# Title: Time-to-Contact for Safety and Reliability of Self-Driving Cars Name: Jonathan Pilling

Authors: Liang Wang, Berthold K.P. Horn *Engineering Research Paper*

Published in: 2017 *Question–Answer Form*

# What is your take-away message from this paper?

Relative velocity calculation is imperative to perfect the self-driving car.

* What is the motivation for this work (both people problem and technical problem), and its distillation into a research question? *Why doesn’t the people problem have a trivial solution? What are the previous solutions and why are they inadequate?*

The motivation for this work is to make self-driving cars safer, in particular making sure the self-driving car is able to calculate relative velocity to vehicles in front of it. The trivial solution to the people problem is to not have self-driving cars, but with perfected technology we could be safer on roads than we are now. Solutions now are taking the time derivative of the measured distance to the leading car. This solution is inadequate because any small noise in the measurement will be amplified.

* What is the proposed solution (hypothesis, idea, design)? *Why is it believed it will work? How does it represent an improvement? How is the solution achieved?*

Proposed solution is to estimate the time to contact, then calculate the relative velocity by multiplying distance measurement by inverse of the time to contact. Believed to work well because the time to contact can be calculated really quickly. This is an improvement because we only need one camera to calculate the Time to Contact, as opposed to two cameras to capture depth and motion information. Solution is achieved by implementing this algorithm on Android smartphones.

* What is the author’s evaluation of the solution? *What logic, argument, evidence, artifacts (e.g., a proof-of-concept system), or experiments are presented in support of the idea?*

Lots of equations to prove the physical properties of velocity. Demonstrates how you can obtain the relative velocity from the TTC. Using the one camera you still need to obtain a distance dn with some other sensor like a radar. Authors also use a controllable robot car to test the TTC algorithm.

* What is your analysis of the identified problem, idea and evaluation? *Is this a good idea? What flaws do you perceive in the work? What are the most interesting or controversial ideas? For work that has practical implications, ask whether this will work, who would want it, what it will take to give it to them, and when might it become a reality?*

I think it’s a good idea, the less cameras the better for self-driving cars, as long as it’s just as safe. This cuts at least camera costs in half. I think any company seriously working on implementing autonomous cars would consider this technology.

* What are the paper’s contributions (author’s and your opinion)? *Ideas, methods, software, experimental results, exper- imental techniques...?*

The paper really talks about the TTC algorithm a great deal. Experimental results from the robot car, when the TTC value gets really small and positive the screen has a red display. Using a low pass filter for noise suppression in TTC estimations. Fully functioning TTC algorithm using Java. Experimental results, reference frames/pictures taken from the car to see how images shift.

# What are future directions for this research (author’s and yours, perhaps driven by shortcomings or other critiques)?

I’d like to personally research more about the TTC algorithm. The author talks about how vibrations from the car can shake the camera and potentially mess up the value of the estimated TTC. Their direction now might be to help solve this issue.

* What questions are you left with? *What questions would you like to raise in an open discussion of the work (review interesting and controversial points, above)? What do you find difficult to understand? List as many as you can.*

I don’t know what the perspective projection equation really does. What is machine vision? What is the focus of expansion? This works well with a robot car going 40cm/sec, how effective will this be in preventing crashes with cars going 80mph? What is optical flow?