# Project Status 2 2nd Report

**THU_ETS 20th January, 2024**

## 1. Debugging of the Microcontroller

When our microcontroller was alive and entered instructions according to the content of the Documentation, there was no response. It was not until we asked Radu that we found the Reset button on the car. The bug wasn't fixed until January 16.When we click the reset button, and input #kl:15;; ^M^J instead of #kl:15;; \r\n^M^J or #kl:15;; \r\n, there is a corresponding output.

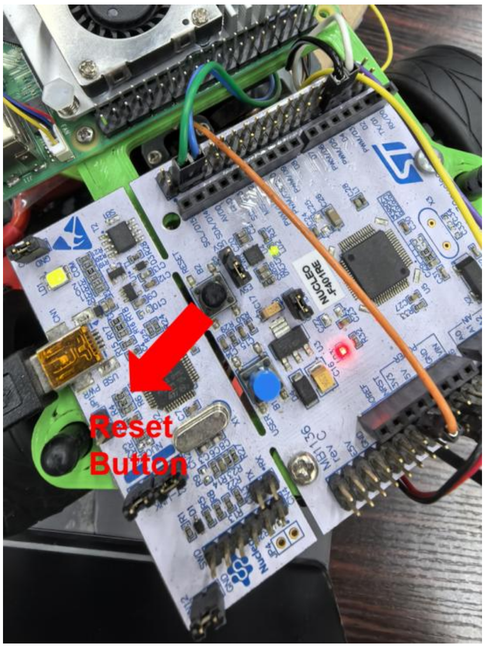



Figure 1 Reset Button of the microcontroller

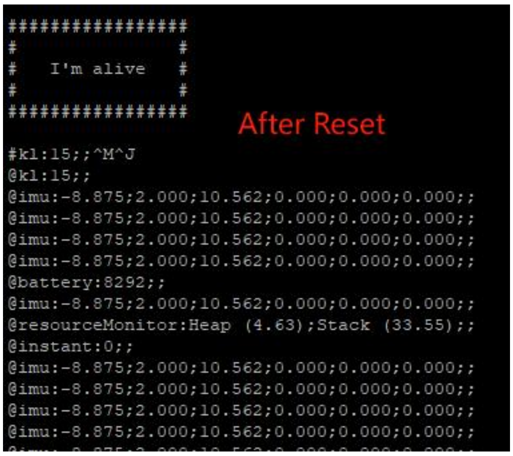



Figure 2 Output of PuTTY(After reset)

There are two main reasons for this bug.

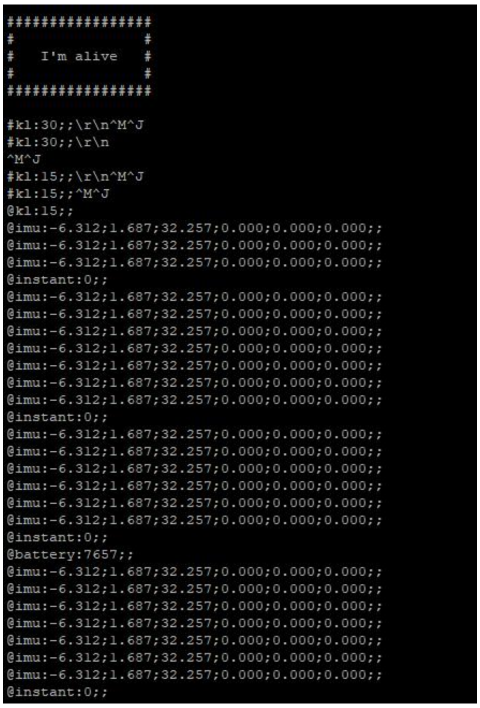
(1) We overlooked the reset function of the microcontroller: a feature common to all microcontrollers. Previously, when using Arduino for burning and writing, we would press the reset button to refresh, but this time the interval was too long, and we forgot this crucial step.

(2) We placed excessive trust in the documentation. According to the documentation, it appeared that \r\n and ^M^J needed to be entered together, but our trials revealed that ^M^J alone sufficed. We have also identified other errors in the documentation. This is

not a tutorial book, and we cannot rely on it entirely.

**2. Outputs for Different Commands**

- Output for KL15 State

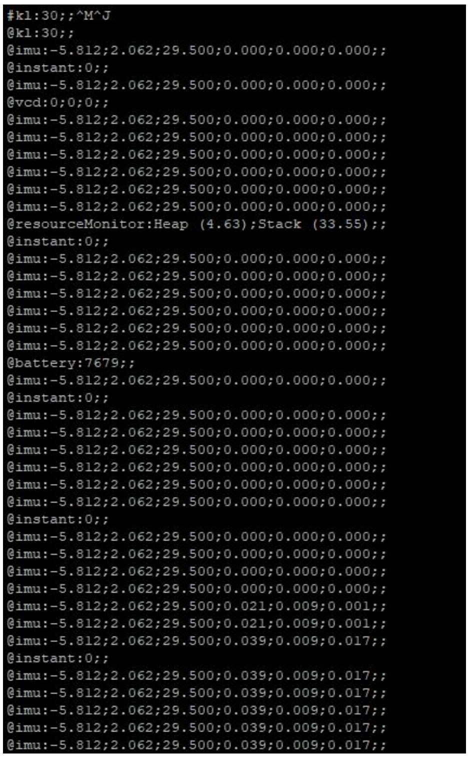


```
#################
#               #
#   I'm alive   #
#               #
#################

#kl:30;;\r\n^M^J
#kl:30;;\r\n
^M^J
#kl:15;;\r\n^M^J
#kl:15;;^M^J
@kl:15;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@instant:0;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@instant:0;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@instant:0;;
@battery:7657;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@imu:-6.312;1.687;32.257;0.000;0.000;0.000;;
@instant:0;;
```

Figure 3 Output for KL15 State

- Output for KL30 State



```
#kl:30;;^M^J
@kl:30;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@instant:0;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@vcd:0;0;0;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@resourceMonitor:Heap (4.63);Stack (33.55);;
@instant:0;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@battery:7679;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@instant:0;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@instant:0;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.000;0.000;0.000;;
@imu:-5.812;2.062;29.500;0.021;0.009;0.001;;
@imu:-5.812;2.062;29.500;0.021;0.009;0.001;;
@imu:-5.812;2.062;29.500;0.039;0.009;0.017;;
@instant:0;;
@imu:-5.812;2.062;29.500;0.039;0.009;0.017;;
@imu:-5.812;2.062;29.500;0.039;0.009;0.017;;
@imu:-5.812;2.062;29.500;0.039;0.009;0.017;;
@imu:-5.812;2.062;29.500;0.039;0.009;0.017;;
@imu:-5.812;2.062;29.500;0.039;0.009;0.017;;
```

Figure 4 Output for KL30 State

- Output for Setting Speed to 60 in KL30 State

```
#kl:30;;^M^J #speed:60;;^M^J
@kl:30;;
@speed:60;;
```

Figure 5 Output for Setting Speed to 60 in KL30 State

- Output for Controlled Movement

```
#kl:30;;^M^J #vcd:80;-130;121;;^M^J
@kl:30;;
@imu:-8.625;2.187;11.375;0.000;0.000;0.000;;
@vcd:80;-130;121;;
```

Figure 6 Output for Controlled Movement

- Output for Battery Capacity

```
#batteryCapacity:12000;;^M^J
@batteryCapacity:ack;;
#batteryCapacity:3000;;^M^J
@batteryCapacity:ack;;
```

Figure 7 Output for Battery Capacity

- Output for Resource Enable

```
@resourceMonitor:kl 15/30 is required!!;;
#kl:30;;^M^J #resourceMonitor:1;;^M^J
@kl:30;;
@resourceMonitor:1;;
```

Figure 8 Output for Battery Capacity

We recorded 2 videos, named “IMU Output” and “Steering Output” respectively. But when we try to input steering and speed to control the motor, the car does not respond. We will continue to debug.

### 3. Exploration of Perception - Depth Camera

We plan to add a depth camera (Inter Realsense D435i), which can detect target objects in the depth distance of 0.2m ~ 10 m in front of us, and achieve high-definition depth image acquisition with a maximum resolution of 1280x720@90fps and a maximum RGB frame resolution of 1920 × 1080.

Figure 9 Inter Realsense D435i

Based on existing depth cameras, the depth map is processed as follows to obtain the position and dimensions of obstacles:

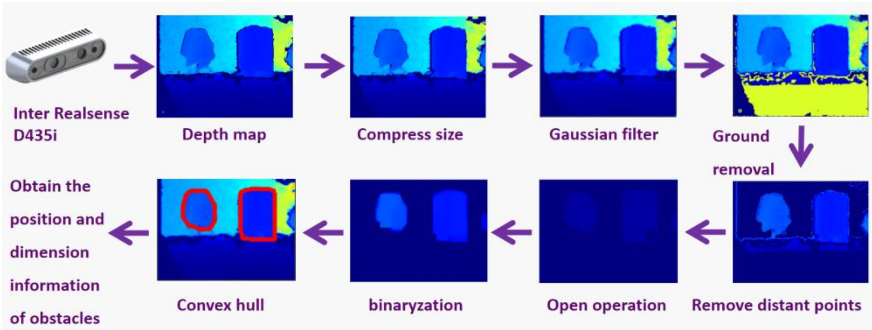



Figure 10 Inter Realsense D435i

As can be seen in the figure, the depth image is obtained from the camera and compressed to improve the recognition speed. After filtering, points on the ground and points far away are removed, so as to obtain the obstacle range. After separating each obstacle through open operation, the obstacle range can be obtained after binarization and convex hull is obtained. Then the position and dimension information of obstacles are obtained by means of coordinate system transformation.

In terms of perception algorithm, we adopt the algorithm version of YOLOv5, which has high accuracy, small model size and good generalization performance. But we are still training the model on the data set and will soon be able to successfully train and integrate it into the vehicle.

## 4. Exploration of Decision - Deterministic sampling method

In terms of decision control, inspired by the "Intelligent Connected Car" course, we chose to explore "deterministic sampling path planning".

The deterministic sampling path planning control method ensures comprehensive coverage of potential paths by systematically sampling within a predefined search space, thereby enhancing the efficiency and accuracy of path planning. During the sampling process, the method considers not only the kinematics and dynamics constraints of the vehicle, such as maximum speed, acceleration, and steering angular velocity, but also ensures that the generated path is optimal and practical. Additionally, by optimizing the performance function, the method evaluates the smoothness of different paths, speed changes, and steering changes, as well as the deviation between the endpoint and the reference point at the sampling points to achieve the optimal path and speed curve. The final output path and speed curves are precisely calculated at the sampling points and can be directly used to guide the actual driving of the vehicle. This method is particularly suitable for complex and variable traffic environments and can find the optimal solution in a reasonable time to meet real-time control needs.

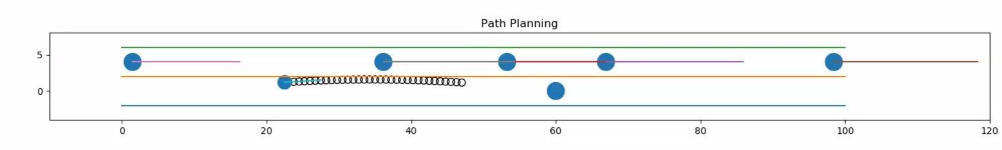



Figure 11 Deterministic sampling algorithm (with lane change, overtaking, etc.)

You can see the report and the gif in the link below:
https://cloud.tsinghua.edu.cn/d/98d6ff65bb084e91ab35/

## 5. Future plan

We have just completed our final exams these past two weeks, and the school has arranged visits and exchange activities with BMW headquarters and Infineon Company in Germany, which has delayed our overall progress.

Figure 11 Visit and communicate

Before the third report, the Chinese Spring Festival will be celebrated from January 29 to February 5, and we will be celebrating the New Year. During other times, we will deeply explore the real vehicle algorithms for different traffic scenarios and implement them at the control level. Regarding computing power, we may require a more powerful unit, such as the Nvidia Orin NX, and we will purchase equipment and assemble and debug it in a timely manner!