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Essay

The essay is due on the June 11, 2015. Please remember that **the essay is a prerequisite to a passing mark**! It cannot be dropped.

One thing you practice in the essay assignment is reading a difficult scientific text, a paper, at some depth. Take time for the reading and follow the instructions below. Reading always includes hunting down references, consulting other papers, looking up things you don't know. The instructions below give some hints for stuff you may need to hunt down and links to some resources for that (e.g., Scheinermann's book). But you may find additional resources. So reading does not necessarily mean only reading the target paper.

The questions listed below are points that you should address in your essay. However, the structure of your essay does not necessarily need to follow the one laid out in the assignment. The essay is an opportunity for you to learn to write a well-structured scientific text. *Write text, that a reader can understand without having read the assignment!* For each point, first introduce the issue, make your points, and conclude or summarize. When you use equations, make sure to introduce all terms.

Cite sources properly, especially when copying figures. If you copy passages of text from sources, mark these using quotation marks (" ") and give a source. Keep such direct quotes to a minimum. One goal in giving you an essay assignment is for you to practice articulating scientific and technical ideas clearly and concisely, using your own words. **Copying text from other student essays or from sources without proper citation is not acceptable and may lead to you failing the essay, and thus the entire course!**

Write in English or German. Your first version will probably need revision. You can hand in hand-written essays, but we strongly suggest you write this on a computer as that makes it easier to revise your text. For typesetting, we recommend using LaTeX; we regularly use this for our own publications, but you can use the word processor of your choice. In any case, leave some margin on the sides for our comments and corrections.

There is no fixed page limit, and neither do we impose fixed formatting constraints. Length should be commensurate with contents and does not by itself influence the grade. It is unlikely, however, that a two page essay treats the subject matter with sufficient depth. On the other hand, if your essay exceeds, say, 15 pages, you may be straying too far from the topic.

Finally, budget an appropriate amount time for working on the essay! In our experience, students tend to underestimate the workload and time required for the essay assignment. **It is unlikely that you can do this assignment in just two or three days!**

Instructions and questions

Read the paper (available on the course's web page): A Dynamical Model of Visually-Guided Steering, Obstacle Avoidance, and Route Selection by B R Fajen, W H Warren, S. Temizer, L P Kaebling *International Journal of Computer Vision* **54**(1/2/3), 1334, 2003

In a first reading, ignore problems you have comprehending. Only look up words critical to your understanding. Try to get a picture of the whole article first. Mark passages you don't understand (but don't work through them yet), underline points you do understand and find important. Try to gain an understanding of what the components of the paper are.

1. Only then write down a short summary of what you think are the main goals of the paper. This is the first point of the essay. Write down that summary now, you have a chance to rewrite it below.

2. Focus now on the dynamics listed in Equation (4).

   (a) Describe (in words, perhaps referring to the terms of the equation) how this dynamics differs from the dynamics discussed in the lecture "Attractor Dynamics Approach" (see also: Schöner, Dose, Engels: Dynamics of Behavior: theory and applications for autonomous robot architectures. Robotics and Autonomous Systems 16:213-245 (1995)
   available at: `http://www.ini.rub.de/publications/396`) .

   (b) Analyze the attractor on which this dynamics is based, focussing on the target acquisition terms (the first line of Equation 4 in the paper). To compute the fixed point of this equation, transform it into a set of two first-order differential equations first. Do this by introducing a second variable (next to ϕ), which you can choose as $\omega = \dot{\phi}$. You need to rearrange terms so that you have an equation with $\dot{\omega}$ on the left and only ϕ and ω on the right. The second equation is the definition of ω itself: $\dot{\phi} = \omega$. The fixed point is the set of values for ϕ and ω at which both of these equations are zero. You can trivially solve those equations.

   (c) This dynamics (the first line of Equation 4) is a damped harmonic oscillator. Look up that topic in a textbook or on the internet. Rewrite the constants so that the analogy is obvious. Based on mapping the equation onto the damped harmonic oscillator, discuss and graphically illustrate the solutions (assuming that the inputs to the equation are fixed). You may make a sketch for an under-damped oscillator and for an over-damped or critically damped oscillator. (A good resource for this is again Scheinermann's book, that I referred to in a previous exercise sheet. Figures 2.11, 2.12, 2.13 of that book are examples of what we need here.).

(d) Also make a phase portrait of the solutions of the damped harmonic oscillator. That is, plot the rate of change, here ω, against the variable, here ϕ, while the solution goes to the fixed point. Compare that to Figure 2 of the paper and discuss, how this matches. (Note: this is not an exact match, as in the simulations of Figure 2 the parameters in the equation are not constant in time as the distance from the goal changes).

3. Now look at the second line of Equation 4, the obstacle avoidance term. How does it differ from the term we used in the lecture? This is a minor difference, which I draw your attention to only to avoid confusion.

   The complete model is used to account for human walking. In Figure 7, realistic simulations of the model are shown that match observed human walking patterns. Doesn't the path seem particularly extreme in the avoidance phase? Look at the units of the different axis and redraw approximately with horiztonal and vertical axis on the same scale. Why did the authors use the unequal scales in Figure 7?

4. Read again the section on the potential field approach and its comparison to the attractor dynamics. This may not be so easy to understand. Write down one or a few paragraphs, in which you summarize what you understand about the potential field approach and how it differs from the attractor dynamics. Do not write anything, that you don't understand. In a second section, write down things that you did not understand, but that are claimed in the paper. This can be a list of questions or it can be a list of statements, the proofs of which you don't understand.

5. Return to the initial abstract that you first wrote. Read it again and revise it, or completely rewrite it, now that you have studied two points of the paper in more depth. Perhaps you have critical comments, or new ideas what one could do, or new questions that came to your mind while working through the paper. Add them to this revised summary.