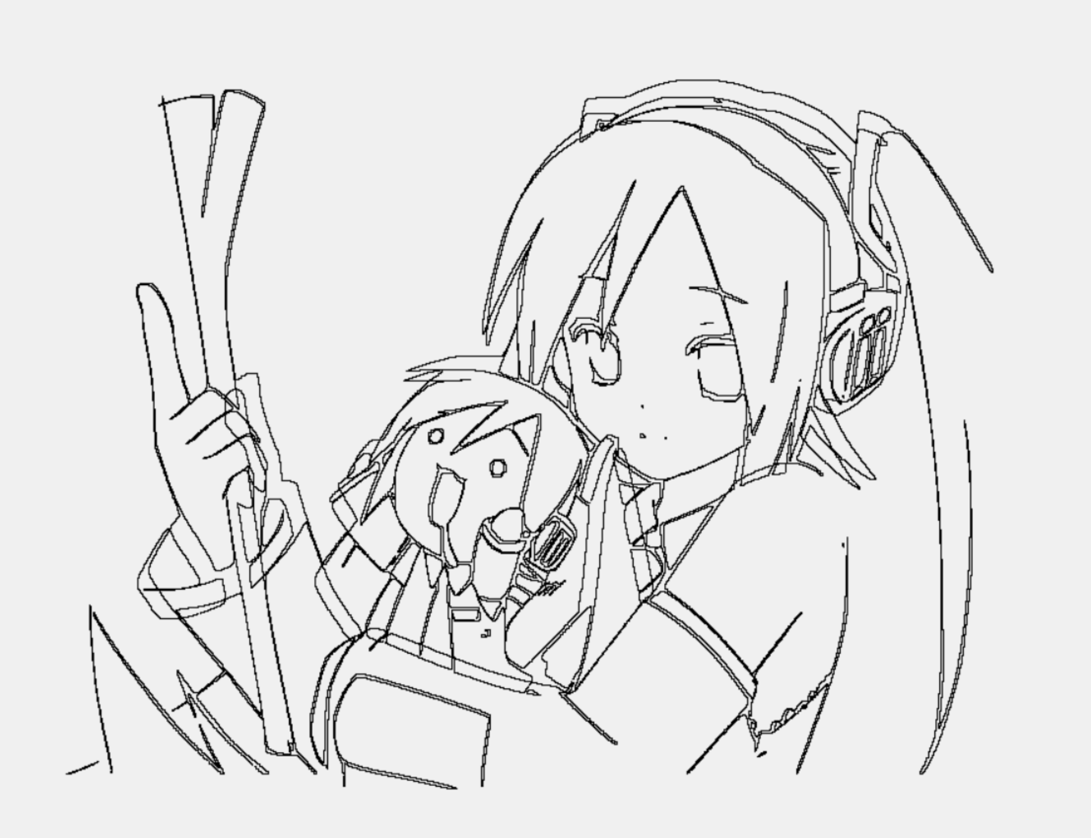

Figure 6: Drawing from the simulator

Project can also use the laser to burn the picture to an image or a piece of wood. Project offered a great hands on practice for developing embedded system device. It demonstrates the use of algorithms and hardware controlling. Project also emphasized the importance of timing inside the code. Source for this project can be found from any members GitHub page.

References

1 FreeRTOS documentation

https://www.freertos.org/Documentation/RTOS_book.html

2 LPCXpresso documentation

https://www.nxp.com/docs/en/user-guide/UM10736.pdf

3 mDraw

https://github.com/Makeblock-official/mDrawBot

4 Bresenham’s line drawing algorithm

https://en.wikipedia.org/wiki/Bresenham%27s_line_algorithm