How to *join* the Robotic Swarm Control Lab

Professor Aaron T. Becker

***Abstract*— The Robotic Swarm Control Lab (RSCL) exists to (1) understand, quantify, and implement the best methods for controlling huge numbers of robots, (2) implement robotic solutions to medical problems, (3) train confident, productive, ethical engineers to perform impactful research.**

This document explains how to earn lab access and the software suite we use.

I. Preliminaries

We are glad you are interested in the lab and looking forward to getting to know you! Figure 1 describes the process of joining the lab. First learn about our lab, then level up by completing a literature review and safety training.

A. Learn about our lab

1) Browse through our YouTube channel youtube.com/aabecker5/, Mathematica Demonstrations Gamification research: SwarmControl.net, and papers: scholar.google.com/Aaron T Becker. Decide: Do any of these seem interesting to you? If so, do you have any tools or techniques that could be applied to these? Could you optimize something? Do you already have a project you want to pursue? If so, can you show how it aligns with my lab's goals or interests?
2) Email Prof. Becker. include your CV, potential project, why you want to attack this problem, any skills you bring to the project (page 3), and funding requirements. Funding MS students is very difficult, funding PhD students is difficult, but there are some opportunities every semester either through my grants or by applying to external sources.
3) Request a meeting with Prof. Becker, or visit during office hours (at least 12 hours after emailing description)

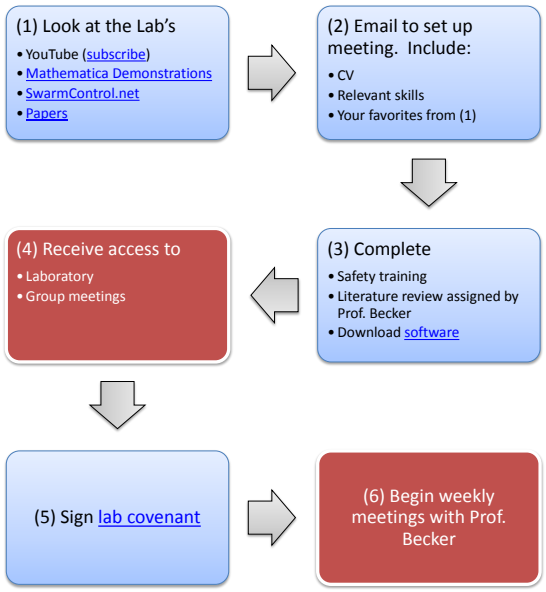

Fig. 1. Some description of figure. All plots must have labeled axes with units in parenthesis, for instance: Robot diameter (μm)

B. Install core software

Our papers are produced in LaTeX, a document markup language. LaTeXis widely used for the communication and publication of scientific documents in many fields. We use a distributed revision control system called Git to backup and share our results.

The following instructions are aimed toward users with Windows operating system. If you use Linux, we will assume you are competent to find your own software.

1) download and run the Basic MiKTeX installer to setup a basic TeX/LaTeX system on your computer http://miktex.org
2) install Texmaker, a front end for LaTeX, http://www.xm1math.net/texmaker/

3) install github. We submit our code and written documents through github, which serves as a distributed backup. The repository for our lab is at github.com/aabecker.
4) install MATLAB. Matlab is useful for plotting, simulating, image processing, etc. It is provided by the University of Houston at Software downloads.
5) (Optional) install Inkscape, a professional vector graphics editor. We save our images as .svg files, and generate .pdf images that can be used for posters, papers, and presentations.
6) (Optional) install Mathematica. Mathematica is useful for equation manipulation, making interactive demonstrations, and making pretty plots. It is provided by the University of Houston at Software downloads.

II. Earning Lab Access

Every potential lab member must complete a literature review and lab safety training before being issued access to the robotics lab.

A. The literature review

Master and PhD scholars primarily share their research through scholarly writing in academic journals and conferences. Members of the RSCL must have one conference paper to be eligible for a Master's degree. Every paper begins with an outline of the problem, followed by an overview of the current solutions in this area this is called the *literature review*. To join the lab *everyone*, from undergraduates to professors, must complete the following literature review.

On a topic selected by Prof. Becker, select no less than eight references from the proceedings of ICRA, IROS, or RSS[1] Go back no more than five years. Older papers have usually been superseded by new algorithms or technology.

The goal is a concise, high-level research summary. For each paper, write only one paragraph. There should be less than three papers per column.

[1]Some conferences are better than others, and some journals are better than others. ICRA, IROS, and RSS are the flagship conferences in robotics. ICRA and IROS have ≈1,000 papers each year, RSS is more elite with ≈ 50 papers.

- Goal of their research
- Assumptions (centralized control vs decentralized, perfect sensors vs partial state feedback, in simulation or in experiments, etc.)
- Limitations (what did they actually do?)

These summaries should be concise: no more than 3 papers per column.

A sample literature review is located at JoiningTheLab/LiteratureReview.

B. Lab Safety training

Your safety is important to us! The class **EH06: General Laboratory Safety and Hazardous Materials Orientation** is mandatory for all lab members. This class can be signed up for online. It is more fun to complete with a friend.

- http://www.uh.edu/ehls/training/
- http://www.uh.edu/ehls/training/eh06/

This class includes toxicology, recognition of hazards, personal protective equipment, understanding MSDS's, proper storage of chemicals, proper disposal of chemicals, fire safety and general safety rules

III. Conclusion

After you submit your literature review, meet with Prof. Becker and arrange a meeting.

Some other things to consider:

- You can join IEEE www.ieee.org/join. Feel free to mention my member # 80569446.
- robotics-worldwide is a weekly update of what is happening in robotics. To subscribe, visit http://duerer.usc.edu/mailman/listinfo.cgi/robotics-worldwide
- IEEE spectrum has a section on robotics: http://spectrum.ieee.org/robotics
- Robohub is another place for robot updates on robotics: robohub.org

IV. Survey of useful Robotics skills

Name:
Email:
Status: undergrad

Mark if you have each skill. Let me know if there is something you really want to learn (TODO: parse the output to auto fill a spreadsheet)

A. Mathematics & Control

- Hidden Markov Models (HMM)
- Nonlinear control design
- Numerical Optimization
- PID control design
- POMDP
- Proof writing
- Quaternions
- Random Process modeling
- Statistical Analysis

B. Electronics

- Antenna design
- Battery Design
- Circuit layout design/fabrication (what software)
- Microscopy
- Oscilloscope use (what brand?)
- Soldering
- Surface mount soldering

C. Fabrication Skills

- Carpentry (framing/finish?)
- CNC
- Have you ever made an electromagnet?
- Manual milling
- Masonry
- Welding (what metals)

D. Software

- CAD software (what software)
- DSP programming (what type?)
- LabVIEW
- Linux
- Mathematica
- Matlab
- MRI pulse sequence design (what type?)
- Player/stage
- Robot Operating System (ROS)
- Microprocessors (which one)
- OpenCV
- Comsol (what packages?)
- Finite Element Analysis (what software?)

E. Programming Languages (indicate skill level 'N'one, 'Basic, 'I'ntermediate, 'A'dvanced)

- C: N
- C++: N
- Java: N
- Python: N
- Ruby on Rails: N
- Shell scripting: N
- Web design: N
- Others:

F. Hobbies

- Microcontroller programming (brand?)
- Model trains
- Quadcopters (construction or piloting?)
- RC airplanes (construction or piloting?)
- Rocketry

G. Training

- Clean room training
- IRB training *at the CITI website select Register for the Course. Select University of Houston as your institution, a username and password, and do coursework for Group 1.*
- Machine Shop training
- Medical training (CPR, first aid,)
- Travel Planning

H. Fine Arts

- Drawing/Painting/Sculpture (List:)
- Gardening/cooking/baking (List:)
- Graphic Design
- Music: instrument/sing (details)
- Photography
- Scriptwriting/acting
- Sports/Dance/Martial Arts (List:)
- Videography/movie editing (software:)