Designing a power steering system for accessible bikes

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This thesis was completed in collaboration with Van Raam, a Netherlands based manufacturer specialising in accessible cycles. Van Raams mission is to give people with reduced cognitive or physical ability the opportunity to cycle safely and with comfort. The goal of this project was to make the steering experience of their larger, multi person bikes feel lighter. Due to their bikes unique geometry and size, steering these multi person bikes at low speeds, or a standstill requires a surprisingly large amount of force to pivot the wheels, making it uncomfortable and intimidating for some riders.

The end goal of this assignment was to design, build and test a power steering system that could be fitted to Van Raams bikes for user testing. The Chat bike (Figure 1) was used for testing this project since it was the easiest to access for this project and it is one of the heaviest bikes Van Raam make.

Figure 1 - Chat bike, Van Raam

This project was completed by first looking at the existing issues with the Chat bikes steering. The force required to steer the bike in several scenarios was measured and recorded. In parallel to these tests, existing solutions for similar, heavy steering scenarios were researched, these solutions mostly consisted of power steering systems found in the automotive industry.

Using this research, hardware choices were made, these being a Brushless DC motor, control board and torque sensor. These parts were chosen with price, accessibility, and complexity

in mind. A combination of these parts would lead to an assisted steering system with the same working principle as an electrical power steering system found in most modern cars. The location of the hardware was chosen and three iterations of a prototype were made.

After checking tolerances and writing software for the device, the final prototype was made using 3D printing, Laser cutting and CNC machining. The result is shown in figures 2 and 3.

Figure 2 - Side view of gearbox and motor

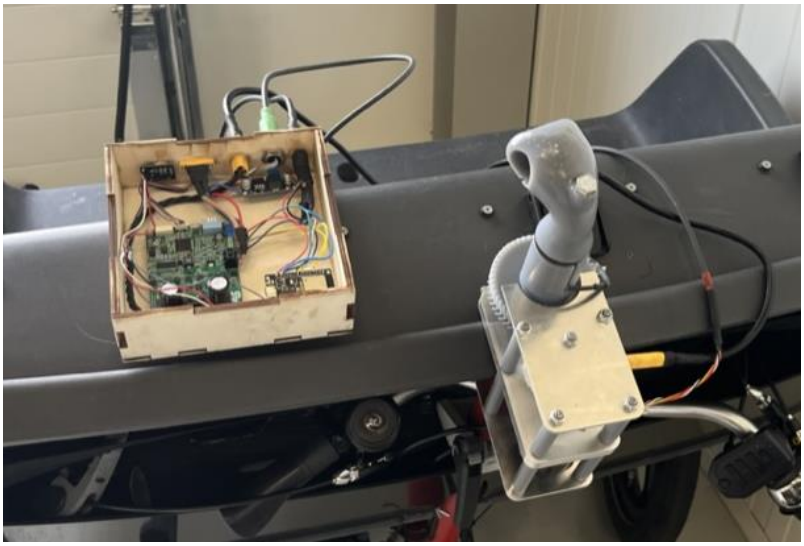

Figure 3 - Top view with electronics

The final prototype was then tested to see its impact on the end users steering experience. The system did not perform as well as expected, the torque sensor in the stem of the bike had issues with it's sensitivity and accuracy. This was due to the simple control software written for the bike as well as it's use case. The sensor is normally used to detect the users pedalling force. In some scenarios, the user had to apply a maximum of 7Nm of force to steer the bike, down from 22Nm. A clear reduction in steering effort was also felt by the rider but the system was not consistent or smooth in all cases.

This project was done within a very limited time frame meaning parts of the prototype were left incomplete. The most significant being the software and gearbox. The software needs

to be developed to account for the poor accuracy of the sensor as well as smoothing the motors assistance. The gearbox also needs a more aggressive reduction to give more assistance and low angular velocities. Currently, the brushless DC motor move too slowly and is very inefficient. After discussions with Van Raam, it was concluded that the technology has merit and will be pursued further in future projects.

This project was essentially, a robotics project that was completed in a very short time frame by a student with very limited robotics experience. Should the project have had more time allocated to it, the end prototype may have worked better, and a more complex control algorithm would have been written to allow smoother operation.