

Index

Symbols

- () (parentheses), 481
- @ (at sign), 101
- / (division operator), 481
- / (forward slash), 100, 607
- (hyphen), 100, 607
- ! (logical operator), 481
- && (logical operator), 481
- || (logical operator), 481
- (minus operator), 481
- % (modulo operator), 481
- * (multiplication operator), 481
- + (plus operator), 481

A

- abstract services. *See* generic contracts
- acceleration sensors, 591
- Ackermann steering, 565
- Action Input Pin, 478
- Actions and Notifications dialog box, 489, 492
- activate, 42
- Activate method, 55, 56, 81
- ActivateDsspOperationHandlers, 136
- ActivationSettings, 41, 72, 74, 765, 768
- ActiveSync, 687
- ActiveSync Remote Display, 688, 690
- activities (VPL), 8, 471. *See also specific activities*
 - basic (list), 479–480
 - configuring, 508–513
 - modifying diagram for real robot, 512–513
 - setting configuration for diagram, 509–511
 - SimpleDashboard service, starting upon execution, 511–512
 - custom, 487–493
 - inputs, 478–479
 - outputs, 478–479
 - services and, 501–502
- Activity activity, 480
- activity boxes, 473
- ActivRobots, 584. *See also* Pioneer 3DX
- actuators, 585, 592–593
 - analog, 585
 - digital, 585
 - digital outputs, 592
 - generic contracts for, 585
 - motors, 592
 - sound/voice synthesis, 593
- Add Bluetooth Device Wizard, 604–606
- AGEIA PhysX engine. *See* PhysX engine
- Aldebaran Nao robot, 580, 734
- Aldebaran Robotics, 580, 734
- Alias Wavefront format, 249
- aliasing, 240
- AllStopHandler, 310
- /ait qualifier, 98, 116, 216, 297, 763
- Ambient color value, 251
- analog actuator, 585
- Analog Input (double), 738
- Analog Output (double), 738
- analog sensors, 585
- AnalogSensor, 270
- AnalogSensorArray, 270
- Angular (member), 382
- AngularDamping, 250, 260
- anti-aliasing setting, 240
- Anycm Blue USB-240 Adapter, 603
- APIs (application programming interfaces), 84
 - operations as, 92
- Append function, 494
- application programming interfaces. *See* APIs
- Application tab, 114
- applications, 84. *See also* services
- Approach mode, 453
- Approach state, 355, 369–370
- Arbiter.Activate, 42, 48, 55
- Arbiter.CombineWith method, 137
- Arbiter.FromHandler, 42, 69
- Arbiter.FromIteratorHandler, 47, 68
- Arbiter.Receive, 46, 47, 55
- arbiters, 38
 - combining, 60–61
 - nested, 60–61
 - receivers and, 55–65
- arithmetic operations, 481

Arm Mover project (VPL), 534–542

ArmMover activity, 535–536, 542
LynxL6Arm activity, 540, 541, 542
Lynxmotion L6 arm and, 542
moving the arm, 539–542
SetPollInterval action, 536–539, 542
Xbox controller and, 534, 535, 537

Arm Pose panel, 675, 676, 677

ArmMover activity, 535–536, 542

arms. *See* **robotic arms**

arrow keys, 181

Articulated Arm contract, generic, 668–670

articulated entities, 377–418. *See also* **joints;**
robotic arms

articulated robotic arms, 419, 565, 574, 655–665.

See also **legged robots; robotic arms**

articulated robots, 10, 375, 467, 655, 656, 665

artificial intelligence ‘roadblock,’ 797

aspect ratio, 206

AssemblyInfo.cs, 278

asynchronous events, 30, 38, 44, 52, 90, 91.

See also **CCR**

asynchronous PTP, 660

at sign (@), 101

Atmel, 732, 733

AttachedCameraEntity, 403, 438

autonomous robots, 10, 12, 13, 170, 265, 457,
572–573, 681–730. *See also* **Stinger CE**

development environment, 684

PC-based, 681–684

AvoidBoundary state, 425

AvoidCollision state, 355, 373–374

AVR brand, 733

Axim PDA, 686, 687

AxleSpeed, 296

B

6-BackAndForth project, 517–518

BackAway state, 356, 372–373

backslashes, 607. *See also* **forward slash**

Ball Follower project, 554–558

BallFollower VPL diagram, 556–558

Simulation Environment, 554–556

BallCourt, 554, 555, 556

BallFollower VPL diagram, 556–558

barriers, 337, 341–342, 374

base.Initialize method, 288, 321, 325

base.Start, 136

base.Val, 405

BASIC, 471, 733, 754

advantages, 733

chips with built-in, 733

Basic Activities toolbox, 473, 479–480

basic input/output system (BIOS), 30

Basic Simulation Environment, 230

BASIC Stamp, 93, 94, 612–613, 642, 731, 732,
733, 735, 736

Battery (generic contract), 270

Bayes Rule, 466

beeping/flashing. *See* **flashing/beeping**

Behavior method, 629, 638, 641

behavior states (Robo-Magellan simulation
scenario), 354–374

behavior-based controllers, 594–596

BehaviorLoop, 356, 357, 367

behaviors, 85, 91–92, 625

reactive, 636

Belkin USB VCD (video capture device), 160,
205, 206

bin directory, 19

binormal axis, 371

BIOS (basic input/output system), 30.

See also **RIOS**

bipedal robots, 580, 655. *See also* **humanoid robots**

bit banging, 755, 765

bitmaps, 81, 99, 194, 243, 462, 544

from byte array, 213

maze, 461, 462, 463, 464, 465

PictureBox and, 206, 213, 214, 215, 364

Simulation Environment and, 546

System.Drawing and, 161, 348

Blender, 318

Blind state, 425, 427

blocking I/O, 76

blocking threads, 46

bluesphere, 260

Bluetooth, 160, 163, 221

Add Bluetooth Device Wizard, 604–606

connection

Boe-Bot, 614–615

LEGO NXT, 602–606

device names, 605

discovery, 603

ZX-Bluetooth module, 754, 755

BMP. *See* **bitmaps**

Board Support Package (BSP), 720

Boe-Bot (Parallax), 8, 9, 93–94, 576–578. *See also*
remotely connected robots

BASIC Stamp, 612–613, 642, 732, 735, 736

Bluetooth connection, 614–615

brick, 169

building, 611–612

bumpers, 167–169

communicating with, 615

flashing/beeping, 640–643

- monitor program, 613
 - Parallax services, 578, 642, 647, 651
 - Robotics with the Boe-Bot*, 611–612
 - using, with MRDS, 611–615
 - wandering, 647–652
 - .bos format, 249**
 - bounciness, 255, 261, 314**
 - boxes, 238**
 - giant, 280
 - BoxShapeProperties, 271**
 - brain. See brick**
 - Braintech, 84**
 - breadboarding, 612**
 - breakpoints, 125, 126**
 - Breakpoints (VPL debugger), 487**
 - brick, 84, 93, 601, 735. See also Generic Brick**
 - contract; *specific robots*
 - brightness sensor, 547–548**
 - Broadcom, 603**
 - BSBumper.cs, 167, 168, 169**
 - BSDrive service, 93, 94**
 - BSP (Board Support Package), 720**
 - BSServices, 122**
 - Build Events tab, 114**
 - Build tab, 114**
 - built-in entities, 252–267**
 - bump notifications, 651–652**
 - bump sensors, 643, 748**
 - bumper array, 586**
 - Bumper service, 169**
 - BumperArrayEntity, 265, 273**
 - BumperPressed function, 790**
 - bumpers, 586, 789. See also contact**
 - sensor array
 - Boe-Bot, 167–169
 - virtual, 586
 - Busy variable, 526, 528**
 - button handling, 184–185**
 - byte array, 213, 767**
- ## C
- C++, 471, 476, 720**
 - templates, 45
 - CAD packages, 318**
 - Calculate activity, 479, 481, 483, 484**
 - arithmetic operations, 481
 - logical operations, 481
 - callback procedures, 55**
 - camera entity, 402–403**
 - camera frames, processing. See vision processing**
 - algorithm
 - Camera menu, 235–236**
 - CameraEntity, 266, 272, 322, 403, 547, 548, 550.**
 - See also AttachedCameraEntity**
 - cameras, 590. See also Main Camera; webcams**
 - for Corobot entity, 322–323, 340
 - hexapod project, 438
 - for Lynxmotion L6 robotic arm, 679
 - non-realtime, 236
 - realtime, 235–236
 - capsules, 238**
 - CapsuleShapeProperties, 271**
 - Cascading Style Sheet (CSS) files, 193, 194, 195, 199**
 - case sensitivity**
 - commands/parameters, 100
 - contract identifiers, 148–149
 - JavaScript, 205
 - URI, 86
 - XML, 188, 193
 - XSLT and, 191
 - CastsShadow property, 259**
 - causalities, 5, 39, 77–79, 91**
 - CCR (Concurrency and Coordination Runtime), 5, 29–82**
 - applications. *See services*
 - architecture, 38
 - DSS v., 29
 - online forum, 27
 - user guide, 27, 29
 - Ccr.Adapters.WinForms, 161, 352, 353, 691, 727**
 - CCRExamples project, 33–34**
 - CenterOfMass, 260**
 - central intelligence. See brick**
 - CF (Compact Framework) services, 54, 154, 171, 219, 572, 578, 680, 749**
 - deploying to PDA, 709–711
 - StingerDriveByWire service, 708–713
 - CF (CompactFlash) slot, 723**
 - Channel 9, 28**
 - chassis, 284, 285, 286**
 - checkform, 204, 205**
 - Child, 69**
 - child entities, 248, 288**
 - chips. See microcontrollers**
 - Choice, 38, 44, 57–59**
 - Chrysanthakopoulos, George, 73**
 - Class Reference (MRDS), 37, 221**
 - classes, 37**
 - generic, 45
 - inheritance, 98, 215. *See also generic contracts*
 - Intellisense and, 37
 - Object Browser and, 37
 - online reference, 37
 - Clear, 51**

- cliff sensors, 532**
- /clone qualifier, 116**
- closed-loop control system, 585, 593–594**
- CLR environment, 38, 39, 45, 50, 54, 65, 66, 73, 76, 243**
- CML (concurrent mapping and localization), 636.**
 - See also* SLAM
- code, sample. *See* sample code**
- coding tips, 37**
- color intensity (value), 450, 452, 463**
- color space**
 - HSV, 450, 452
 - RGB, 450, 452, 462, 463, 590
- ColorValue, 270**
- COM ports, 87, 132, 570, 574, 605, 607, 608, 609, 614, 615, 623, 707, 714**
- combined rendering mode, 239**
- combining arbiters, 60–61**
- command overload, 776–779**
- CommandArguments, 543, 544**
- commands (MRDS), 100–101**
- Comment activity, 479, 480**
- common directory, 19**
- Community forum, 27**
- Community Technology Preview. *See* CTP**
- Compact Framework environment. *See* CF services**
- CompactFlash cards, 683, 723**
- CompactFlash (CF) slot, 723**
- companion robots, 797**
- compass sensors, 590–591**
- compiling diagrams to services, 502–508**
 - service compilation example, 503–508
 - service compilation options, 502–503
- compiling services, 121–123**
- completion ports, 68, 69, 139–141**
- Concatenate function, 494**
- concurrency, 30–31, 39**
- Concurrency and Coordination Runtime. *See* CCR**
- “Concurrent Affairs,” 81**
- concurrent mapping and localization (CML), 636.**
 - See also* SLAM
- Concurrent receiver group, 64, 92**
- conditionals (VPL), 482–484**
- cones. *See* traffic cones**
- config directory, 19**
- config file, 89**
- ConfigureBrick, 748**
- ConfigureDevices, 749**
- Connect button, 171, 207, 264, 443, 608**
- ConnectDrive, 207**
- connection requests, 207–209**
- Connectors, 382**
- ConnectR, 797**
- ConnectWebCam, 207, 210**
- Conscious Robots website, 467**
- Console Output, 99, 106, 629**
- Console.WriteLine, 33, 98, 220. *See also* LogError; LogInfo; LogVerbose; LogWarning**
- Constructor service, 99, 100**
- contact sensor array, 168, 647, 648, 789**
- contact sensors, 586. *See also* bumpers; whiskers**
- Contact state, 425, 427**
- ContactSensor, 270**
- ContactSensorUpdate, 509**
- continuations, 44, 55**
- Continuous option, 422**
- Contract Directory, 106–107**
- contract directory cache, 124**
- contract ID, 208, 265**
- contract identifiers, 85, 86–87**
 - case sensitive, 148–149
- ContractPrefix, 503**
- contracts, 85, 86–87**
 - generic. *See* generic contracts
 - information on. *See* DssInfo
- control loop, 585. *See also* closed-loop control system**
- Control Panel, 99, 102–103**
 - manually start services with, 102–103, 205
 - Motion Recorder, 675
- control structures, 68**
- controllers, 584, 593–596**
 - behavior-based, 594–596
 - closed-loop control system, 593–594
 - PID, 216, 585, 593, 594, 596, 636, 730
- controllers (game). *See* game controllers**
- controlling multiple robots, 520–522**
- ConvertFile method, 544**
- convex mesh, 262**
- ConvexMeshShapeProperties, 271**
- Coordinations, 699**
- CoreCon component, 720**
- Corobot entity, 7, 11, 269, 276. *See also* Corobot robot; Robo-Magellan simulation scenario; soccer environment**
 - appearance, enhancing of, 318–321
 - Approach state, 355, 369–370
 - AvoidCollision state, 355, 373–374
 - BackAway state, 356, 372–373
 - behavior states, 354–374
 - cameras for, 322–323, 340
 - chassis, 284, 285
 - Corobot service, 277–281, 336
 - defining, 281–293
 - Drive methods, 293–296
 - DriveDistance, 312
 - testing, 312–313

- FinalApproach state, 356, 371–372
 - Finished state, 356, 373
 - GPS and, 337, 367, 368, 374
 - IR distance sensors, 323–336, 355, 356, 360, 361, 368, 372
 - CorobotIEntity, 323–331
 - SimulatedIR service, 331–336
 - meshes, 318–321
 - circuit boards/battery, 319–320
 - modeling chassis/platform, 319
 - modeling tools, 318
 - realism v. speed, 318
 - tweaking simulation environment, 320
 - wheel geometry, 318
 - MotorTorqueScaling, 313–314
 - platform shape, 284, 285, 286
 - RotateDegrees, 312
 - testing, 312–313
 - SimulatedQuadDifferentialDrive service, 296–313, 336
 - manifest, 349
 - simulation entity notifications, 300–310
 - testing, 310–312
 - SimulatedWebcam service, 322–323
 - in soccer environment. *See* soccer environment
 - tire friction, 314–315
 - tuning, 313–321
 - vision processing algorithm, 362–366
 - Wander state, 355, 367–369
 - wheels, 284, 285
 - encoders, 317–318
 - turning of, 315–317
 - Corobot robot (CoroWare), 159, 281, 282, 319, 457, 583**
 - Corobot service, 277–281, 336**
 - Corobot soccer services, 457**
 - Corobot.cs, 278**
 - CorobotIEntity, 323–331**
 - Corobot.manifest.xml, 278**
 - CorobotSoccerPlayers service, 447, 448**
 - CorobotTypes.cs, 278**
 - CoroWare Corobot robot. *See* Corobot robot**
 - Counting mode, 466**
 - CountNotification, 489, 490, 491, 493, 495, 496, 506, 507**
 - courseware package, 11–12**
 - installation, 20
 - Create, 94**
 - Create (robot). *See* iRobot Create**
 - CreateAlways, 144**
 - CreateDefaultState, 305**
 - CreateHexapod method, 436**
 - CreateService, 95**
 - critical sections, 30**
 - CSS (Cascading Style Sheet) files, 193, 194, 195, 199**
 - CTP (Community Technology Preview), 4, 33**
 - cubes, 238**
 - Current Node, 486–487**
 - Current variable, 519**
 - CurrentHeading property, 265**
 - custom activities, 487–493**
 - 7-CustomActivity project, 488–491**
 - 8-CustomActivity project, 491–493**
 - compilation, 503–508
 - CustomActivityInOrderOperations class, 506**
 - CustomActivityorderForLoop service, 508**
 - CustomJoint, 383, 385**
 - cyclical behavior, 367**
 - cyclone player, 422, 427, 428, 429. *See also* sumo environment**
- ## D
- damping effect, 594**
 - Dance service, 625–643. *See also* remotely connected robots**
 - building, 626–630
 - contract identifier, 86
 - flashing/beeping, 640–643
 - improving behavior, 636–640
 - main operations port, 86–87
 - Dance.BoeBot.manifest.xml, 635**
 - Dance.Lego.manifest.xml, 635**
 - Dance.LegoV2.manifest.xml, 635**
 - Dance.manifest.xml, 630–634**
 - Boe-Bot, 633–634
 - LEGO NXT Tribot, 632–633
 - Dance.SimTut2.manifest.xml, 630, 635**
 - Dance.Simulation.manifest.xml, 632, 635**
 - DARPA Urban Challenge, 13**
 - Dashboard service, 25, 26, 31, 93, 109, 130, 144, 150, 157, 160, 161, 170, 185. *See also* SimpleDashboard service; TeleOperation service**
 - L6 robotic arm and, 670–671
 - remotely connected robots and, 615–625
 - user interface, 267
 - Data activity, 476, 479, 481**
 - Data Connections dialog box, 475, 477**
 - data flow languages, 471–473. *See also* VPL**
 - data flow loops, 482**
 - DataConnections dialog box, 509**
 - .dds files, 254**
 - dead reckoning, 591**

- dead zone, 198, 594, 616**
- deadlocks, 30**
- Debug and Trace Messages page, 105–106, 219, 220**
- debug print statements, 220**
- Debug tab, 114–115**
- debugger, 125–126, 219–221**
 - Visual Studio, 219–220
 - VPL, 485–487
- debugging, of service on PDA, 711–713**
- Decentralized Software Services. See DSS**
- DefaultTexture, 249**
- DeferredTaskQueue, 273**
- degrees of freedom (DOF), 378**
 - one, 366–369
 - six, 377, 390–392, 418. *See also* Lynxmotion L6 robotic arm
 - Swing, 378
 - Twist, 378
- delegates, 43–44**
- Delete, 94**
- DeleteSimulationEntity, 304**
- demoscene.manifest.xml manifest, 525**
- Density (property), 250, 260**
- deploying services, 151–155**
- desktop CLR, 54. See also CLR environment**
- Devantech Ltd, 734**
- devices, 735. See also Generic Brick contract**
 - enums, 747–748
 - names, 737
 - as pins, 735
- Diagram State, 485, 486**
- diagrams (VPL), 7, 8**
 - BallFollower, 556–558
 - converting, to services. *See* compiling diagrams to services
 - creating, 474–475
 - debugging, 485–487
 - directory, 19
 - execution model, 484–485
 - line-follower, 551–553
 - nested, 8
 - projects
 - 6-BackAndForth project, 517–518
 - 7-CustomActivity, 488–491
 - 8-CustomActivity, 491–493, 503–508
 - 5-DriveDistance diagram, 515–516
 - 3-DriveInCirclesSim, 513–514
 - 2-GenericContactSensorNXT, 512–513
 - 1-GenericContactSensorSim, 509–512
 - 1-Hello VPL project, 474–475
 - 2-Hello VPL project, 476–477
 - 7-LaserRangeFinder, 518–519, 526
 - 9-Lists, 495–499
 - 5-Loops, 482–483
 - 6-Loops, 484–485
 - 3-Notifications diagram, 478–479
 - 4-Spiral project, 514–515
 - 8-TwoRobots project, 520–522
 - 4-Variables diagram, 480–482
 - VPL Explorer, 523–528
 - running, 475–477
 - sensor data, reading of
 - from real robots, 512–519
 - from simulated robot, 509–512
 - state, 480
 - VPLExplorer, 524–528
 - VPLSumo, 529–534
- differential drive robots, 565**
 - in simulation environment, 263–267
- Differential Drive service, 157, 160**
- differential drives, 84. See also generic differential drive**
 - VPL and, 513–516
- DifferentialDriveEntity, 263, 265, 289**
- DifferentialDriveTT, 459**
- Diffuse color value, 251–252**
- DiffuseColor, 261**
- digital actuator, 585**
- Digital Input (Boolean), 738**
- Digital Output (Boolean), 738**
- digital outputs (actuators), 592**
- digital sensors, 585**
- Dimensions/Radius, 261**
- Direct Draw Surface, 254**
- Direct3D, 234**
- directional lights, 257–258**
- DirectionDialog activity, 478, 479, 481, 482**
- directory structure (MRDS), 19–20**
- DirectoryInsert, 136, 145**
- DirectX, 16, 19, 227, 228, 229–230**
 - SDK, 230, 254
 - Texture Tool, 254, 319
- DisableRendering flag, 251**
- DisableRotation flags, 249**
- discovery (Bluetooth), 603**
- Discussion Forums (MRDS), 108, 219, 563, 573, 730, 732, 733, 734, 736**
- dispatcher queues, 39, 65–68**
- dispatchers, 5, 39, 65–68**
- distributing executables, 154**
- division operator (/), 481**
- DLLs, 270–276. See also specific DLLs**
 - helper, 750–753
 - references, 275
 - signing, 751
 - using statements, 276

- DoCompletePhysicsShapeUpdate flag**, 251
documentation (MRDS), 27, 29, 37, 155
documentation directory, 19, 37
DOF. *See* degrees of freedom
dog robots, 10, 565, 580. *See also*
 RobuDog models
dominos, 230, 413, 414, 415, 416, 417, 418, 679.
 See also robotic arms
 Reverse Dominos button, 415
 Topple Dominos motion, 415, 416–417
 ToppleDominoPosition array, 417–418
dongle, 602
Drive (generic contract), 270
Drive methods (Corobot entity), 293–296
Drive-By-Wire service, 159, 171, 221, 565, 690.
 See also StingerDriveByWire service;
 TeleOperation service
DriveControl Form, 162, 173–175
DriveControlEvents, 174
DriveDistance, 159, 184, 216, 270, 290, 291, 293,
 295, 308, 749
 Corobot entity, 312–313
5-DriveDistance diagram, 515–516
3-DriveInCirclesSim project, 513–514
DriveTargetOrientation, 379
DriveTargetPosition, 380
DriveTargetVelocity, 379, 380
Drop, 94
dropping services, 141–142
DSS (Decentralized Software Services), 6, 83–155,
 157. *See also* services
 advanced service concepts, 157–222
 CCR v., 29
 command-line tools, LineMesh and, 543–544
 Manifest Editor. *See* Manifest Editor
 online forum, 28
 tools, 149–151
 tutorials, 27
 user guide, 27
 web pages, 101–108
DSS nodes, 98–99
 directory structure of, 99–100
DSS Protocol. *See* DSSP
DssDeploy utility, 20, 21, 151–155
DssHost, 98–99
 config file, 106
 shutting down, 108
 starting, 100–101, 205
dsshost commands
 backward/forward slashes and, 607
 hyphens and, 607
dsshost.exe.config, 106
DssInfo, 150–151
DssNewService tool, 115–116
 qualifiers. *See* qualifiers
 simulation service with, 277–278
DSSP (DSS Protocol), 83, 90, 91, 92
 service operations (list), 94–95
 SOAP v., 83
 specification, 94
DsspDefaultDrop, 53
DsspDefaultLookup, 53
DssProjectMigration tool, 16, 151
DssProxy, 71, 92, 123, 134, 696, 697, 742,
 746, 750
DsspServiceBase class, 40, 41, 55, 65, 66
DssService1, 34–37
dynamic entities, 238
dynamic joins, 61
DynamicFriction, 261
- ## E
- eBox-2300**, 572, 579, 580, 582, 683, 684, 685,
 713–725
 boot process, 714–719
 menu, 714–715
 MS-DOS refresher, 717–719
 Jump Start kit, 572, 684, 713, 724
 serial port, setting up, 719–720
 setting up, 713–725
 StingerDriveByWire service, establishing
 connection, 721–723
 transferring files to/from, 723–724
 Visual Studio and, 720–721
editor. *See* Manifest Editor; Simulation Editor
Effect (shader program), 249
Effect type, 275
elbow joint, 397, 405, 662
elbowVal, 405
embedded PCs, 683–684. *See also* eBox-2300;
 Windows CE
Embedded Resource Manager, 99
embedded resources, 83, 187, 191, 192, 193, 194,
 195, 203
 Generic Brick contract and, 753–754
Enable rigid body for default camera (option), 241
EnableCollisions, 382
EnableContactNotifications, 261
Encoder, 271
encoders (wheel). *See* wheel encoders
end effector, 656–657
End of Arm (EOA), 657, 661, 669, 671
End variable, 483, 485
enhanced Dashboard. *See* Dashboard service
enqueued, 50, 67, 68. *See also* posting

entities, 238. See also articulated entities; Corobot entity; specific entities

- built-in, 252–267
- child, 248, 288
- creating, 247–248
- custom, 269. *See also* Corobot entity
- dynamic, 239
- general-purpose, 259–263
- kinematic, 239
- manipulating, 246
- name of, 250
- overlapping, 247
- parent, 248, 288
- positioning, 246
- properties. *See* entity state
- robot, 263–266
- rotating, 246
- saving/loading, 247
- selecting, 245
- sky and ground, 253–257
- static, 239
- velocity of, 250

Entities menu, 247–248

Entities pane, 244

Entity (member), 381

entity state, 248–250

- graphics assets, 249
- material properties, 251–252
- Misc heading, 249–250
- physical properties, 250

Entity type, 271

EntityJointConnector, 381

EntityName, 381

EntityState, 248, 255, 256, 260, 261, 263, 271, 273, 289

EOA (End of Arm), 657, 661, 669, 671

error handling, 77–80, 135. See also causalities; Success/Failure ports

Euler angles, 272, 542

Evaluate action, 518

EvaluateRanges activity, 518–519

event handlers. See handlers

event-driven approach, 176

_eventsPort, 162, 174, 175, 176

exceptions, 39

Exclusive receiver group, 64, 65, 92

exclusivity, 64

executables, distributing, 154

Execute button, 675, 677

ExecuteToCompletion arbiter, 68, 69

execution context, 85, 93–94

Exit Simulator item, 244

exploration algorithms, 465, 466, 467

Explorer project (simulation), 457–467. See also VPL Explorer project

- DifferentialDrive service, modified, 459–460
- future directions, 466–467
- Maze Simulator, 159, 458, 461–464

ExplorerSim application, 24–26, 464–466

- background, 458–459
- Dashboard, 465
- drawing modes, 466
- last messages and, 70–71
- maps, 465

exposure setting, 240

Extensible Markup Language. See XML

Extensible Stylesheet Language Transform.

See XSLT

exteroceptive sensor data, 585

exteroceptive sensors, 586–592

eyepoint, 232

F

failures. See Faults

FalloffEnd, 258

FalloffStart, 258

Faults, 39, 77, 83, 135. See also error handling

Fault.xslt file, 203

feedback loop, 585. See also closed-loop control system

field of view, 589

FieldGrass.dss texture, 341

FIFO (first-in-first-out) queue, 50, 51

FinalApproach state, 356, 371–372

FindBall commands, 453, 454, 455, 456

FindPartner, 144, 145

Finished state, 356, 373

finite state machines. See FSMs

first-in-first-out (FIFO) queue, 50, 51

Fischer technik robot models, 8

Fixed Moves checkbox, 18, 159, 184

flags. See also specific flags

- miscellaneous, 250–251
- physics behavior characteristics, 249

flash drives, 723

flash memory, 683

flashing/beeping. See also remotely connected robots

- Boe-Bot, 640–643
- LEGO NXT Tribot, 640–643

fog, 254

FollowLine directory, 551. See also Line

Follower project

FollowLine state, 429

ForceLimit, 380

ForLoop activity, 482–484

- custom
 - defining, 488–491
 - final improvement, 499–500
 - improving, 491–493

form tag, 195, 198, 199, 205**FormEvent, 177****FormInvoke, 172, 175, 176, 206, 214, 357, 674, 676****forms. See Web Forms; WinForms****forums (online), 27–28. See also Discussion Forums**
XNA, 275**forward kinematics, 410, 661–664**

- arm linkage configuration, 661–662
- geometry for, 662–664

forward slash (/), 100

- dsshost commands and, 607

frames, 242

- joint. See joints
- webcam, processing of, 212–215

friction, of ground, 255**FromWinformEvents class, 352–353****FSMs (finite state machines), 70, 87, 89. See also**
state machines**fully synchronous PTP, 660****funneling, 76****G****GAC (Global Assembly Cache), 275****gain, proportional, 593****Game Controller service, 164–166, 170, 183****game controllers, 9, 93, 159, 163, 164, 166, 169, 170, 175, 179, 599. See also gamepads;**
joysticks; trackball; Xbox controllers**gamepads, 160, 161, 166, 171, 615, 616, 623–624****Gates, Bill, 4****GearRatio, 379****General Form Operations, 177****general-purpose entities, 259–263****generic Articulated Arm contract, 668–670****Generic Brick contract, 132, 731, 734–754. See**
also Hemisson robot; Integrator robot

- automatic connection, 737–738
- design, 736–740
- Device class, 743–747
- device enums, 747–748
- devices
 - input/output types, 738
 - names for, 737
- embedded resources in, 753–754
- hardware identifiers, 737
- helper DLL, 750–753

- I2C bus and, 740
- Integrator robot and, 763–775
- motors/wheel encoders, 739
- operations, 748–750
- reconfiguration and, 737
- sensor/actuator locations, 739
- state, 740–748
 - defining, 740–742
 - members, 740, 742–743
- switch/LED access, 739
- terminology, 735–736
- timestamps, 737
- unit conversion/calibration, 738–739

generic classes, 45**generic contracts, 31, 84, 93, 98, 215**

- for actuators, 585
- creating, 217–219
- extending, 217, 219
- implementing, 215–217
- in RoboticsCommon.dll, 270–271
- for sensors, 585
- version numbers, 219

generic differential drive, 31, 93, 157, 438, 446, 458, 513, 516, 520, 521, 552, 558, 618, 627, 637, 690, 697, 698, 734, 739, 749, 775, 781, 784, 794**2-GenericContactSensorNXT project, 512–513****GenericContactSensors activity, 509, 510, 511, 512****1-GenericContactSensorSim project, 509–512****GenericDifferentialDrive activities, 520, 521, 558****GenericDifferentialDrive service, 438, 446, 513–516****geometry modeling, 318****Get, 53, 79, 94, 118, 127****GetHandler, 79, 80****GetHappiness method, 355, 356, 368, 369, 374****GetIndex function, 494****GetRandom action, 498–499****GetRequestType, 118****GetSensors, 749****GetSwitches, 749****giant boxes, 280****GIF file format, 194, 462, 544****Global Assembly Cache (GAC), 275****global positioning system. See GPS****global variables, 44, 47, 51, 130, 210, 274, 782, 783****GlobalInstance, 273****GlobalInstancePort, 274****goldencapsule, 260****GPS (global positioning system), 299, 459, 590**

- Corobot entity and, 337, 367, 368, 374

graphics assets, 249
graphics cards (MRDS requirements), 16
simulation and, 22, 23, 227, 228
Graphics Settings, 233, 240–241
GraphicsDevice, 275
Gravity (option), 242
greybox, 260
GridSpacing, 464
Grip parameter, 411
grippers, 592, 656, 657, 662, 665, 668, 669, 676, 678, 679
grippers (simulated), 394, 395, 396, 397, 401–402, 403, 407, 408, 410, 411, 412, 415
gripperVal, 405
ground, 253–257, 280, 340–341
friction, changing, 255
HeightFieldEntity and, 255
restitution, changing, 255
TerrainEntity and, 256
TerrainEntityLOD and, 257
texture, changing, 255
uneven, 256
Ground flag, 251
guarding, 64. See also Interleave
Gumstix boards, 732

H

handlers, 39, 55, 85, 91, 92
adding to WinForms, 178–180
persisted, 57
happiness function, 355, 356, 368, 369, 374
hardware. See also robotics hardware
configuration/troubleshooting (online forum), 28
requirements, graphics card, 16
hardware identifiers, 736
Generic Brick contract, 737
hardware services (new), 731–798
H-bridge, 592
HeightFieldEntity, 255
HeightFieldShapeProperties, 271
1-Hello VPL project, 474–475
2-Hello VPL project, 476–477
Help menu (simulator), 235
helper DLL, 750–753. See also Generic Brick contract
Hemisson Brick service, 787–791
IR sensors, 788–790
testing, 791
Hemisson Drive service, 76, 95, 789, 791–797
Hemisson robot, 786–797
drive calibration, 792–793
drive power settings, 791

IR sensors, 788–790
hexapod project (simulation), 430–443
building, 435–436
camera, 438
future directions, 443
HexapodDifferentialDrive service, 438–439
joints
creating/attaching, 436–437
defining of, 434–435
main body and legs, 431–434
MoveLegs method, 439–441
MoveLegs2 method, 442–443
HexapodDifferentialDrive service, 430, 438–439, 443
HexapodEntity service, 430, 431, 438, 442
HexapodShapeDescriptor class, 433
Hong, Hoon. See Hoon Hong
Hoon Hong, 665
HostingTutorials directory, 19
HSV color space, 450, 452. See also RGB color space
HTML (Hypertext Markup Language), 188
HTTP utilities, 200, 201
HttpGet requests, 89, 105, 127, 170, 185, 186, 188, 196, 197
HttpPost requests, 170, 185, 188, 198, 199, 202, 793, 795, 796
HttpPostFailure, 203, 795
HttpPostSuccess, 202, 796
hue, 450, 452
humanoid robots, 10, 565, 574, 580, 655, 665, 668, 734
hunt, 594
Hypertext Markup Language. See HTML
hyphen (-), 100
dssshost commands and, 607

I

/i parameter, 116, 216, 297, 764
I2C bus, 740
ICOP Technology, 683
IEnumerable interface, 45
If activity, 480, 482, 483
IgnoreGravity flag, 249
ImageProcessResult, 363, 364
image/video sensors, 590. See also cameras; webcams
imperative programming model, 471–472
Import Manifest button, 510, 512
IncludeDebugInfo, 503
IndexBuffer, 275
industrial robots, 14, 564, 573, 574, 661

- InertiaTensor**, 250, 260
 - infinite loop**. *See* **MainLoop**
 - infrared distance sensors**. *See* **IR distance sensors**
 - inheritance**, 98, 215. *See also* **generic contracts**
 - InitError property**, 250
 - Initial State Partner**, 129–130
 - initialization**, 136–137
 - iterators and, 137
 - Initialize actions**, 489, 490, 491, 492, 495, 496, 497, 508
 - Initialize method**, 272, 285–286, 288
 - InitializedWithState flag**, 251
 - Initializing state**, 425, 426
 - Innovation First, Inc.**, 734
 - input tags**, 198
 - inputs**, 478–479
 - Insert**, 94
 - InsertEntity**, 273
 - InsertEntityGlobal**, 273
 - InsertEntityNotificationHandler**, 303
 - InsertItem function**, 494
 - Integrator robot (Picblok)**, 731, 754–785
 - command overload, 776–779
 - direction control pins, 762–763
 - Drive service, new, 775–785
 - Generic Brick contract and, 763–765
 - testing, 785–786
 - GenericBrickTest, 785–786
 - initialization, 764–765
 - monitor program, 756–763
 - main loop, 757–759
 - PICAXE Programming Editor, 756–757
 - pin assignments, 757
 - protocol commands, 760–763
 - polling and, 770–773
 - serial communications, 765–770
 - services, creation of, 763–775
 - timed operations, 779–783
 - Intellisense**, 37, 135
 - Interleave**, 63–65, 71, 76, 82, 85, 91, 96, 136, 137, 162, 164, 166, 172, 206, 302, 353, 360, 776, 796
 - internal state**. *See* **state (of service)**
 - InternalDrivingMilliseconds**, 426, 427
 - IntersectRay**, 273
 - intPort**, 50, 55, 56
 - inverse kinematics**, 410–412, 664–665
 - I/O**
 - blocking, 76, 100
 - completion routine, 44
 - ports, 736
 - IP Camera service**, 160, 590
 - IR (infrared) distance sensors**, 323–336, 355, 356, 360, 361, 368, 372, 586–587. *See also* **laser range finders**
 - CorobotIEntity, 323–331
 - Hemisson robot, 788–790
 - Line Follower project and, 547–549
 - SimulatedIR service, 331–336
 - Stinger CE and, 699–704
 - iRobot Create**, 8, 9, 581–582
 - Line Follower project and, 542, 550, 551, 552
 - model, 7
 - simulation environment, 263–264
 - sumo competition, 9–10
 - VPL Sumo and, 530, 532
 - iRobot Create Environment**, 230
 - iRobot.Create.Simulation.Manifest.xml manifest**, 520–521, 550
 - IRobotStateHandler**, 426
 - isEnabled property**, 265, 289
 - isEntityNameInUse**, 273
 - ITask interface**, 39
 - ItemCount property**, 51, 70
 - iterators**, 45–50
 - initialization and, 137
 - key points, 46–47
- ## J
- jaggies**, 240
 - JavaScript**, 127, 185, 188, 201
 - case sensitive, 205
 - for client-side scripting, 203–205
 - tutorials, 203
 - JIT (Just-In-Time) compiler**, 54
 - jitter**, 314, 594
 - Join activity**, 480, 481, 482, 483, 484, 485
 - JoinAlpha class**, 507
 - JoinReceive arbiter**, 59, 62
 - joins**, 38, 59–60
 - dynamic, 61
 - static, 61
 - joint(s)**, 288, 377–394, 656
 - connectors, 386–387
 - controlling, 658–661
 - speed, 658–660
 - travel constraints, 660–661
 - with different connector orientations, 392
 - elbow, 397, 405, 662
 - frame, 378
 - hexapod project, 434–435, 436–437
 - with motion limits, 393–394
 - one DOF, 386–389
 - properties, 378–382

joint(s) (continued)

- revolute, 377
- shoulder, 397, 405, 434, 435, 662
- six DOF, 377, 390–392, 418
- SmallDamper, 389
- TestBench. See TestBench
- wrist, 401, 405, 411, 662

Joint Positions panel, 675, 677

JointAngularProperties, 378, 379, 386

JointAxis, 381

JointConnectPoint, 381

JointDriveProperties, 380, 386

JointLimitProperties, 380

JointLinearProperties, 380–381

JointMover service, 387–388

JointNormal, 381

JointProperties, 382, 391

joysticks, 31, 71, 76, 159, 160, 161, 166, 170, 171, 198, 599, 623, 624, 776. See also Xbox controllers

JPG file format, 194, 243, 462, 544

Jump Start Kit (eBox), 572, 684, 713, 724

Just-In-Time (JIT) compiler, 54

K

keyboard handling, 180–184

- StingerDriveByWire service and, 691, 692–694

KeyDown event handler, 180–181, 184

KeyLocation, 503

KeyPreview property, 181

KeyUp event, 184

Khepera robots, 786. See also Hemisson robot

Kick command, 453, 455, 456

Kilner, Chris, 734

kinematic entities, 239

Kinematic flag, 249

Kondo KHR-1 robot, 8, 565, 580

K-Team, 731, 734, 786

KUKA Educational Framework, 14–15, 655, 680

KUKA LBR3 robotic arm (simulated), 7, 14, 230, 655. See also Lynxmotion L6 robotic arm

L

L0Entity, 398–399

L1Entity, 399–400

L2Entity, 400

L3Entity, 400, 401

L4Entity, 400, 401

Laboratory for Perceptual Robotics, 13

laptops, robots and, 682

laser range finders (LRFs), 26, 70, 90, 267, 409, 458, 518–519. See also IR distance sensors; SICK Laser range finder

- VPLExplorer diagram and, 525–528

LaserRangeFinder activity, 526

7-LaserRangeFinder project, 518–519, 526

LaserRangeFinderEntity, 267

LaserRangeFinder.fx, 324, 325

last message, 70–71

LateralFunction, 315

LayoutPaths static class, 99

LEDs (light-emitting diodes), 581, 589, 613, 739, 757, 773, 788

left-handed coordinate systems, 234

legacy code, 81, 172. See also WinForms

legged robots, 565, 574, 591. See also humanoid robots

LEGO Mindstorms NXT kit, 575–576

LEGO Mindstorms software, 565, 602, 606

LEGO NXT Brick service, 607–608

LEGO NXT services, 602

LEGO NXT services V2, 602, 608–611

LEGO NXT Tribot, 8, 512–513, 575–576. See also remotely connected robots

- Bluetooth connection, 602–606
- brick, 601
 - communicating with, 606–608
- building, 601
- flashing/beeping, 640–643
- manifest, setting up, 616–619
- Maze Simulator and, 464
- model, 7
- setting up, 601–611
- in simulation environment, 230, 264–265
- soccer environment, 446, 447
- Swann wireless camera on, 158
- using, with MRDS, 601–611
- wandering, 644–647

LEGO NXT V2 Brick service, 610–611

LEGO.NXT.Tribot.Manifest.xml manifest, 512, 617

LEGO.NXT.Tribot.Simulation.Manifest.xml manifest, 511, 515

lexan, 666

lexical closure, 44

light sensors, 589–590

light shadows, 259

light-dependent resistors, 589

light-emitting diodes. See LEDs

LightEntities, 258, 271

LightEntity, 257, 259, 271

lights, 257–258

- directional, 257–258
- omni, 258
- spot, 258

LimitThreshold, 380**Line Follower project, 542–553**

- brightness sensor, 547–548
- iRobot Create and, 542, 550, 551, 552
- line-follower VPL diagram, 551–553
- LineMesh utility, 542–547
- Simulation Environment, 549–551

Linear (member), 382**linear motion, 661****LinearDamping, 250, 260****line-follower VPL diagram, 551–553****LineMesh utility, 542–547**

- DSS command-line tools, using, 543–544
- mesh generation, from image file, 544–547

Lisp-based languages, 44**List activities, 480, 493–494**

- example, 495–500

List Functions activity, 480, 494**9-Lists project, 495–499****literal loops, 483****LoadResources, 273****local axis, 378****local procedure calls, 92****localization, 458, 459, 636. See also SLAM****LocalPose, 316****Log method, 220****LogError, 98, 220****logical AND, 38, 59. See also joins****logical operations, 481****logical OR, 38, 57. See also Choice****LogInfo, 98, 106, 136, 141, 220, 221****logjam, 679****LogVerbose, 98, 220****LogWarning, 98, 220****Lookup, 94****loops (VPL), 482–484. See also ForLoop activity;****If activity**

- data flow, 482
- literal, 483

loops, timing, 31**5-Loops, 482–483****6-Loops, 484–485****lossless formats, 544****lossy compression, 462, 544****LowerTwistLimit, 379****LRFs. See laser range finders****LynxL6Arm activity, 540, 541, 542****Lynx.L6Arm.Simulation manifest, 405****Lynxmotion L6 robotic arm, 394, 578–579, 655.****See also robotic arms**

- Arm Mover project and, 542
- building, 666
- controlling, 667–677
 - with Dashboard, 670–671
 - with generic Articulated Arm contract, 668–670
 - with Motion Recorder, 666, 668, 671–677
- gripper, 578, 656
- inverse kinematics, 410
- logjam, 679
- overhead camera, 679
- ‘pick and place’ operation, 677–679
- setting up, 665–667
- simulation model. *See* robotic arms (simulated)
- six DOF, 665
- starting, 666–667

Lynxmotion website, 394, 410**LynxTerm, 579, 666****M****Mad Libs, 495****MadeBits, 690****MagellanReferee, 339, 342, 344, 345, 346****magic numbers, 89, 101, 104, 764, 793****Main Camera, 232, 236, 241, 242, 254, 271, 279****Main Thread 8, 34****MainLoop, 125, 128, 138, 140–141, 758–759****MainPortInterleave.CombineWith function, 82****MakeSumoPlayer utility, 427–428****Maneuver message, 533–534****Manifest Editor (DSS), 149–150, 349–351, 620–621****Manifest Load Results, 109–110****Manifest Loader, 99, 617****manifests, 20, 84, 93, 121, 616–617. See also****specific manifests**

- config file specified in, 130–131
- creating/modifying
 - with Manifest Editor, 149–150, 349–351
 - manually, 146–149
- LEGO NXT Tribot, 616–619
- saving/loading, 243

maps, ExplorerSim, 465**Marbles sample, 231–232, 239****marshaled parameters, 92****Mass (property), 250, 260****MassDensity category, 260****Material category, 261****MaterialEditor, 452****MaterialIndex property, 261****MaterialName property, 261**

Matrix, 270, 274

MaximumForce, 382

MaximumTorque, 382

Maya, 318, 404

Maze Simulator, 159, 458, 461–464

config file, 461–462

LEGO NXT robot, 464

Pioneer3DX robot, 464

measurement model, 587

Mecano, 797

mechatronics, 563, 680

MEDC (Mobile and Embedded Developers Conference), 9, 419, 422, 572. See also sumo environment

Merge activity, 480, 483, 485, 496, 540, 541

meshes, 249

convex, 262

for Corobot entity, 318–321

circuit boards/battery, 319–320

modeling chassis/platform, 319

modeling tools, 318

realism v. speed, 318

tweaking simulation environment, 320

wheel geometry, 318

LineMesh utility, 542–547

for robotic arm, 404

shadow, 259

Meshes property, 251

MeshRotation, 251

MeshScale, 251

MeshTranslation, 251

message passing, 38

MessageBox, 209

messages, 5, 38

last, 70–71

modifying, 50–51

multiple, receiving, 61–63

passing through services, 90

ports and, 50–53

Microchip Technology, 732

microcontrollers (chips), 732–733

with BASIC interpreters, 733

with PIC prefix, 732

Microsoft Open Software Promise, 83

Microsoft Robotics Community page, 15

Microsoft Robotics Developer Studio (MRDS), 3–28

Boe-Bot with, 611–615

Class Reference, 37, 221

components, 5–8. See also CCR; DSS; Visual Simulation Environment; VPL

directory structure, 19–20

Discussion Forums. See Discussion Forums

documentation, 27, 29, 37, 155

Downloads page, 9

forums, 27–28, 82

framework, 30–32

hardware requirements, graphics card, 16

installation, 16–21

verification, 21–26

LEGO NXT tribot with, 601–611

microsoft.com/robotics, 27

as operating system for robots, 30

operating system requirements, 15–16

partners, 15

ports. See ports (MRDS)

prerequisites, 16

robotics and, 4, 798

robotics hardware with, 563–597

services, for robots, 8–9

support for

projects/products, 12–15

resources, 27–28

vendors, 734

Team, 4, 444

template. See templates

tutorials, 27, 29

user guides, 27, 37

versions, 4–5, 33

1.5 Refresh, 4, 16, 33

2.0, 4, 5, 16, 33, 798

sample code and, 17, 33

Microsoft Robotics Studio (MSRS), 4, 33

Microsoft robotics team, 4, 444

Microsoft Visual Studio. See Visual C# Express; Visual Studio

Microsoft XNA. See XNA

microsoft.com/robotics, 27

Microsoft.Robotics.PhysicalModel namespace, 270

Microsoft.Robotics.Simulation.Physics namespace, 271

Microsoft.Xna.Framework namespace, 274

Microsoft.Xna.Framework.dll, 274–275, 278, 340
adding reference to, 275

Microsoft.Xna.Framework.Graphics namespace, 275

migrations, 16, 151. See also

DssProjectMigration tool

Mindstorms website, 575. See also LEGO Mindstorms NXT kit

minus operator (–), 481

mip-maps, 319

Misc category, 261

misc directory, 19

Misc heading, 249–250

mistakes. See traps/mistakes

Mobile and Embedded Developers Conference (MEDC), 9, 419, 422, 572. See also sumo environment

mobile robots, 564–565. *See also* remotely connected robots

Mobile Robots, Inc, 265, 584. *See also* Pioneer 3DX Mode, 380

modeling tools, 318

modulo operator (%), 481

monitor program (Integrator robot), 756–763

- main loop, 757–759
- PICAXE Programming Editor, 756–757
- pin assignments, 757
- protocol commands, 760–763

/month qualifier, 116, 297

Moreno, Raúl Arrabales, 467

Motion Recorder, 666, 668, 671–677. *See also* Lynxmotion L6 robotic arm

- Arm Pose panel, 675, 676, 677
- buttons, 675, 676, 677
- Control Panel, 675
- Execute button, 675, 677
- inside, 672–674
- Joint Positions panel, 675, 677
- simulated Lynx arm and, 672
- using, 675–677

MotionLimit, 381

MotionRecorder.cs, 672, 673

MotionRecorderTypes.cs, 672

MotionRecorderUI.cs, 672, 673

MotionSpeed, 182, 193, 201, 202

Motor (generic contract), 271

motors, 592. *See also* actuators; servo motors

- Generic Brick contract, 739

MotorTorqueScaling, 265, 289, 290, 313–314

Mount Service, 99

mountpoint, 32, 99, 130

MoveArm project. *See* Arm Mover project

MoveLegs method, 439–441

MoveLegs2 method, 442–443

MoveNext method, 47

MoveTo method

- HexapodEntity, 438
- SimulatedLynxL6ArmEntity, 405, 406, 408, 410, 412, 414, 415

MoveToPosition method, 410, 412, 415, 675

- parameters, 411–412

MRDS. *See* Microsoft Robotics Developer Studio

MS-DOS

- filenames, 725
- refresher, 715–719

MSRS. *See* Microsoft Robotics Developer Studio; Microsoft Robotics Studio

MTA (Multi-Threaded Apartment) model, 81

Multiple Item Receiver, 61, 62, 69

Multiple Port Receiver, 61, 62, 63, 69

multiple robots, controlling, 520–522

Multiple Simulated Robots, 230

multiplication operator (*), 481

MultiShapeEntity, 262

Multi-Threaded Apartment (MTA) model, 81

multi-threading, 30–31, 39, 43. *See also* concurrency; tasks

mutexes (mutual exclusion), 30

mutual exclusion. *See* mutexes

N

name, of entity, 250

/namespace qualifier, 116

NamespacePrefix5, 503

nested arbiters, 60–61

nested diagrams, 8

.NET 3.0, 19

.NET CLR. *See* CLR environment

.NET Compact Framework environment. *See* CF services

.NET Global Assembly Cache (GAC), 275

.NET Reflector, 16

New Entity dialog, 247, 248

New Project dialog box, 34, 35

914 PC-BOT (White Box Robotics), 583–584, 682

no rendering mode, 240

None option, 422

non-realtime cameras, 236

normal axis, 378

normalized measurements, 738

Notification Output Pin, 478

notifications (VPL), 6, 90, 91, 163, 478–479

Notifications tab, 489

3-Notifications diagram, 478–479

NotSpecified state, 355, 357

numbers, magic, 89, 101, 104, 764, 793

O

.obj format, 249

Obj2Bos.exe tool, 249

Object Browser, 37, 66, 130, 221. *See also* reflection

object-oriented approach, 215, 733

objects, overlapping. *See* entities

obstacles. *See* barriers

occupancy grid, 465

odometers, 591. *See also* wheel encoders

omni lights, 258

OnClosed, 162, 177, 179, 206

OnConnectHandler, 207

on-demand approach, 176

one DOF joint, 386–389
online documentation (MRDS). *See* documentation
online forums. *See* forums
OnLoad, 162, 177, 179, 206
OnMove, 182
onsubmit attribute, 198, 205
OOPic hardware, 733
open loop control system, 636
OpenGL, 234
operating system, MRDS as, 30
operations, 6, 50, 57, 63, 85, 91, 92. *See also*
 behaviors; specific operations
 (list), 94–95
 as APIs, 92
operations port, 53
 Dance service, 86–87
 ServiceA, 117
options files, 101
orchestration services, 7, 31–32, 84
 Robo-Magellan, 347–354. *See also* Robo-Magellan
 simulation scenario
 ServiceA. *See* ServiceA
 SimpleDashboard. *See* SimpleDashboard service
 VPL and, 523–559
/org qualifier, 116
outputs, 478–479
overlapping entities, 247
Overwrite mode, 466

P

P (angle of approach), 411
packages, 9–12. *See also* courseware package;
 soccer package; sumo package
 directory, 20
 installation, 20
 viewing contents of, 155
pairing, 602, 605
Parallax, 170, 566, 567, 576, 577, 578, 581, 732,
 733. *See also* Boe-Bot; Scribbler
Parallax services, 578, 642, 647, 651
parameters, 100, 101. *See also* specific parameters
 case sensitivity and, 100
 options files and, 101
parent entities, 248, 288
Parent function, 69
ParentChild class, 434, 435
parentheses, 481
Park Arm button, 414
Partner attribute, 144–145
PartnerList, 149, 302
partnerships, 6, 31, 84, 85, 93. *See also* execution
 context
passkey, 602, 614, 689
patterns, 68
**PAVE (Princeton Autonomous Vehicle
 Engineering)**, 13
PC-based robots, 681–684. *See also* autonomous
 robots
 914 PC-BOT (White Box Robotics), 583–584, 682
PDAs (personal digital assistants), 681, 682–683
 Axim, 686, 687
 connection, testing, 711–712
 debugging of service on, 711–713
 deploying CF service to, 709–711
 setting up, 686–690
PE.exe (Process Explorer), 690
Pending Nodes, 487
Pending state, 425, 426, 427
PendingTaskCount, 67
periodic events, 73–75
Periodic Timer, 74
persisted handlers, 57
persistent settings, 241
persisting state, 89, 129–132
 load state from config file, 129
 Initial State Partner, 129–130
 in manifest, 130–131
 saving state to config file, 131–132
personal digital assistants. *See* PDAs
photoresistors, 589
phrases activity, 497–498
physics engine, 242. *See also* PhysX engine
 disabling, 242, 243, 244, 246
 types, 271–272
Physics menu, 241–243
physics rendering mode, 237–239. *See also*
 combined rendering mode
PhysicsEngine object, 274, 275
PhysicsEngine.dll, 274
PhysicsEngine.Raycast2D method, 327, 409, 410
PhysicsEntity, 273, 274
PhysicsJoint, 377, 378
PhysX engine (AGEIA), 19, 154, 228, 229, 261,
 272, 286, 314, 318, 382, 391, 397, 407
PIC (programmable interface controller), 732
PICAXE microcontroller, 731, 733, 754, 755. *See
 also* Integrator robot
PICAXE Programming Editor, 756–757
Picblok, 754. *See also* Integrator robot
‘pick and place’ operation, 677–679
PictureBox, 206, 213, 214, 215, 364
PID (proportional-integral-derivative) controllers,
 216, 585, 593, 594, 596, 636, 730
ping, 66, 587, 588
PinOperations, 642

- pins, 736. See also devices**
 - assignments, 757
 - direction control, 762–763
 - Pioneer 3DX (Mobile Robots), 8, 9, 464, 467, 584**
 - ArcosCore.cs for, 136–137
 - Maze Simulator and, 464
 - model, 7
 - in simulation environment, 230, 265–266, 458
 - VPLExplorer diagram and, 524
 - Pixar Shader Model, 16**
 - Platform Builder, 720**
 - platform shape, 284, 285, 286**
 - platforms directory, 19**
 - PlayerOne activity, 529, 530, 531, 533**
 - PlayTone operation, 96, 97, 641, 642, 749, 774**
 - Pleo, 797**
 - PluralNouns activity, 496–497**
 - plus operator (+), 481**
 - PNG files, 194, 243, 544, 784**
 - Pocket PC (PPC) Command Shell, 687, 688**
 - point-to-point motion. See PTP motion**
 - polling, 90, 163**
 - Integrator robot and, 770–773
 - PollInterval value, 537, 540**
 - PopulateWorld method, 340, 341, 345, 346, 383, 385, 554**
 - port parameter, 101**
 - ports (I/O), 736**
 - ports (MRDS), 5, 38. See also specific ports**
 - advantage of, 51
 - completion, 68, 69, 139–141
 - guarding, 64
 - messages and, 50–53
 - operations. See operations port
 - reading from, 51–53
 - Success/Failure, 59, 79–80
 - PortSets, 53–55**
 - limits on declaring, 54
 - Pose, 261, 270, 293**
 - Position property, 249, 251**
 - Position/Rotation property, 261**
 - Post method, 50, 54, 69, 695, 749**
 - PostAndTest, 51**
 - posting, 38, 50**
 - PostUnknownType method, 55**
 - Power Toys, 687, 688, 710**
 - power v. speed, 629**
 - Power value, 252**
 - PPC (Pocket PC) Command Shell, 687, 688**
 - PressEnter function, 52**
 - Previous variable, 481, 482**
 - Princeton Autonomous Vehicle Engineering (PAVE), 13**
 - Process Explorer (PE.exe), 690**
 - ProcessDialogKey, 181, 182**
 - ProcessedTaskCount, 67**
 - ProcessFrame method, 362**
 - ProcessFrameAndDetermineBehavior method, 452, 453, 456**
 - ProcessFrameHandler, 452**
 - ProcessImage method, 362, 365, 427**
 - Professions activity, 495, 496, 497, 498**
 - programmable interface controller. See PIC**
 - Project Properties (Visual Studio), 114–115**
 - Project toolbox, 474**
 - Projection (member), 382**
 - ProMRDS sample code. See sample code**
 - ProMRDSbettersoccerplayer service, 450, 456, 457**
 - ProMRDSSimplesoccerplayer service, 449, 456. See also SimpleSoccerPlayer**
 - Properties pane, 244**
 - Properties toolbox, 474**
 - proportional gain, 593**
 - proportional- integral- derivative controllers. See PID controllers**
 - proprioceptive sensor data, 585**
 - Prospect 12, 13**
 - protocol commands (Integrator robot), 760–763**
 - proxy assemblies, 114, 123**
 - Proxy DLLs, 92, 121, 123**
 - proxy generator, 97, 123, 285**
 - PTP (point-to-point) motion, 660–661**
 - asynchronous, 660
 - fully synchronous, 660
 - synchronous, 660
 - pulse width modulation. See PWM**
 - PWM (pulse width modulation), 216, 568, 592, 698. See also PID controllers**
 - commands, 757
 - method, 730
- ## Q
- quadruped robots, 10, 467, 565, 580. See also RobuDog models**
 - qualifiers**
 - /alt, 98, 116, 216, 297, 763
 - /clone, 116
 - /month, 116
 - /namespace, 116
 - /org, 116
 - /year, 116
 - Qualify option, 422**
 - Quality Level, 240**
 - quaternions, 270, 274, 451, 536, 542, 659, 675, 739**

Query, 91, 95

QueryFrame request, 206, 212, 452

QueryInfraRed, 95, 96

queues

dispatcher, 39, 65–68

enqueued, 50, 67, 68. *See also posting*

FIFO, 50, 51

R

ramp, 239

Random Move button, 415

random number generator, 124–125

range scan, 589

range sensors, 586–589. *See also* IR distance sensors; laser range finders; sonar sensors

Ranges variable, 519

reactive behaviors, 636

ReadFormData request, 200

reading, from ports, 51–53

Ready state, 355, 357, 425, 426

Ready variable, 517

ReAlign command, 453, 455, 456

realtime cameras, 235–236

reason, 135

Receive example, 56–57

receivers, 5, 38, 46, 50

arbiters and, 55–65

nonpersistent, 47

recursion, 483, 492, 526, 527, 542

referee service, 338–347

cameras, 340

running from browser, 339, 342–343

SimulationTutorial1 service, 338–339

sky/sun/ground, 340–341

traffic cones, 343–346

world, 340

Reference Paths tab, 115

references, 122–123

reflection, 37, 66, 92, 116, 124, 130, 137, 385, 403. *See also* Object Browser

Reflector. *See* .NET Reflector

Refresh option, 422

ReliableSubscribe, 166, 169

remote controller, universal, 734

remote driving, Stinger CE, 690–702

remote procedure calls, 92

remotely connected robots, 59, 565, 599–653

Bluetooth connection

Boe-Bot, 614–615

LEGO NXT, 602–606

dance service, 625–643

building, 626–630

flashing/beeping, 640–643

improving behavior, 636–640

Dance.manifest.xml, 630–634

Boe-Bot, 633–634

LEGO NXT Tribot, 632–633

Dashboard, 615–625

joystick/gamepad, 623–624

manifests

creation, 616–621

multiple, managing, 634–635

partnering with robot, 630–635

running, 621–623

reviewing results, 635–636

sensors, 643–652

types, 643

setting up, 600

Boe-Bot, with MRDS, 611–615

LEGO NXT tribot, with MRDS, 601–611

shortcut for running, 624–625

Simple Dashboard, 619–621

wandering

Boe-Bot, 647–652

LEGO NXT Tribot, 644–647

RemoveEntity, 273

RemoveItem function, 494

Render method, 273, 316

Rendering Materials property, 452

Rendering menu, 236–241

combined rendering mode, 239

Graphics Settings, 240–241

no rendering mode, 240

physics rendering mode, 237–239

visual rendering mode, 236

wireframe rendering mode, 237

RenderState, 275

rendezvous point, 59

Replace, 90, 95, 132–133

Representational State Transfer (REST) model, 83

request/response cycle, 57, 90, 91

requests, 50, 90, 91. *See also* messages; *specific requests*

Reset state, 355, 359, 362

resistors, 587

light-dependent, 589

photo, 589

Resource Diagnostics, 108

responses, 50, 90, 91. *See also* messages

REST (Representational State Transfer) model, 83

restitution, 255, 261, 314, 380

Result Output Pin, 478

returning errors, 135

Reverse Dominos button, 415

Reverse function, 494

- revolute joints, 377**
- Revolution Education, 733**
- RGB color space, 450, 452, 462, 463, 590. See also HSV color space**
- Richter, Jeffrey, 81**
- right-handed coordinate systems, 234**
- RIOS (robotic arm interactive operating system), 579, 661, 666**
- roaches, mechanical. See hexapod project**
- 'roadblock,' artificial intelligence, 797**
- Roberts, Paul, 155, 524, 529**
- RoboCup 2007, 10, 444**
- Robo-Magellan competition/rules, 337, 343, 374**
- Robo-Magellan simulation scenario, 269, 276, 336, 337–374**
- barriers, 337, 341–342, 374
 - behavior states, 354–374
 - future directions, 374
 - happiness function, 355, 356, 368, 369, 374
 - manifest, creation of, 349–351
 - orchestration service, 347–354
 - referee service, 338–347
 - cameras, 340
 - running from browser, 339, 342–343
 - SimulationTutorial1 service, 431
 - sky/sun/ground, 340–341
 - traffic cones, 343–346
 - world, 340
 - SimMagellan service, 70, 277, 336
 - generation of, 347–349
 - WinForm connection to, 352–354
 - simulation services, 277
 - state machine, 355, 356, 361
 - defining, 355–356
 - implementing, 356–362
 - WinForm
 - connecting to SimMagellan service, 352–354
 - creation, 351
- RoboRealm, 84, 221, 467, 582, 590**
- RoboSoft, 10, 11, 444, 580**
- robot(s). See also robotics hardware; specific robots**
- articulated, 10, 375, 467, 655, 656, 665
 - autonomous. See autonomous robots
 - bipedal, 580, 655
 - buying, 573–584
 - companion, 797
 - components of, 584–596. See also actuators; controllers; sensors
 - actuators, 585, 592–593
 - controllers, 584, 593–596
 - sensors, 585–592
 - differential drive, 263–267, 565
 - dog, 10, 565, 580. See also RobuDog models
 - Hemisson. See Hemisson robot
 - humanoid, 10, 565, 574, 580, 655, 665, 668, 734
 - industrial, 14, 564, 573, 574, 661
 - Integrator, 754–785
 - laptops and, 682
 - mobile, 564–565
 - MRDS supported, 574–584
 - PC-based, 681–684
 - quadruped, 10, 467, 565, 580
 - remotely connected. See remotely connected robots
 - safety considerations, 564
 - tethered, 565–572. See also remotely connected robots
 - types of, 564–573
 - Windows XP-based, 682
- robot entities, 263–266**
- robot service, running, 109–112**
- robotic arm interactive operating system (RIOS), 579, 661, 666**
- robotic arms (real), 655–680. See also Lynxmotion**
- L6 robotic arm**
- articulated, 419, 565, 574, 655–665
 - forward kinematics, 410, 661–664
 - arm linkage configuration, 661–662
 - geometry for, 662–664
 - introduction, 656–665
 - inverse kinematics, 410–412, 664–665
 - 'pick and place' operation, 677–679
 - state, 656
- robotic arms (simulated), 394–418**
- camera entity, 402–403
 - custom meshes, 404
 - dominos, 230, 413, 414, 415, 416, 417, 418, 679
 - Reverse Dominos button, 415
 - Topple Dominos motion, 415, 416–417
 - ToppleDominoPosition array, 417–418
 - gripper entities, 401–402
 - inverse kinematics, 410–412
 - L0Entity, 398–399
 - L1Entity, 399–400
 - L2Entity, 400
 - L3Entity, 400, 401
 - L4Entity, 400, 401
 - Motion Recorder and, 672
 - MoveToPosition, 410–411
 - MoveToPosition method, 410, 412, 415, 675
 - parameters, 411–412
 - moving, 405–407
 - physics model, 394–404
 - picking up objects, 407–410
 - SimulatedLynxL6Arm service, 394, 395, 397, 403, 405, 410, 412, 418

robotic arms (simulated) (continued)

SimulatedLynxL6ArmEntity, MoveTo method, 405, 406, 408, 410, 412, 414, 415
user interface, 412–418
visual enhancement, 403–404

robotics, 3, 563. See also robots
courseware package, 11–12
MRDS and, 4, 798
team (Microsoft), 4, 444

robotics hardware. See also robot(s)
autonomous robots, 10, 12, 13, 170, 265, 457, 572–573, 681–730
MRDS with, 563–597
new hardware services, writing, 731–798
remotely connected robots. *See* remotely connected robots
robotic arm, 655–680

Robotics Tutorials, 27, 512
4, 159, 171, 185, 351, 565, 690
6, 565, 566
directory, 19

Robotics with the Boe-Bot (book), 611–612

RoboticsCommon.dll, 151, 270
generic contracts, 270–271
types, 270

RoboticsCommon.Proxy, 122, 161, 348, 626, 643, 691, 751, 764

RoboticsConnection website, 579, 685, 686, 713, 720, 730, 734. See also Stinger CE

RobotUpdateBumpersHandler, 427

RobotUpdateButtonsHandler, 426

RobuDog models, 10–11, 444, 580

rocker switch, 181

Roomba (iRobot), 8, 532, 581, 582, 739. See also iRobot Create

root directory, 32, 99, 130. See also mountpoint

RotateDegrees, 159, 184, 216, 270, 290, 291, 293, 295, 308, 749
Corobot entity, 312–313

rotateVal, 405

RotatingWheelEntity, 317

Rotation and Translation Movement Scale, 240

Rotation property, 249, 251

Rovio, 797

Ruby, 44

running services, 123–125

S

/s parameter, 297

sample code (ProMRDS), 32, 37

coding tips, 37
installation, 21

verification, 23–26

MRDS versions and, 17, 33

updates, 17, 33

samples directory, 19–20

saturation, 450, 452

Savage Innovations, 733

saved state, 89. See also config file

SaveState, 58, 131

saving state, 131–132. See also persisting state

SBCs (single-board computers), 683

scenes

lights for, 257–258

saving/loading, 243

screen images, saved to files, 243

Scribbler (Parallax), 571, 576, 581, 681, 733, 735

SDK (software development kit), 3. See also

Microsoft Robotics Developer Studio

Seattle Robotics Society (SRS), 337. See also

Robo-Magellan simulation

Security Manager, 99, 107–108

SegmentEntities, 435, 436, 437

Segway Scooter, 13, 573

semaphores, 30

sensor data

exteroceptive, 585

proprioceptive, 585

reading of (VPL diagrams)

from real robots, 512–519

from simulated robot, 509–512

types of, 585

sensors, 585–592

acceleration/tilt, 591

analog, 585

bump, 643, 748

compass, 590–591

contact, 586. *See also* bumpers

digital, 585

directory, 19

exteroceptive, 585–592

generic contracts for, 585

GPS. *See* GPS

light, 589–590

range, 586–589. *See also* IR distance sensors;

laser range finders; sonar sensors

remotely connected robots and, 643–652. *See also*

remotely connected robots

sonar, 587–588, 643

sound, 591

video/image, 590. *See also* cameras; webcams

wandering with, 703–707

wheel encoders. *See* wheel encoders

whiskers. *See* whiskers

sequential processing, 68–69

serial ports, 75–76

Serializer board, 160, 216, 566, 579, 580, 686, 734, 735, 739

interfacing to, 697–699

Serializer services, 686, 691, 697

service(s), 6, 31, 84. See also DSS; specific services

abstract. See generic contracts
 accessing, from web pages, 185–188
 activities (VPL) and, 501–502
 advanced concepts, 157–222
 behavior. See behaviors
 compiling, 121–123. See also compiling diagrams to services
 components of, 85–94
 context of. See execution context
 creation (with DssNewServiceTool), 115–116
 creation (with Visual Studio)
 DssService1, 34–37
 ServiceA, 113–115
 deploying, 151–155
 diagrams converted to. See compiling diagrams to services
 dropping, 141–142
 generic. See generic contracts
 initialization. See initialization
 manifests. See manifests
 messages between, 90
 migrating. See DssProjectMigration tool
 orchestration. See orchestration services
 polling, 90
 running, 123–125
 source files. See source files
 starting/stopping
 manual, 102–103, 205
 with Partner attribute, 144–145
 programmatically, 137–143
 state of. See state
 versioning, 609
 webcam added to, 206
 WinForms added to, 172–173
 WinForms and, passing information between, 175–180

service assemblies, 122**service directories, 93**

Service Directory, 22, 99, 103–105, 111, 136, 205, 264, 266, 267, 278, 311, 323, 336, 443, 512, 611

service forwarder ports, 83, 134, 138, 140

Service Instance Directory, 104, 110

service operations. See operations

Service Tutorials, 112

4, 306, 335

8, 215

9, 215, 219

#6, 185

directory, 19

ServiceA, 112

breakpoints, 126
 compiling, 121–123
 contract, 116–117
 contract directory cache, 124
 creation of, 113–115
 Get operation, 118
 main operations port, 117
 main service implementation file, 119–120
 manifest, 124
 Project Properties, 114–115
 references, 122–123
 running, 123–125
 with ServiceB, 143
 source files, 114, 116–121
 state, 117

ServiceB, 112

breakpoints, 126
 compiling, 121–123
 config file, specified in manifest, 130–131
 creation of, 115–116
 defining state for, 127–128
 operations, 117
 random number generator, 124–125
 running, 123–125
 with ServiceA, 143
 saved state, 132

ServiceContract property, 250, 265, 266, 303, 551

ServiceForwarder, 139, 208, 423

ServiceInfoType records, 208

ServicePaths class, 130

ServicePort attribute, 87

ServiceRecordType, 94

Services toolbox, 473, 474

search groups in, 475

ServiceUri, 129–130

servo motors, 592, 656, 657–658. See also SSC-32 servo controller

Set Configuration, 510, 512, 521

set point, 593

SetActuators, 749

SetBounceThreshold method, 556

SetCameraImage method, 364

SetDrivePower, 182, 183, 749

SetEndEffectorPose, 540, 542, 668, 669, 675, 676

SetLEDs, 749

SetPollInterval action, 536–539, 542

SetPose, 273, 299, 300, 360

shader programs, 240, 249

shadows, 259

ShapeDescriptors, 431, 433

Shaped, 261

sharing source code, 152–154

shortcuts

Windows CE, 688

Windows Mobil, 688

shoulder joint, 397, 405, 434, 435, 662

shoulderVal, 405

SICK Laser range finder (LRF), 573, 584, 589.

See also laser range finders

code, 75

service, 17, 19

SICK LRF. See SICK Laser range finder

SickLaserRangeFinder activity, 525

SimMagellan service, 70, 277, 336. See also

Robo-Magellan simulation scenario

generation of, 347–349

using, 374

WinForm connection to, 352–354

SimPhotoCell, 547, 549, 550, 551, 552

SimPlayerPlayerOne service, 530, 532

SimpleDashboard service, 17, 19, 263–264, 296,

310, 311, 336, 438, 442, 511–512

remotely connected robots and, 619–621

SimpleDialog activity, 476, 479, 481, 500, 518

SimpleHandler method, 40, 41, 42

SimpleSoccerPlayer, 444, 445, 446, 449, 450

SimpleVision service, 556, 558, 559

SimplifiedConvexMeshEnvironmentEntity, 262–263

Simulated IR sensor. See IR distance sensors

simulated robotic arms. See robotic arms (simulated)

simulated sonar sensor service, 467

SimulatedBumper service, 263

SimulatedDifferentialDrive service, 263

SimulatedGenericContactSensors service, 511

SimulatedIR service, 331–336

SimulatedIRobotLite service, 420, 423, 424, 425,

426, 530, 531

SimulatedLaserRangeFinder service, 525

SimulatedLynxL6Arm service, 394, 395, 397, 403,

405, 410, 412, 418

SimulatedLynxL6ArmEntity, 394, 405

MoveTo method, 405, 406, 408, 410, 412,

414, 415

SimulatedQuadDifferentialDrive service,

296–313, 336

manifest, 349

simulation entity notifications, 300–310

testing, 310–312

SimulatedRangeFinder activity, 518

SimulatedSoccerReferee service, 444, 447

SimulatedSumoReferee service, 421–423, 529

communicating with, 423–425

SimulatedWebcam service, 26, 266, 277, 350, 362,

445, 446

Corobot entity, 322–323

simulation(s). See also simulator

directory, 19

DLLs, 270–276

example projects, 419–467

Explorer project. See Explorer project

hexapod project. See hexapod project

soccer environment. See soccer environment

sumo environment. See sumo environment

online forum, 28

Simulation Editor, 225, 243, 244–252, 269, 272,

281, 283, 285, 289, 317, 330, 366, 374,

452, 520, 550

simulation entity notifications, 300–310

Simulation Environment. See Visual Simulation Environment

Simulation Environment with Terrain, 230

simulation scenario, 276, 337. See also Robo-Magellan simulation scenario

simulation services, 276–281

creating, 277–281

Robo-Magellan simulation, 277

Simulation Tutorials, 27

1, 230, 231, 243, 254

2, 243

SimpleDashboard service and, 17

5, scene from, 6

SimulationCommon.dll, 271–272

SimulationEngine class, 273–274

SimulationEngine service, 230, 263, 511

SimulationEngine.dll, 272–274

SimulationEngine.Proxy.dll, 274

SimulationState, 271

SimulationTutorial1 service, 243

HexapodEntity service, 431

referee service, 338–339

simulator. See also simulations

advantages, 226

built-in entities, 252–267

Camera menu, 235–236

hardware requirements, 227–228

Help menu, 235

limitations, 226–227

navigating in, 232–233

Physics menu, 241–243

Rendering menu, 236–241

scenarios, 230

software requirements, 228–230

starting, 230–231

using, 231–244

- simultaneous localization and mapping (SLAM), 458, 459, 467, 636.** *See also* autonomous robots; Explorer project
- single-board computers (SBCs), 683**
- SingleShapeEntity, 248, 259, 260–262, 344, 383, 385, 395**
- SingleShapeSegmentEntity, 383–385**
- Single-Threaded Apartment (STA) model, 66, 81, 172, 175, 567, 691**
- six DOF joints, 377, 390–392, 418**
 - Lynxmotion L6 arm, 665
- six-legged walker.** *See* hexapod project
- skid steering, 565**
- sky, 253–257, 279, 340–341**
- SkyDomeEntity, 253–254**
- SkyEntity, 253–254**
- SLAM (simultaneous localization and mapping), 458, 459, 467, 636.** *See also* autonomous robots; Explorer project
- SlerpDrive, 379**
- SmallDamper joint, 389**
- SOAP (Simple Object Access Protocol), 83, 114**
 - DSSP v., 83
 - Fault, 57, 79, 80, 95, 203
 - namespace, 119
 - port, 101
- soccer environment (simulation), 444–457**
 - Corobot services, 457
 - CorobotSoccerPlayers service, 447, 448
 - future directions, 457
 - LEGO NXT robots, 446, 447
 - ProMRDSbettersoccerplayer service, 450, 456, 457
 - ProMRDSsinglesoccerplayer service, 449, 456
 - SimpleSoccerPlayer, 444, 445, 446, 449, 450
 - soccer players
 - behavior improvements, 453–456
 - building, 449–456
 - changing, 446–449
 - image processing improvements, 450–453
- soccer package, 10–11, 444**
 - installation, 20, 444
- software development kit.** *See* SDK
- solid-state storage devices, 683**
- SolidWorks, 318**
- SolverIterationCount, 286**
- Sonar (generic contract), 271**
- sonar ring, 588**
- sonar sensor service (simulated), 467**
- sonar sensors, 587–588, 643**
- Sort function, 494**
- sound sensors, 591**
- SoundPlayer activity, 519, 541**
- sound/voice synthesis, 593**
- source code, sharing, 152–154**
- source files (service), 114, 116–121**
 - main service implementation file, 119–120, 172
 - manifest. *See* manifests
 - types file, 116–119
- SourceLocation, 503**
- Spawn, 40–42**
- SpawnIterator method, 48–50, 81, 82, 137**
- Specular color value, 252**
- speed v. power, 629**
- spheres, 238**
- SphereShapeProperties, 271**
- 4-Spiral project, 514–515**
- spline function, 314**
- spot lights, 258**
- SpotUmbra, 258**
- Spring (properties), 380**
- Spykee, 797**
- SRS (Seattle Robotics Society), 337.** *See also* Robo-Magellan simulation
- SSC-32 servo controller, 80, 566, 657, 658, 659, 660, 664, 665, 666, 667, 668, 669, 670**
- STA (Single-Threaded Apartment) model, 66, 81, 691**
- Start Match button, 422**
- Start method, 33, 36, 120, 136, 162**
- Start variable, 483, 484, 485**
- state (behavior).** *See* behavior states
- state (diagram), 480**
- state (entity).** *See* entity state
- state (FSM).** *See* state machines
- state (Generic Brick).** *See* Generic Brick contract
- state (of service), 6, 30, 64, 87–91**
 - adding fields to, 117
 - debugging information for, 220
 - defining, 127–128
 - displaying, with XSLT, 196–198
 - persisting. *See* persisting state
 - saved, 89
 - saving, 131–132
 - serialization of, 89
 - viewing, 111–112
- state (wandering).** *See* wandering
- state machines, 70, 355**
 - finite, 70, 87, 89
 - Robo-Magellan scenario, 355, 356, 361
 - defining, 355–356
 - implementing, 356–362
 - sample sumo player, 425–427
- State Partner Service, 99**
- StateService, 94, 109, 149**

static entities, 239

static joins, 61

StaticFriction, 261

status bar, 234–235

Stinger CE (RoboticsConnection), 572, 579–580, 684

autonomous operation, 728–729

IR sensors, 699–702

wandering and, 703–704

remote driving, 690–702

Serializer board, 160, 216, 566, 579, 580, 686, 734, 735, 739

setting up, 685–686

wandering behavior, 703–707

defining wander modes, 704–707

IR sensors, 703–704

running code, 707

StingerDriveByWire service, 688, 689, 690–702, 707, 723, 729, 730

CF version, 708–713

code overview, 691

keyboard handling, 691, 692–694

Serializer board, interfacing to, 697–699

service operations, 694–697

state, 87–89

WinForm interface, 691–692

StingerPWMDrive, 215, 216, 217, 739

store directory, 19

strong type-checking, 54, 749

strong-name signing, 17

Subjugator, 3, 12

submarine, robotic, 3, 12

Submit, 95

Submit button, 188, 198, 199, 412, 795

Subscribe, 95

subscribing, 6, 90, 163

to state changes, 164–166

Subscription Manager service, 168–169

SubscriptionManager, 306, 332

Success/Failure ports, 59, 79–80

sumo competition, 9–10, 419, 420

sumo environment (simulation), 420–430. See also VPL Sumo project

future directions, 430

sumo player, 421

behavior, 425–427

creating, 427–429

state machine, 425–427

sumo referee, 421–423

sumo referee service, 423–425

sumo package, 9–10, 419, 420

installation, 20, 420

sample sumo player service, 423

sumo player

hardware platform, 420–421, 430

simulation model, 421

behavior, 425–427

creating, 427–429

state machine, 425–427

sun, 279, 340–341

Sun SPOTs, 732

Surveyor SRV-1, 160, 205, 571, 582–583

Swann wireless camera, 158, 160, 205, 600

swarm algorithms, 443

Swing DOF, 378

Swing1Limit, 379

Swing1Mode, 379

Swing2Limit, 379

Swing2Mode, 379

SwingDrive, 379

Switch activity, 480, 493

synchronization, completion ports for, 139–141

Synchronized Dance service, 70

synchronous PTP, 660

System.Drawing, 161, 348

T

TargetFramework, 503

Task Execution Policy, 67

values, 67–68

tasks, 39–43

TCP (Tool Center Point), 657, 669

Tear Down receiver group, 64, 92

teardown, 59

technologies directory, 19

teleoperation, 157, 565, 599. See also remotely connected robots

remote control and, 599–600

TeleOperation service, 157–158, 583, 590, 775, 776, 785, 791, 792, 797

creating, 160–163

current state, 186–187

DriveControl Form. See DriveControl Form

enhancements for, 221

references, 160–161

WebCamForm. See WebCamForm

telepresence, 797. See also TeleOperationservice

templates

C++, 45

Master Page, 187, 191, 192, 195

MRDS, 192, 193–196

programming patterns, 68–76

robotics, 34

Simple Dss Service (1.5), 34, 113

XSLT, 189–190, 193–196

- TerrainEntity**, 256
 - TerrainEntityLOD**, 257
 - test directory**, 19
 - Test method**, 51, 55
 - TestBench**
 - joints
 - with different connector orientations, 392
 - with motion limits, 393–394
 - one DOF, 386–389
 - six DOF, 377, 390–392, 418
 - SmallDamper, 389
 - SingleShapeSegmentEntity, 383–385
 - tethered robots**, 565–572. *See also* remotely connected robots
 - Text to Speech service (Microsoft)**, 593
 - TexttoSpeechTTS activity**, 474, 475, 476, 483, 484, 485
 - Texture Tool**, 254, 319
 - Texture2D**, 275
 - TextureCube**, 275
 - TextureFileName**, 261
 - thread affinity**, 172
 - threadPoolName**, 67
 - ThreadPriority**, 66
 - values, 67
 - Threads window**, 67, 125, 220
 - Thread.Sleep**, 71, 73, 137
 - 3D graphics**, 16, 225, 227
 - 3D Studio Max**, 318
 - Threshold variable**, 519
 - throttling**, 76
 - thumbsticks**, 264, 524, 525, 534, 537, 538, 539, 616, 624, 671
 - thunks**, 53
 - ticks**, 593
 - TIFF file format**, 243, 544
 - tilt sensors**, 591
 - Time (parameter)**, 405, 411
 - Time Base Run-time Settings**, 242
 - time constant**, 594
 - time delays**, 71–73
 - TimeoutPort**, 72, 73, 75, 137, 793
 - timeouts**, 75
 - Timer activity**, 515, 537
 - TimerHandler method**, 426, 427, 448
 - TimeSpan property**, 183
 - timestamps (Generic Brick contract)**, 737
 - timing loops**, 31
 - tips, coding**, 37
 - tire friction (Corobot entity)**, 314–315
 - Tone class**, 97
 - Tool Center Point (TCP)**, 657, 669
 - toolboxes**
 - Basic Activities, 473, 479–480
 - Project, 474
 - Properties, 474
 - Services, 473, 474, 475
 - Topple Dominos motion**, 415, 416–417
 - ToppleDominoPosition array**, 417–418
 - ToString method**, 51
 - tracing**, 221
 - trackball**, 159, 161, 175, 176, 264, 266, 311, 623
 - Tracking state**, 425, 427
 - traffic cones**, 343–347
 - transducers**, 584. *See also* sensors
 - traps/mistakes**, 81–82
 - Traxster**, 579, 686. *See also* Stinger CE
 - TriangleMeshEnvironmentEntity**, 263
 - TriangleMeshShapeProperties**, 271
 - trigger shapes**, 343–346, 423
 - Trower, Tandy**, 4
 - TryPostUnknownType**, 55
 - tutorials**, 19
 - directories for, 19
 - DSS, 27
 - JavaScript, 203
 - MRDS, 27, 29
 - robotics. *See* Robotics Tutorials
 - service. *See* Service Tutorials
 - simulation. *See* Simulation Tutorials
 - VPL, 27
 - Twist DOF**, 378
 - TwistDrive**, 379
 - TwistMode**, 379, 386
 - 8-TwoRobots project**, 520–522
 - type safety**, 38
 - typeof**, 54, 219, 695, 749
 - types**, 270–275
 - in RoboticsCommon.dll, 270
 - in SimulationCommon.dll, 271–272
 - Visual Studio Help and, 272
- ## U
- UART (universal asynchronous receiver/transmitter)**, 765
 - uBot-5**, 13–14
 - UIMath**, 272
 - Uninitialized state**, 425, 426
 - universal asynchronous receiver/transmitter (UART)**, 765
 - universal remote controller**, 734
 - Universal Resource Identifiers**. *See* URIs
 - unsubscribing**, 165, 167

Update, 90, 95, 133–135
 adding handler to process, 134–135
 defining class for, 133–134
Update method, 272–273
UpdateElapsedTime method, 360
UpdateFrame messages, 162, 206, 210, 212
UpdateGameControllerAxes, 176
UpdateSensors, 749
UpdateState method, 79, 80, 335
UpdateStateFromSimulation, 305, 460
UpperTwistLimit, 379
Upsert, 95
URIs (Universal Resource Identifiers), 85, 86.
 See also *contract identifiers*
Use a Manifest, 510, 512, 521, 525
UseExisting, 144, 146
UseExistingOrCreate, 144, 145, 164
UsePartnerListEntry, 144, 148–149
user guides
 CCR, 27, 29
 DSS, 27
 MRDS, 27, 37
user interfaces, 170, 222. See also *Web Forms*;
 WinForms
UsesAlphaBlending flag, 250
using statements, 162

V

validate function, 204
ValidateFrameHandler, 362, 426
value (color), 450, 452, 463
Variable activity, 479, 480–482, 484
variables (VPL), 480–482. See also
 specific variables
4-Variables diagram, 480–482
VCD (video capture device), 160, 205, 206
Vector2, **Vector3**, **Vector4**, 270, 274
vectors, 270
veer, 596
velocity, 250, 380
versioning (service), 609
versions (MRDS), 4–5, 33
 1.5 Refresh, 4, 16, 33
 2.0, 4, 5, 16, 33, 798
 sample code and, 17, 33
Vertex, 16
VertexBuffer, 275
Vex Robotics Design System, 734
VFW (Video for Windows) standard, 205
video capture device. See *VCD*
video cards. See *graphics cards*
Video for Windows (VFW) standard, 205

video/image sensors, 590. See also *cameras*;
 webcams
ViewDssDeployContents, 155
virtual bumpers, 586
vision processing algorithm, 362–366. See also
 ProcessImage method
Visual C# Express (Microsoft), 16, 33
Visual Programming Language. See *VPL*
visual rendering mode, 236. See also *combined
 rendering mode*
Visual Simulation Environment, 6–7, 225–267.
 See also *simulations*; *simulator*
 extending, 269–336
 graphics card, 22, 23
 models, 7
 online forum, 28
 tutorials. See *Simulation Tutorials*
 VPL projects and. See *VPL projects/examples*
Visual Studio (Microsoft), 16, 37
 creation of services with. See *services*
 debugger. See *debugger*
 eBox and, 720–721
 Help, types and, 272
 Project Properties. See *Project Properties*
VisualEntity, 247, 272, 282, 336, 385
 methods/members, 272–273
voice/sound synthesis, 593
VOLTS-IQ, 84
VPL (Visual Programming Language), 7–8, 471–500,
 501–522, 523–559
 activities. See *activities*
 basics, 471–500
 conditionals, 482–484
 data flow language, 471–473
 debugger, 485–487
 development environment, 473–474
 diagrams. See *diagrams*
 differential drives and, 513–516
 execution model, 484–485
 extensibility, 7
 loops. See *loops*
 notifications. See *notifications (VPL)*
 orchestration services and, 523–559
 reading sensors with, 517–518
 tutorials, 27
 directory, 19
 variables. See *variables*
VPL Explorer project, 523–528
VPL projects/examples
 Arm Mover, 534–542
 6-BackAndForth project, 517–518
 Ball Follower project, 554–558
 7-CustomActivity, 488–491

- 8-CustomActivity, 491–493, 503–508
 - 5-DriveDistance diagram, 515–516
 - 3-DriveInCirclesSim, 513–514
 - 2-GenericContactSensorNXT, 512–513
 - 1-GenericContactSensorSim, 509–512
 - 1-Hello VPL project, 474–475
 - 2-Hello VPL project, 476–477
 - 7-LaserRangeFinder, 518–519
 - Line Follower, 542–553
 - 9-Lists, 495–499
 - 5-Loops, 482–483
 - 6-Loops, 484–485
 - 3-Notifications diagram, 478–479
 - 4-Spiral project, 514–515
 - 8-TwoRobots project, 520–522
 - 4-Variables diagram, 480–482
 - VPL Explorer, 523–528
 - VPL Sumo, 529–534
 - VPL Sumo project, 529–534**
 - bumper sensors, reading of, 532–533
 - IR sensors, reading data from, 532
 - iRobot Create, 530, 532
 - main diagram, 529
 - Maneuver message, 533–534
 - PlayerOne activity, 529, 530, 531, 533
 - SimulatedSumoReferee, 529
 - Start action, 530–531
 - VPLExplorer diagram, 524–528**
 - LRF data, reading of, 525–528
 - Pioneer3DX robot and, 524
 - Xbox controller, interfacing with, 524–525
- ## W
- W (rotation angle of wrist joint), 411**
 - Wait method, 71, 72, 73**
 - walking gaits, 565**
 - Wall Colors, 462**
 - Wall Textures, 462**
 - WallBoxSize, 464**
 - wandering**
 - Boe-Bot, 647–652
 - code, running, 707
 - LEGO NXT Tribot, 644–647
 - states (modes), 355, 367–369, 425, 427, 704–707
 - Stinger CE, 703–707
 - WAV files, 593**
 - waypoints, 343, 360, 369, 374**
 - Web Forms, 95, 105, 107, 185–205**
 - creating, 198–203
 - JavaScript and See JavaScript
 - steps for using, 187–188
 - WinForms v., 170
 - web services, 83, 92, 114. See also DSSP; SOAP**
 - Webcam (generic contract), 271**
 - Webcam service, 103, 104, 105. See also**
 - SimulatedWebcam service**
 - manually start, 102–103, 205
 - _webCamEventsPort, 162, 210**
 - WebCamForm, 162, 173, 174**
 - _webCamFormLoaded, 210**
 - webcams, 205–215, 590. See also cameras**
 - adding, to services, 206
 - aspect ratio, 206
 - connecting, 210–212
 - frames, processing, 212–215
 - settings, changing, 206
 - video feed, 173, 205, 600
 - WinForm for, 207–212
 - Webcam service, 205
 - wheel encoders, 216, 271, 591–592, 593, 602, 627, 637, 639, 640, 730, 739, 779**
 - Generic Brick contract, 739
 - simulated, 317–318
 - WheelEntities, 287**
 - WheelShapeProperties, 271, 287**
 - whiskers, 167, 170, 569, 586, 594, 595, 612, 613, 647, 651**
 - White Box Robotics 914 PC-BOT, 583–584, 682**
 - WIDCOMM, 603**
 - Wiimote, 37**
 - Windows CE, 10, 16, 152, 154, 420, 421, 572, 579, 580, 681, 683**
 - booting, 715
 - SDK, 720
 - service on
 - running, 725–729
 - setting up, 726–727
 - testing, 727–728
 - shortcuts on, 688
 - system image, building, 724–725
 - Windows Forms. See WinForms**
 - Windows Mobile, 16, 152, 154, 181, 184, 683, 684, 687, 688, 731**
 - shortcuts, 688
 - Windows Presentation Foundation (WPF), 172**
 - Windows XP-based robots, 682**
 - WinForms (Windows Forms), 66, 81, 171–185**
 - Adapter, 161, 352, 353, 691, 727
 - adding, to services, 172–173
 - SimMagellan service, 352–354
 - creating, 173–175
 - for Robo-Magellan scenario, 351
 - event handlers, adding, 178–180
 - instantiating, 353

WinForms (Windows Forms) (continued)

receiving from, 175
sending to, 175
services and, passing information, 175–180
StingerDriveByWire and, 691–692
for video feed, 207–212
Web Forms v., 170

WinFormsServicePort, 175, 176

wireframe rendering mode, 237

Worker activity, 526, 527

WorkerThreadCount, 67

world, 340

WowWee Robotics, 797

WPF (Windows Presentation Foundation), 172

wrappers, 39, 40, 53, 55, 79, 81, 95

wrist joints, 401, 405, 411, 662

wristVal, 405

writing new hardware services, 731–798

X

X position, 411, 534, 538, 541, 664

Xbox controllers, 31, 264, 534, 535, 615, 623, 624, 671

Arm Mover project and, 534, 535, 537
thumbsticks, 264, 524, 525, 534, 537, 538, 539, 616, 624, 671

VPLExplorer diagram and, 524–525

XDrive, 381

XInputController activity, 525, 537

XML (Extensible Markup Language), 188. See also manifests

case sensitive, 188, 193
editing. See Manifest Editor

XMotionMode, 380

XNA (Microsoft), 19, 154, 228, 229, 240, 275, 279

forums, 275

Microsoft.Xna.Framework namespace, 274

Microsoft.Xna.Framework.dll, 274–275, 278, 340
adding reference to, 275

Microsoft.Xna.Framework.Graphics
namespace, 275

SDK, 275

XSLT (Extensible Stylesheet Language Transform), 185, 188–198, 784

case sensitivity and, 191

development environment for, 188–191

displaying state with, 196–198

embedded resources. See embedded resources

for enhanced information display, 191

file, creation of

from scratch, 192–193

using MRDS template, 192, 193–196

HttpGet requests and. See HttpGet requests

HttpPost requests and. See HttpPost requests

Y

Y position, 344, 411, 534, 538, 539, 664

YDrive, 381

/year qualifier, 116, 297

yield break, 45, 46, 69

'yield is your friend,' 73

yield return, 44, 45, 46, 47, 58, 69, 73

YMotionMode, 380

Z

Z position, 411, 534, 538, 539, 664

ZDrive, 381

ZMotionMode, 380

ZX-Bluetooth module, 754, 755