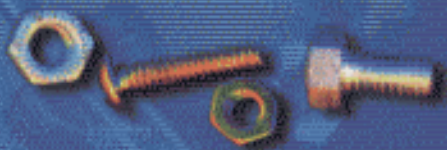


BUILD YOUR OWN ROBOT!



KARL LUNT

Table of Contents

Foreword	xiii	
Acknowledgments	xv	
Introduction	xvii	
Part 1. Getting Started	1	
Inspiration and Implementation	3	Review of <i>Mobile Robots</i> book; parts list for basic 68hc11 robot computer; introduction to 68hc11 MCU.
Your First 68hc11 Microcontroller	9	Schematic for basic 68hc11 robot computer; pinout of 68hc11 PLCC socket; schematic for RS-232 converter; modifying hobby R/C servo motors; using PCBUG11.
Allow Me to Introduce Huey	19	Huey, my first 68hc11 robopet; construction techniques; templates for robot code in 68hc11 assembly language.
The Basics of Hobby Robotics	31	Frame materials, fasteners, tools, motors, batteries; hacking hobby R/C servo motors.
An Intro to 68hc11 Firmware	39	Software utilities for robotics; using PCBUG11; writing SBasic programs; controlling hobby R/C servo motors.
Part 2. Software	49	
My Tiny Forth Compiler	51	Introducing tiny4th; using the Rayovac Renewal rechargeable batteries.

A First Look at SBasic	61	Introducing SBasic; a review of <i>Sensors for Mobile Robots</i> , by Bart Everett.
Remote Reloads with 811bug	71	811bug, a powerful 68hc11 utility; details on firmware for BYRD; pulse-width modulation (PWM) software in SBasic.
The Ultimate PC Robot Tool	91	BOTBios, a robotics software system for the V25 microcontrollers; the innards of BOTBios; ROMMAKER, a tool for building ROM discs.
Inside the 68hc11	99	A beginner's view of robotics software; what happens after reset; using interrupts; a review of <i>Understanding Small Microcontrollers</i> , by Jim Sibigtroth; a quiz on boolean operators.
Part 3. Electronics	109	
Quick and Easy 68hc11 Expansion	111	Using the CGN 1101 expanded-mode 68hc11 microcontroller board; adding battery-backed RAM to the 1101; introducing the Forth programming language.
Introducing the BOTBoard	121	A review of Marvin Green's BOTBoard; using IR LEDs; the IR Robo-Tool; a review of the icc11 C compiler.
A Simple DC Gearhead Motor Controller	131	How to control small DC gearhead motors; mods to the BOTBoard; a first look at the Pacific Science Center robots.
A Gel-cell Battery Charger for Cheap	139	Build a simple and cheap gel-cell battery charger; a couple of show-bot ideas.
Build a Switcher with the MAX642 IC	147	Using the Maxim MAX642 switching power supply IC; adding another level to Max, my robotic research platform.
Try This Junk Box Switcher Supply	155	Build the Junk-Box Switcher; 5th GEAR, a robotics campout; a look at "Frank's thingy."
Son of BOTBoard	163	Introducing the BOTBoard-2, an expanded 68hc11 computer board; the Tamiya motor gearboxes; some catalogs for robot builders.
More (and More) LEDs	171	Add lots of IR LEDs to your robot; tools for designing your own PCBs; a 68hc11 board from Down Under; choosing a programming language for robotics.

Design of a Simple Line-following Array	179	Design of a line-following sensor array; a “thank you” to those who have helped me; how to load and run your SBasic program, step-by-step.
Stepper Motor Basics	187	Working with stepper motors; a look at the L/R and chopper drivers; build a chopper drive system; SBasic code for running the chopper drive electronics.
A First Look at the 68hc12	195	Three SRS members hack the new 68hc12 microcontroller; the software, the electronics, and the PCB.
Check Out This New 68hc12	205	A first look at the 68hc912b32, Motorola’s newest microcontroller; using SBasic to create 68hc12 code; test-driving the 68hc12’s PWM subsystem.
Part 4. Mechanics	215	
A Basic Robot Design	217	A report on 4th GEAR; we design a simple mechanical robot base; a small solar-powered robot; looking at Nature’s designs.
And Now, Here’s... Max!	225	Build Max, my research robot platform; the basics of pulse-width modulation; I review TopDraw, a graphics editing program.
Build an Open-frame Robot Body	235	Constructing an open-frame robot; techniques for working with brass and copper frames; organizing a line-following contest; the Leatherman’s Super Tool.
Adding an Encoder to a R/C Servo	243	How to add encoders to hobby servo motors; an SBasic program for using shaft encoder information.
Part 5. Robotics Projects	255	
The Rapid Deployment Maze	257	A review of the CGN 1001 68hc11 module; details of the Rapid Deployment Maze (RDM); rules for running an RDM event; building my RDM robot.
Build BYRD, a Back Yard Research Drone	265	I construct BYRD, my BackYard Research Drone; details on BYRD’s design; adding tele-operation; a first look at BYRD’s operating firmware.

Rally 'Round the 'Bot, Boys!	275	Time-Speed-Distance (TSD) road rallies, using robots; concepts behind TSD rallies; rally instruction basics; adding more challenges to a TSD robot rally.
The Dead-Reckoning Event	285	Building a stepper-based robot for the Dead-Reckoning (DR) contest; the National Semiconductor SimpleSwitcher® IC; setting up the motors; SBasic code for my DR robot.
Hercules, My Smallest Robot	295	Hercules, my smallest robot; driving high-current latches with the 68hc11 SPI bus; the Cyborgs and low-power computing.
My Marble Maze Machine	303	Running a marble through a maze; building a two-servo jointed platform; SBasic code for my marble maze-runner.
Tackle-bot, a Backyard Explorer	309	Mars Pathfinder as inspiration; Tacklebot, a backyard explorer robot; my robot's innards; roboscrn, a generic graphical robot controller.
Try Your Hand at a Mini-Sumo Robot	319	A look at mini-Sumo, a smaller version of robot Sumo; the beginnings of an SBasic program for a mini-Sumo robot; how to start a robot club like the SRS.
I Start on a Fire-fighting Robot	329	I try to build a fire-fighting robot; the Trinity College Fire-fighting Robot contest; my search for 68000 tools; the Software Development Systems' demo package.
Part 6. Adventures in Hacking	345	
Decoding a TV Remote Control	347	Marvin and I hack a TV remote control; deciphering the pulse stream; writing tiny4th code to interpret the signals; Marvin's BBOT robot frame; a review of the Rug Warrior robot kit.
Wiring Up an RF Modem Link	357	The Proxim RDA-100 RF modem; building the base station; building the remote unit; setup and testing.
A Dirt-Cheap 8051 Development System	365	Hacking the Practical Peripheral's PP144 external modem; making a dirt-cheap 8051 development platform; building a simple robotic eye.
A Dirt-Cheap 8051 Development System, Part Two	375	Hacking the PP144, part 2; controlling the board's 74hc595 latches; using IR for serial communications.

Hacking a 68302 Modem Board	383	A cheap 68302 development board, based on the Practical Peripheral's Pro-Class 14.4K external modem; figuring out the memory map; my first 68302 program.
Hacking a 68302 Modem Board, Part Two	391	Part 2 of hacking the Pro-Class modem; using batteries for power; rewiring the serial port.
The Ready-Set-Go Toy Truck	399	My shiny, new Ready-Set-Go toy truck; tracing out the truck's control wiring; replacing the on-board MCU with a 68hc11 BOTBoard; SBasic code for controlling the RSG.
Reworking the GameBoy®	411	Driving the Precision Navigation Vector-2X electronic compass with a BOTBoard; the Nintendo GameBoy® as a possible robot controller; finding tools for hacking the GB.
Part 7. The 68hc11	421	
A Look At the SPI	423	An in-depth look at the Synchronous Peripheral Interface (SPI); timing details; using the 74hc595 as an eight-bit output latch on the SPI; hooking an LCD to the SPI; tiny4th code for controlling the LCD via the SPI.
68hc11 Memory Expansion	433	Adding memory and I/O devices to the 68hc11 in expanded mode; adding battery-backed RAM; using PCBUG11, Motorola's Freeware tool; an 8x751 development kit from Philips Semiconductor.
Part 8. Way Cool Robots	445	
A Visit to the MIT Campus	447	The MIT 6.270 class; my trip to Cambridge; some intense robot building; rounding up some pirate treasure.
Designing an Interactive Robot Display	459	Details on the SRS' construction of the Pacific Science Center robot display; a look at the beacon circuitry; Hall-effect sensors; the PSC-bot frame; some recommendations.
Deep-Sea Submersible Robots	467	Finishing the hack of the Pro-Class external modem; some of my favorite California surplus stores; an up-close and technical look at MBARI's deep-sea submersibles, <i>Ventana</i> and <i>Tiburon</i> ; a short review of <i>Star Trek Creator</i> , by David Alexander.

Cleaning up the Tennis Court	475	Four SRS members claim a national title; cleaning up the tennis court; details on the design of a vision-based robot; Alan Alda sees M1 in action.
Robot Soccer	485	Taking a world championship in robot soccer; an insanely difficult design task; how our team solved all the problems; details of the matches.
The Extremes of Hobby Robotics	495	From the smallest to the largest; the Photopopper, a light-seeking robot; building a Photopopper kit; details of its design; the big, bad 'bots of Robot Wars.
A Whole Lot of Robots	503	The first Northwest Regional Fire-Fighting Robot contest; a look at lots of SRS robots; a review of the Technological Arts' ADAPT-11C75 board; I say "Goodbye" to the Amateur Robotics column.
Part 9. Sidelights	515	
The NCC AI-CDROM	517	I sample the Network Cybernetics Corporation's AI CD-ROM; a review of Albert Leenhouts' classic, <i>Step Motor System Design Handbook</i> ; vectored execution in tiny4th.
A Typical(?) SRS Meeting	529	An up-close look at a typical Seattle Robotics Society (SRS) club event; a description of several contests; ideas for staging your own events.
Some Powerful Software Tools	541	Building up your set of tools; the Internet as a resource; a review of PFE-32; some 68hc11 C compilers.
Appendix A. Contacts	559	Contact information for companies mentioned in the book.
Appendix B. Hobby Servo Mods	563	Instructions for modifying a Futaba S148 servo motor for use in robotics.
Appendix C. Web Pages	565	Web sites of interest to robot builders.
Index	569	