Preface

Orbis non sufficit

Ever since I saw the motion picture Brainstrom it has been a great inspiration to me. The idea of recording reality, or even better — reproducing an artificial one, in such a way that a person perceives it genuinely — without being able to differentiate the factitious from the actual reality — is an intimidating science fiction concept. However, this may very well be possible in the future. The conception requires, of course, the manipulation of all senses. In this book, I will present the fundamentals and the engineering aspects regarding to human spatial hearing that is one of the key features in creating such a system: the auditory illusion.

The treatise you are about to read is a major exertion from a single person, helped by several others. It has not been an easy task and much more time consuming than beforehand planned. Occasionally, matters could have perhaps been done simpler, but in many cases certainly not better. The challenging and demanding, yet most interesting, inter-disciplinary fields of sciences — acoustics, signal processing, human spatial hearing, amongst other things — have taught me a great deal during the past eighteen months in the Laboratory of Acoustics and Audio Signal Processing at the Helsinki University of Technology. However, the time has given me much education about the way of life, naming here only some aspects: project work, human relations and intercourse, presence of mind and assertiveness, ambition and gratitude, and, of course, science work. The latter has given me strong subjective evidence how real science is been made:

1) Knowledge is power, but in the absence of it: rely on your instincts.

2) A scientist cannot afford to obey the time, one must be able and prepared to work with enduring persistence twenty-four hours a day, if necessary.

3) Scientific debates, which are the genuine gems of science, can only be carried out at night hours, usually without exception.

4) Academic freedom is a paradox — but no real scientist starts his workday early in the morning.
I have had the honorable opportunity to work with fine people at the acoustics laboratory, doing fulfilling research on the topics I have always wanted. My greatest gratitude belongs to the persons who made this possible: my instructor Jyri Huopaniemi (Lic. Tech) and supervisor Matti Karjalainen (Prof.). They have continuously guided me during this work, given intriguing discussions, commented and proofread many versions of this work and helped me remarkably in the world of programming and digital signal processing, amongst other things.

In the beginning of this research my colleagues and I visited Danish universities. This journey taught me about constructions in anechoic chambers, HRTF measurements, listening tests and so on. I thank our wonderful hosts, especially Henrik Møller (Prof.) and Dorte Hammershøi (Dr.) at Aalborg University, Søren Bech (Dr.) at Bang&Olufsen and Graham Naylor (Dr.) at Oticon.

The measurement constructions and hardware caused also a lot of hard work, for which I would have needed an unthinkable length of time to do it all myself. I owe a big thanks to the guys at the workshop of our electrical faculty, especially to the chief, Matti Korhonen, who believed in me. He understood so well my needs and revived me the art of technical drawing, unfortunately he reached to retire on the day when the system was completed. Also, Pertti Vänskä, my main man at the workshop deserves a great thanks; he made the major parts of the measurement constructions, such as the Golgatan X-cross, as he fittingly named it. Our laboratory craftsman Jari Saronsalo helped me unceasingly during the whole process of planning, making, constructing and using the measurement system. I appreciate much of his working efforts, understanding and friendship and often pointing out to me the obvious facts I didn’t notice. Risto Niska, my long-time friend, a true universal genius, and the greatest of all in electronics, has likewise ceaselessly advised me within this research project. To that and the outstanding preamplifier he conjured in only one weekend, I owe him big time. Heikki Salminen, my friend of mechanics and the main reason for my pursuit of splendid photography, has given me also many good hints for the constructions and joyful moments flying his combats and riding his speedboat.

I wish to express my utmost gratitude to all my test subjects, who voluntarily suffered the horrible measurement procedure for almost two hours, and some even longer. Without their unselfish assistance there would have been no data to analyze and no reports to write.

I’m grateful to all the brothers and sisters at the acoustics lab and elsewhere at the HUT, for being there and giving me useful hints at many occasions. The keen discussions with Unto Laine (Dr.), Tapio Tassu Takala (Prof.), Riitta Hari (Prof.) have shown me that there are, indeed, persons of kindred souls to me in the academic world. I also thank her of commenting the second chapter in this work.
and for her kind and appreciative words. I appreciate Vesa Välimäki (Dr.) for his upright morals and advising me in DSP issues, Esa Piirilä for being a real friend, Martti Rahkila for understanding my unique sense of humor, Panu Maijala for his many computer talents, especially making the Samba system work, Lauri Savioja and Toomas Aaltosaar for fruitful conversations, Antti Järvinen for organizing matters and his good comprehension on acoustics and our laboratory secretary Lea Söderman for arranging regular matters. In addition, I’d like to thank Tero Tolonen, Aki Härmä, Miikka Huttunen, Jussi Hynninen, Ila Tokola, Ville Pulkki and Riitta Väänänen for cheering me up. I praise Hanna Järveläinen for her musical gifts and persistence as a first-rate test person during the repeatability measurements, suffering several hours from 48 microphone insertions in her ears.

I also thank the guys at the HUT video studio, e.g., Vesa Kantola for enduring me in some many of his courses while teaching me secrets of visual communication, Markku Nousiainen for taking the color photos of me shown in this work, Anu Karjalainen for mastering Photoshop for the fish-eye pictures and Esa Eklund for unselfishly letting me use their stuff for marvelous illustrations in this study.

I’m thankful to numerous persons at many companies lending me support both professionally and academically. I thank Juha Backman, Nick Zacharov, Ari Varla and Jorma Salmi for their profound wit of acoustics and the pleasant talks with them, Petri Haavisto (Dr.), Mauri Väänänen and Matti Hämäläinen for their interest and suggestions in 3-D sound and virtual acoustics. Also, I thank all the Ladies at the cafeteria of the faculty for providing me nourishment at odd hours.

I bless my family and rare friends for understanding and being patient with me, even though I had only little time for them while working so hard for this project. I thank my old neighbor Markus Jylhä, my old and wise handwork teacher Olavi Lahdenperä, my roommate Ari Peltoniemi and the others, with whom I have spent wonderful moments riding snowboard and forgetting everything else, especially at the most beautiful peaks of world, at the Alps. Meine deutsche Verwandten Onkel Willy und Tante Dori Riederer, u. die lieben Fehchenheimer, die mit mir ihre kluge Lebensauffassungen beteilten haben, danke ich aus meinem ganzen Herzen. I express my special thanks to my big brother Eerik Riederer, who has always guided me for life and helped me crucially with PCs so many times that I can’t remember, and to my mother and my father Heli & Leo Riederer, who have supported and cared for me and learned me even the things I didn’t care of. The last praise and thanks I give for my best friend Petriina, who has taught me that there exist matters greater than the life itself, such as love and devotion.

Satisfied, but tired, at home in Helsinki, on the second day of the year 1998, six o’clock in the morning.