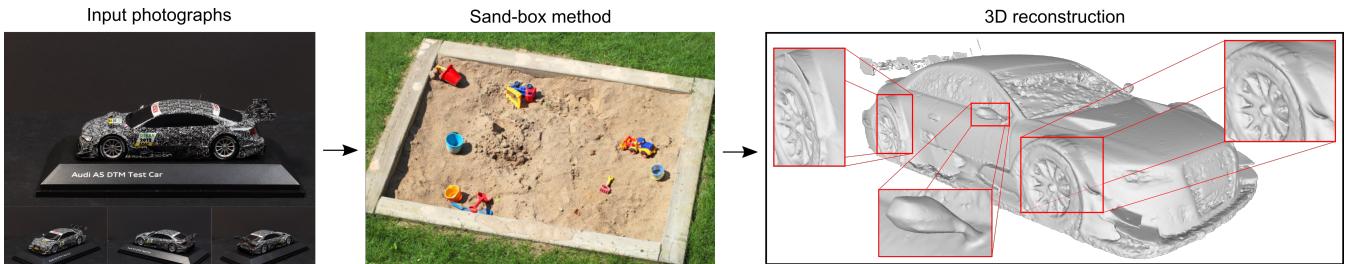


A Free Computer Vision Lesson for Car Manufacturers or It is Time to Retire the Erlkönig

Maximilian Weiherer Bernhard Egger

Fantastic-Amazing-University Erlangen-Nürnberg (FAU)

maximilian.weiherer@fau.de
bernhard.egger@fau.de



Oh no – we can recover very detailed 3D shape from Erlkönig photographs. How could this have happened? And even worse, the reconstruction is best in the parts where there is a pattern. Well, we guess someone didn't know about the basics of computer vision.

Abstract

In award winning prior work [1], we identified the inability of autonomous cars to honk as the key reason that they are not broadly deployed on our streets. In this work [2], however, we suggest that the core reason is the lack of most basic computer vision knowledge of car manufacturers. To hide their most fancy new cars they put a special camouflage pattern on their so called *Erlkönig* prototypes. The pattern is designed to trick our perception; at the same time it enables computer vision systems to perfectly recover the 3D shape of the prototype – even better than without the pattern as we show in this paper. How could we expect a prototype car that already demonstrates a lack of computer vision knowledge to ever evolve into an autonomous vehicle?

1. Introduction

We could now tell you the whole story of the Erlkönig and Dazzle Camouflage patterns, but that is way to much work. The interested reader (if any) is kindly asked to read the relevant literature here: https://en.wikipedia.org/wiki/Dazzle_camo. The relevant portion is that the pattern is designed to make it hard to estimate the range, speed and heading of a ship and it might also make it harder to estimate the type of the ship, see Figure 1. And this is all cool and everything, but over 100 years have passed since the pattern was described by Norman Wilkinson during the last pandemic. This does not hold back car manufacturers to paint their dinosaur eating machines (also the sun eating counterparts) with patterns motivated by this idea and brag about it (<https://www.bmw.com/de/automotive-life/erlkoenig-auto.html>). The car manufacturers might try to hide the shape of their cars, and it might work pretty well when it comes to the human eye. It might even hold some cameras back from using their automatic focus. But all of that only holds for a single view! The moment we have multiple



Figure 1. Damn hard to estimate the heading of the boat on the left with the Dazzle camouflage pattern, right? Source: Encyclopædia Britannica, 1922 / Wikipedia.

viewpoints – tadaaa – we can use the whole ballpark of computer vision algorithms and even algorithms from the stone-age (all historic works before 2022) of computer vision lead to an almost perfect 3D reconstruction.

To summarize, in this paper, we impressively show that the 3D shape of a car covered with camouflage patterns (i.e., an Erlkönig) can be very well reconstructed just from a set of ordinary photographs, taken from different perspectives. To make the embarrassment for car manufacturers perfect, we demonstrate that the 3D reconstruction of the same car *without* patterns is much worse. That's bitter.

1.1 Related Work

Besides a Twitter thread with various researchers almost scooping us, there is no relevant prior work (see Figure 2).



Jaakko Lehtinen
@jaakkolehtinen

I've thought for long that these camouflage patterns used by car manufacturers on their prototypes should in fact make it *a lot* easier to reconstruct their accurate 3D shape by multi-view stereo compared to the good ol' featureless solid paint..

(Picture: Polestar)



3:20 PM · Jan 12, 2022 · Twitter Web App

4 Retweets 79 Likes

Figure 2. Almost scooped: <https://twitter.com/jaakkolehtinen/status/1481269802681393153>.

2. Methods

Given a set of photographs taken from different perspectives, we used BASIC photogrammetry for 3D reconstruction, see e.g. <https://en.wikipedia.org/wiki/BASIC>. The choice fell on BASIC because we are absolute beginners when it comes to programming (and all this computer stuff in general). Following common practice and due to the lack of knowledge, we do not reveal all the details about our method. But we want to sprinkle in some unnecessary details like for example the parameters

$$\xi \text{ and } \zeta \quad (1)$$

that are not introduced but very critical and car-fully set to the value 5. As far as we understand, a key step in our pipeline involves the solution of the *Perspective-n-Point* (P-NP) problem. Having a solution of the P-NP problem at hand and exploiting the fact that $P = NP^1$, obtaining the final 3D reconstruction in form of a triangular surface mesh is dead easy and no more information is needed to re-implement this.

3. Experiments and Results

We took 32 photos of an Erlkönig² and applied the method described earlier to obtain a 3D reconstruction. About the same procedure was used to reconstruct the same car *without* a pattern. Ev-

¹ A proof is provided in the Appendix. In essence, however, the ingenuity in our proof was to use the well-known fact that $e^{i\pi} - 1 = 0$ <MW: Damn, just realized we've been using this formula wrong all the time. BE: Relax. No one will notice.>. Kudos to Leo Euler. @ClayInstitute: We expect the money no later than May 1st, 2022. We need it. Desperately.

² Due to an ongoing legal dispute, we unfortunately cannot share any details about the car. Please refrain from e-mail inquiries. Authors may not have access to the internet for an unknown period of time.



Figure 3. See, pattern leads to awesome reconstruction whilst no pattern no good. Please print in grayscale on dead trees for better visibility of details.

erything went perfect on the very first try (yes, no testing or training or what else was needed) and our method produced spectacular results, see Figure 3. As expected by computer vision experts, the reconstruction of the Erlkönig is at least a million (10^6) times better than the reconstruction obtained from the same car without a pattern. These results are so good that we don't even need a quantitative evaluation, right?

4. Limitations

Car manufacturers will say we are missing something here and things are more complex. Don't believe them. They also say burning dinosaurs is cool and that we will have autonomous cars next year! We win, they loose – it's that easy.

5. Conclusion

To summarize, the pattern might be able to cause a collision with a Tesla, but for any other purpose it is beyond repair: the Erlkönig is asking for retirement – loud and clear. Just like this Tim Brady!

Our future mission should be clear and obvious: reveal the shape of all the things in this world covered with a camouflage pattern (or something that looks like a camouflage pattern; doesn't matter, our method will tackle it anyway because it generalizes). This immediately leads to the following research questions: what the heck is really hiding under a military uniform? And, can we trust QR codes? Stay tuned and make sure to follow us on Twitter.

Finally, if you want to learn more about computer vision: there might be a cool lecture at your favorite astonishing university (FAU). If you are a car manufacturer: we have some ideas to help you out of your misery and are looking for funding.

References

- [1] B. Egger and M. Siegel. Honkfast, prehonk, honkback, prehonkback, hers, adhonk and ahc: the missing keys for autonomous driving. *SIGBOVIK*, 2020.
- [2] M. Weiherer and B. Egger. A free computer vision lesson for car manufacturers or it is time to retire the erlkönig. *SIGBOVIK (under careful review by very talented, outstanding reviewers)*, 2022.