Chapter

1

Introduction

The motivation to write this tutorial came from the great experience we've had during RoboGames 2006, in San Francisco. We were able to see how friendly competitors are, exchanging information, showing their robots in detail even for their next opponents. Several teams publish in their websites detailed build reports, with step by step information on how they've built their robots. There are also great books and tutorials showing how to build combots, however there was nothing written in Portuguese. This is why I started writing this tutorial, right after RoboGames 2006.

The tutorial was first released in August 2006, in Portuguese, as a free download both at the RioBotz website www.riobotz.com.br and at the website of the Brazilian combat robot league RoboCore, www.robocore.net. The idea was to stimulate the creation of new Brazilian combot teams, as well as to help the existing ones. It was very well received, with 1,500 downloads within the first week, 10,000 in the first 6 months, and more than 20,000 so far. A few people say that it might have helped with the increasing number of Brazilian teams that we see today.

A few builders asked me to generate an English version of this tutorial, so here it is. The tutorial was originally aimed for beginners, but its contents grew so much since the 2006 version that even veterans might find it useful. It basically includes everything that we've learned since January 2003, when RioBotz was created. We're still young compared to several great international teams, however we still hope we can contribute in some way with this text.

My biggest challenge was to try to include the maximum possible amount of information, from basic to advanced topics, in a compact way that would be easy to understand. We want to stimulate new teams to start building robots, showing that you don't need to be a rocket scientist to create a competitive combot. It is possible to do it even with little engineering background.

Feel free to distribute or print out this tutorial, I would just ask to keep it in its original form. I believe that this tutorial will help not only combat robot builders, but also anyone who wants to build robust and resistant mobile robots, to participate in any type of competition.

Excuse me if I make any mistakes in the following pages, some pieces of information include personal opinions, and therefore they can be biased. In spite of that, almost all the presented ideas have been tested in practice, in the arena, either by us or by other builders. I would love to receive your feedback in anything related with this tutorial, including comments, suggestions, corrections, anything that might improve future versions of the text, posted to the "RioBotz Combot Tutorial" topic on the RFL Forum. Thanks.
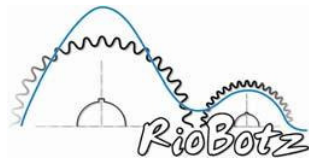
1.1. A Brief History of Robot Combat

Robot competitions have existed for a long time. They have been attracting competitors and spectators from all over the world. A very good review, along with great photos, can be found in the book "Gearheads – The Turbulent Rise of Robotic Sports" by Brad Stone [9].

I'll try to introduce the subject based on my personal experience. One of the first competitions involving robot confrontation was the Design 2.007 course (http://pergatory.mit.edu/2.007), a 2 night event that happens every year since 1970 at the Massachusetts Institute of Technology (MIT). The robots are built during one semester by undergraduate students taking the 2.007 course, Introduction to Design and Manufacturing, from the Department of Mechanical Engineering. The objective is to build a radio-controlled robot that fulfills certain tasks, such as collecting balls or transporting parts, in an arena with obstacles. Every year the task is modified to stimulate creativity.

I had the opportunity to witness as a graduate student the 1996 MIT 2.007 competition (pictured to the right). I was fascinated with the enthusiasm and mainly with the students' creativity. The best thing about these competitions is that the tasks were disputed with two robots facing each other at the same time in the arena. One wins by scoring more points collecting balls, transporting parts, it varies. At some point, you are allowed to block your opponent. It was noticeable that this was the part that most drivers waited for and when the audience really cheered: blocking the opponent. Seeing robots confronting each other, pushing and blocking in an ingenious way the opponent was more exciting than just completing the tasks. I wish I knew back then that robot combat had already been created, 4 years earlier.

The success of Design 2.007 helped inspire the creation in 1992 of a robot competition among high school students, organized by FIRST (For Inspiration and Recognition of Science and Technology, www.usfirst.org), which is held annually. Unfortunately, it doesn't include combat robots.

In that same year, the US designer Marc Thorpe connected a vacuum cleaner to a remote control tank to help perform domestic tasks. The invention didn't work very well as a vacuum cleaner, but it caused damage, a fundamental requirement for a combat robot. At that time, he worked for Lucas Films and, inspired by the Star Wars movie, he created in 1994 the first official competition, Robot Wars. The first event was disputed in Fort Mason Center, San Francisco.

In 1997, Robot Wars was televised in the United Kingdom by BBC, starting the robot combat fever in that country. Legal disputes aside, it was such a success that Robot Wars moved to the UK. For more information on current UK combot events, check out the Fighting Robot Association (FRA) website at www.fightingrobots.co.uk.

Robotica and BotBash competitions were later created in the United States, filling the void left by Robot Wars.
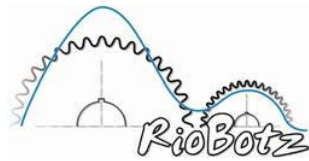
In 1999, Trey Roski and Greg Munson founded in San Francisco the BattleBots league (www.battlebots.com), creating the competition with most media exposure until today. The first event was held in Long Beach, California, in August 1999, with 70 enrolled robots. The second event was one of the most famous, held in Las Vegas in November 1999, televised by pay-per-view. In 2000, BattleBots started to be televised by Comedy Central, quickly becoming popular, being transmitted during 5 seasons.

In 2001, the first Brazilian combat robot competition was held, based on BattleBots rules, in an arena built at the Unicamp University. In 2002, the second competition was held again at Unicamp, this time during the ENECA event (National Meeting of Control and Automation Students). Since then, Brazilian competitions have been held yearly during the ENECA, organized by the Brazilian league RoboCore (www.robocore.net), attracting an ever increasing public.

In 2002, the Robot Fighting League (www.botleague.com) was created in the US. It is the combat robot league with largest activity in the world, organizing from local events to the RFL Nationals, as well as RoboGames, which counts with several countries.

In December 2003, the RoboWars competition (www.robowars.org) had its debut in Australia.

In 2005, another Brazilian competition was created, the Winter Challenge, which is held annually in July (southern hemisphere, winter, July - you'll figure it out). The 2005 competition was held, for the first time ever, on an ice arena. At the end of 2006, the Brazilian league RoboCore became a proud member of the RFL.

1.2. Structure of the Tutorial

The tutorial is divided into 10 chapters. This chapter includes the introduction, robot combat history, and acknowledgments. Chapter 2 talks about the fundamentals of the design of several types of combots. Chapter 3 introduces the main materials used in those robots, and how to select them. Chapter 4 presents the main joining elements, such as screws and welds. Chapter 5 deals with motors used in the robot's drive and weapon systems, as well as power transmission elements, such as gears and belts. Chapter 6 deals with weapon design, and how to improve your robot's weapon system. Both chapters 5 and 6 include several equations, based on basic physics and dynamics calculations, however they are not essential to understand the text and its conclusions. Chapter 7 discusses the several electronic and electric components necessary to power the robot, while chapter 8 talks about batteries. Chapter 9 gives important tips on how to get ready to an event and how to behave before, during and after it. Chapter 10 shows build reports of all the combots from RioBotz, including the entire Touro family, exemplifying several concepts presented in the preceding chapters. I've also included, after the conclusions, a section of frequently asked questions (FAQ), a bibliography containing a few of the best books about combots, and a few appendices with useful information in a summarized form.
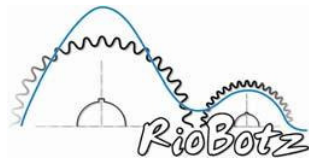
1.3. Acknowledgments

I would like to thank the entire RioBotz team, without whom the ideas here presented would not have left the drawing board, and for the careful revision of this tutorial. More specifically, I thank Eduardo "Dudu" Ristow for his effort as our team captain, for using the mill and lathe at the same time all night long without losing the smile; Bruno Favoreto for being able to master Solidworks even blindfolded; Felipe Maimon and Alexandre Ormiga for their effort in creating powerful and robust electronic systems; Daniel "Esguerda" Freitas and Rodrigo "Delay" Almeida for their great driving skill; Guilherme Porto for his excellent Spektrum programming lessons; Julio Guedes for his fidelity to the team since its creation; Ilana Nigri for helping us turn civilized our most frenzied pitstops; Marcio "Senador" Barros for our webpage; Gustavo "Emo" Parada for his grinding skill; and to Guilherme Franco, Thiago "Tico" Pimenta, Marcos "Pet" Marzano, Camila Borsotto, Carlos "Gotinha" Witte, Carlos "Minhoca" Nascimento, Daniel "Toioio" Lucas, Debora Almeida, Michel "Tocha" Feinstein, and Rodrigo "Cowboy" Nogueira, for all their help building combots. Thanks again to Eduardo Ristow, Felipe Maimon and Bruno Favoreto, for their contributions to this tutorial, especially in chapter 7. Thanks also to our past members, such as Felipe Scofano, Filipe "Saci" Sacchi, Claudio Duvivier, Rafael "Pardal" Moreira, Gustavo "Calouro" Lima, and several other students and alumni from the PUC-Rio University.

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