The Evolving Scholar (2023)

https://doi.org/10.24404/63fe2c902f198c184a58ee9b

Bicycle and Motorcycle Dynamics 2023
Symposium on the Dynamics and Control of Single Track Vehicles
18 – 20 October 2023, Delft University of Technology, The Netherlands

Type of the Paper: Extended Abstract

Adapting a variable stability mechanism for a tilting tricycle from the delta to the tadpole wheel configuration

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Name of Editor: Christoph Schmidt
Submitted: 01/03/2023
Accepted: 20/03/2023
Published: 26/04/2023
Citation: Dressel, A. & Moore, J. (2023). Adapting a variable stability mechanism for a tilting tricycle from the delta to the tadpole wheel configuration. The Evolving Scholar - BMD 2023, 5th Edition.

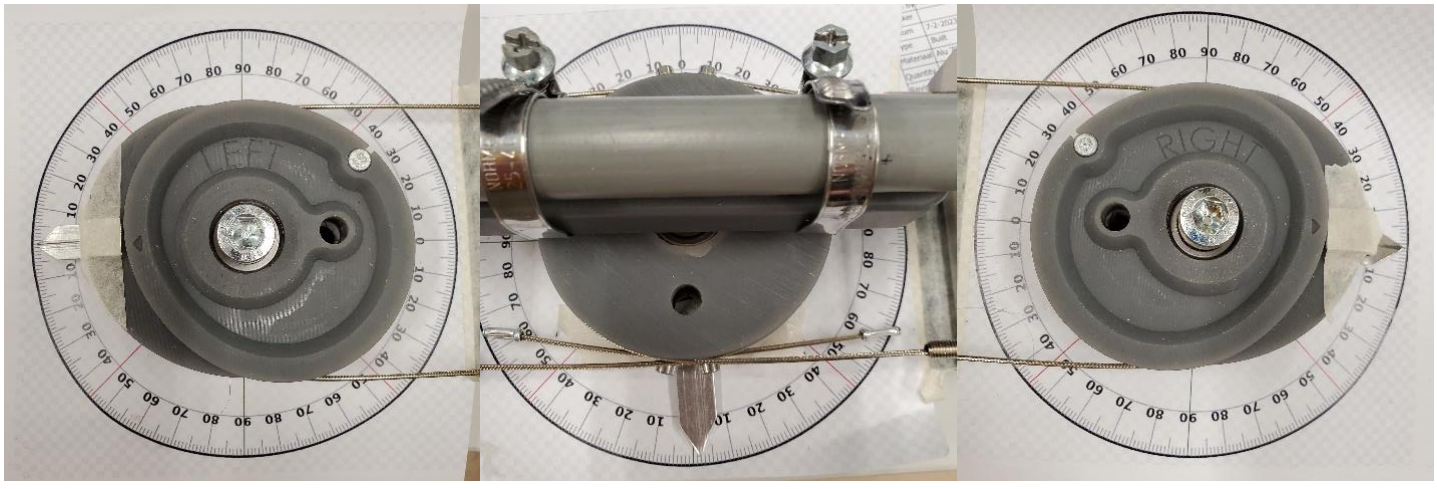
Abstract:

We previously presented a narrow-track tilting tricycle with a variable stability mechanism integrated between the swing arms that support a pair of rear wheels, in the so-called “delta” configuration. We now examine adopting that variable stability mechanism to work on a tricycle with a parallelogram linkage between a pair of front wheels, in the so-called “tadpole” configuration.

It was fairly straightforward to allow for varying the stability by splitting the parallelogram into two independent halves, each comprising two A-arms and a kingpin, and then controlling the motion of the two halves with a bell crank and two tie rods, just as we did with the swing arms of the previous vehicle.

We have also separated the two tasks of positioning the tie rod ends on the bell crank and enforcing symmetry of the tie rods. The former does not require much force and can be easily implemented with the same cables the rider uses to control the mechanism, but the latter does require large forces and is better implemented with a local linkage.

Implementing a decent Ackermann steering geometry, allowing for both large tilt and steer angles, and decoupling tilting from steering, however, proved to be quite a challenge, at least while we attempted to implement it with bar linkages. Fortunately, we discovered a 2006 paper by Prof Drstvenšek et al. describing a Bowden cable and cam system that looked promising.



ISSN: 2667-2812

Figure 1. Images of the cable and cam steering system proof-of-concept prototype.

The system performed well in numerical simulations, but we were concerned that drag in the Bowden cables would interfere with the natural self-stability we hoped the vehicle would demonstrate. Thankfully, evaluations of several commercially available steer-by-cable cargo bikes and a couple of our own proof-of-concept prototypes proved that very low friction was possible.

Finally, we are building a working prototype of the complete vehicle and will evaluate its handling in a separate submission.

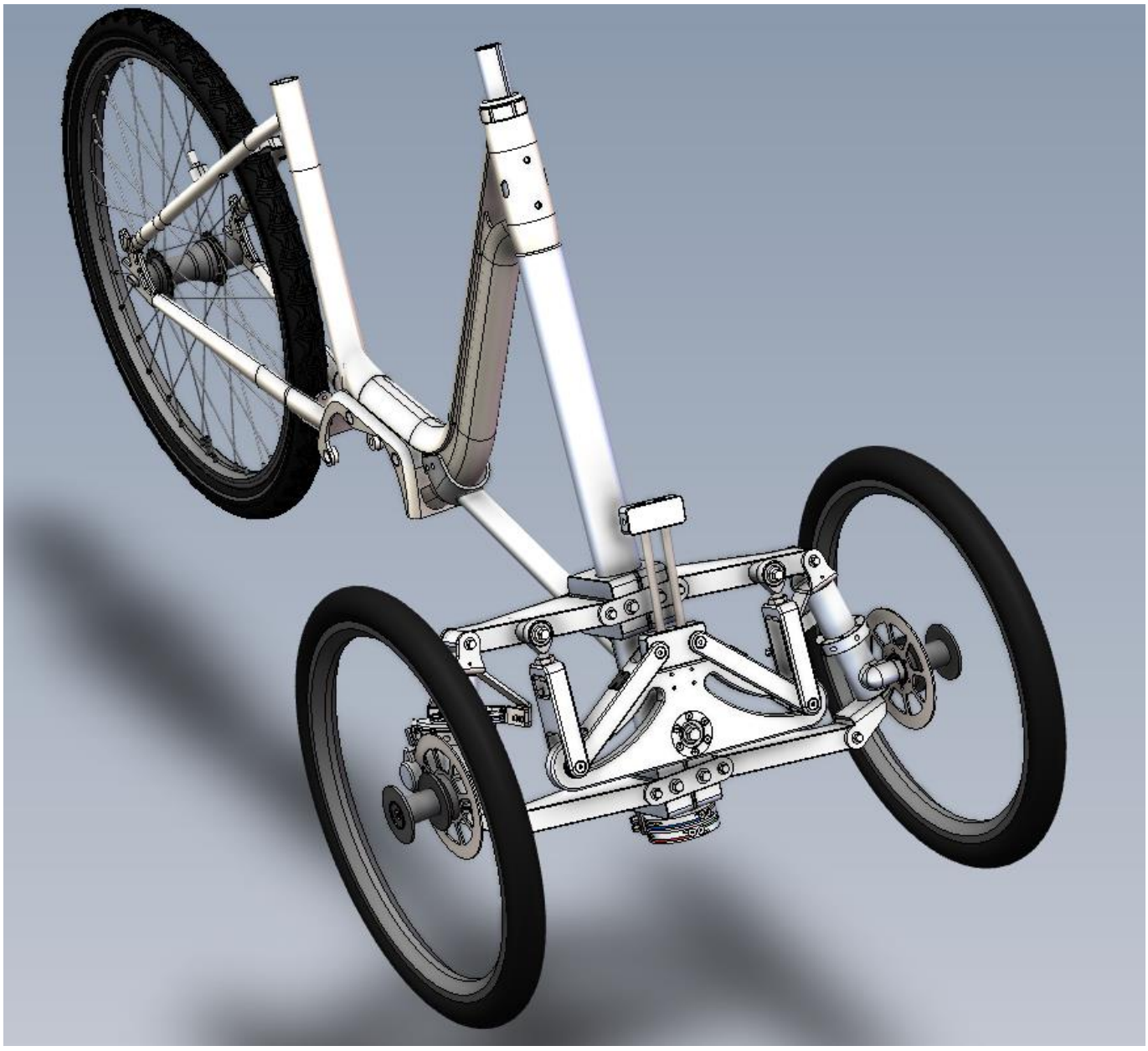


Figure 2. Final design solid model.

This project was financed and supported by the TKI/ClickNL 'De Fiets van de Toekomst' grant and Royal Dutch Gazelle.

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ISSN: 2667-2812