

Index

A+ innovations, 178–179 Advanced Construction Technology Center (ACTEC), 3-4, 25 aeration system inspection robot, 272-273 aerial robots, 18-23 aerial construction with quadrotor teams, 126-128 for building structure assembly, 123-128 in flight assembled architecture, 124 Aerial Vision Group, 19 AGV-based integrated on-site logistics system, AIST, 198 Anex Industrial Hong Kong Limited, 233 Ansan Korea, 208-209, 261 Architectural Institute of Japan (AIJ), 3-4, 292 Asada, H. Henry, 210-212 asbestos material removal robot, 287-290 asbestos removal, collecting and packaging robot, 283-286 Ascending Technologies, 19 ASIMO bipedal robot, 209-210 assistive devices. See exoskeletons, wearable robots and assistive devices Atkociunas, S., 95 Auto-Clamp crane-end effector, 145 Auto-Claw crane-end effector, 144 automated building construction system (ABCS), automated coating robot for external walls, 196 automated concrete distribution system, 82-83 automated construction lift, 109-110 automated crane for rebar positioning, 43-44 automated guided vehicle (AGV) for construction sites, 114-115 integrated on-site logistics system, 113 automated mini logistics unit, 123 automated on-site delivery system, 115-117 automated on-site logistics system, 117-118 automated paving machine, 180-184 automated site-measuring and construction progress monitoring, 14-23

automated vertical material delivery lift, 110-111 automated/robotic on-site 3D concrete structure production, 46-57 automatic climbing formwork SKE plus, 48-49 cable-suspended robotic contour crafting system, 54-55 gantry type contour crafting robot, 50-53 minibuilders, 57 Platform System ACS P, 50 robots equipped with end-effectors for additive manufacturing for extraterrestrial construction, 55-57 automated/robotic on-site factories, 1, 2, 3, 5 automated/robotic on-site truss/steel structure assembly, 58-62 location orientation manipulator, 61-62 robotic assembly of truss structures, 62 automatic climbing formwork SKE plus, 48-49 automatic compacting leveling system MAI®2Floor Master, 89 automatic digging and soil removing system, 27 automatic excavation system for diaphragm-wall production, 26 automatic floor screeding robot, 92–93 automatic modular assembly system (AMAS), 131-133 automatic on-site soil removing/logistics system, 29 - 30automatic rendering machine, 233 AutoMine product family, 38 autonomous construction equipment, 34-35 Autonomous Haulage System, 34 Autonomous Solutions, Inc., 35-36 Auto-Shackle, 141 AUWEL 3 small sized column welding robot, 154 Ball State University, 70-71 Baxter/Sawyer humanoid construction robot, 201-202 Behdinan, Kamran, 72-73 Bespoke Access Solution, 266-267 Big Canopy, robotic end effector for, 146



328 Index

bio-inspired facade inspection robot "C-Bot", swarm robotics and self-assembling building 252-253 structures, 128-139 Blium, Jeremy, 137-139 tile setting and floor finishing robots, 175 "Boardman" mobile material handling robot, C-Bot bio-inspired facade inspection robot, 231 252-253 Bock, Thomas, 175 ceiling and wall panel installation Bodyweight Support Assist Device, 209–210 light-weight manipulator for, 222 Bouygues Construction, 179-180 robot for, 223 Brazauskas, T., 95 ceiling glass installation robot, 168 bricklaying robots, 62-77 ceiling handling robots, 216 ceiling panel positioning robot "CFR-1", 223-224 bricklaying robot concept, 72-73 BRONCO, 67-68 Centaur hauler, 32 Hadrian, 73-75 "CFR-1" ceiling panel positioning robot, 223-224 OSCR, 70-71 Chang Soo Han, 208-209, 261 ROCCO, 68 chimney cleaning and dismantling robot, 278 Semi-Automated Masonry System (SAM), CHIMP - CMU Highly Mobile Platform, 199-201 Ciências Sem Fronteiras, 72-73 Solid Material Assembly System (SMAS), 65 Clearpath Robotics, 18 BRONCO (onsite bricklaying robot), 67-68 climbing robots, 293-294 Brooks, Rodney, 201-202 COMB system, 35 Brunkeberg Systems AB, 169-175 Computer Aided Management Systems, 296 Building Contractors Society, 3-4 Computer-Aided Engineering Systems, 296 Building Research Institute of the Japanese concrete finishing robots, 94-108 Construction Ministry (BRI), 3-4 mobile concrete exterior floor finishing robot, built-in-rail guided building facade maintenance robot, 261 mobile concrete floor finishing robot, 99-100 Flat-KN, 101-102 cable-suspended robotic contour crafting system, Surf Robo mobile, 102-104 mobile concrete floor levelling and screeding CAFE semi-automated cost effective cleaning robot, 106 system, 254-255 mobile floor finishing robot, 104-105, 108 CALM concrete floor leveling robot, 91–92 mobile floor troweling robot Robocon, 96 "Canadian Crab" rail guided facade cleaning mobile robotic concrete floor troweling system, robot, 255-256 95 carbon fibre layer application robot, 282-283 concrete floor compaction systems, 86-87 concrete floor levelling robot, 91–92 Carnegie Mellon University, 129–130, 199–201 categories, STCRs, 14-23 concrete levelling and compaction robots, 86-94 bricklaying robots, 62-77 automatic floor screeding robot, 92-93 concrete distribution robots, 77-84 concrete floor compaction systems, 86-87 concrete finishing robots, 94-108 concrete floor leveling robot, 91-92 concrete levelling and compaction robots, concrete wall compaction system, 87 screeding robot LOM 110, 93-94 86-94 crane-end effectors, 139-146 concrete screeding, 92-93 concrete surface removing robot I, 277 earth and foundation work robots 23-31 exoskeletons, wearable robots and assistive concrete surface removing robot II, 277 devices, 202-214 concrete wall compaction system, 87 facade coating and painting robots, 184-196 Construction Robot System Catalogue, 7 facade installation robots, 155-175 Construction Robotics, 75-77 fireproof coating robots, 237-243 Construction Site Robotics Lab (CSRL), 70-71 humanoid construction robots, 196-202 cooperative robots, 214 interior finishing robots, 215-236 counter crafting system, 54-55 reinforcement production and positioning crane-end effectors, 139-146 robots, 39-46 Auto-Clamp, 145 renovation and recycling robots, 274-290 Auto-Claw, 144 Auto-Shackle, 141 robotized conventional construction machines, for Big Canopy, 146 service, maintenance, and inspection robots, Mighty Shackle Ace, 143-144 243-274 Mighty-Jack, 139-140 site logistics robot, 109-123 NIST Robocrane, 142-143 steel welding robots, 146-155 CYBERDYNE Inc., 204-205



Index 329

Dae Hie Hong, 261
Daewoo Shipbuilding and Marine Engineering
(DSME), 203–204
Daiho Construction, 25
D'Andrea, Raffaello, ix, 124
d'Arabeloff Lab, 210–212
DARPA Robotics Challenge (DRC), 199–201
DB Robot concrete distributor, 80
Demsetz, Laura, 234–235
desk and chair arrangement robot, 270–271
Doggett, William, 62
Doka, 48–49
Dong Hwan Lim, 208–209
DXR 310 demolition robot, 275–276

earth and foundation work robots, 23–31 automatic digging and soil removing system, 27 automatic excavation system for diaphragm-wall production, 26 automatic on-site soil removing/logistics system, 29–30

EM 320S robot for digging vertical shafts, 30–31 overhead rail guided digging robots, 25, 29 Ehime University, 26

Eindhoven University of Technology, 178–179 EM 320S robot for digging vertical shafts, 30–31 end-effectors, 55–57

Enterprise Resource Management Systems, 295 Enterprise Resource Planning (ERP), 296 ERO concrete recycling robot, 286–287 ETH Zurich, 124

exoskeletons, wearable robots and assistive devices, 202–214

affordable and modular cooperative robots, 214 exoskeleton for handling heavy steel elements, 203–204

FORTIS exoskeleton, 206–208 Hybrid Assistive Limb (HAL), 204–205 Lower Extremity Exoskeleton Robot for Concrete Placing (HEXAR-PL), 208–209 smart glasses, 212–214

Supernumerary Robotic Limbs (SRLs), 210–212 Walking Assist device with Bodyweight Support System, 209–210

EZ Renda Construction Machinery Limited, 233

facade cleaning robots

for large glass facade of public buildings, 259–260

RobuGlass, 256–257 SIRIUS platform, 257–259

facade coating and painting robots, 184–196 automated coating robot for external walls, 196 automatic balustrade and facade painting system OSR-1, 194–195

facade diagnostics, cleaning and painting robot,

facade painting robot system, 190–192, 193–194 for painting exterior walls, 187–189 "SB-Multi Coater", 184–186 facade concrete panel installation robot, 161 facade delamination robot "Jet Scrapper", 279 facade diagnostics, cleaning and painting robot, 192

facade inspection robot, 244–245, 246–247, 248–250

facade installation robots, 155–175 automatic facade panel installation using movable fixture, 161–163

movable fixture, 161–163
Brunkeberg® System, 169–175
ceiling glass installation robot, 168
facade concrete panel installation robot, 161
facade element installation robots, 157–158,

for facade panel installation in building renovation, 175

on-site material handling systems, 166–167 for positioning of facade elements from upper level on lower levels, 158–161

for post and beam structures, 157 roof cover installation robot, 165–166 "Shuttle System" for facade element installation, 168–169

facade maintenance robot, 247 facade painting robot system, 190–192, 193–194 Fastbrick Robotics, 73–75

FH Johanneum Industrial Design, 35 fire fighting robot, 268–269

fireproof coating robots, 237–243

fireproof coating and rock-wool spraying beam-attached/rail guided robot, 242–243 fireproof coating and rock-wool spraying

mobile robot, 240–241

SSR robot series, 238–240

TN-Fukkun, 241

Flat K-N mobile concrete floor finishing robot, 101-102

flight assembled architecture, 124 FORTIS exoskeleton, 206–208 FRAC Orléans, 124

Fraunhofer IFF, 250–252, 257–260

Fullimoter 1FF, 230–232, 237–200 Fujita Corporation, 3–4, 91–92, 119, 122, 149–151, 153–154, 161–163, 168–169, 240–241, 242–243, 270–271, 272–273

Future Cities Laboratory (FCL), 179-180

GaiaX excavator, 32 Galler, Niklas, 252–253 Gambao, E., 254–255

gantry type contour crafting robot, 50–53 "Garapagos" on-site material recycling robot, 276

Georgia Institute of Technology, 15 GGR Group, 166–167 Google, 212–214 Gory, Stanislay, 252–253

Goyo, 3–4 Gramazio & Kohler, 124 GRASP Lab, 126–128

Gryphin extreme wheel loader, 32



330 Index

Hadrian bricklaying robot, 73-75 Hanyang University, 13, 168, 208-209, 261 Harvard University, 133–135 Hasegawa, Yukio, 2, 297 Hazam, 3-4 Hazama Ando Corporation, 96-99, 176-177, 216 heavy bar, positioning of, 40 heavy reinforcement bars, positioning of, 45 heavy-component installation, mobile robots for, 228-229 Hee Don Lee, 208-209 Hilhorst Tegelwerken, 178-179 Hitachi, 3-4 Honda Motor Co., 198, 209-210 horizontal concrete distribution robot, 81-82 HRP robot series, 198 humanoid construction robots, 196-202 Baxter/Sawyer, 201-202 CHIMP - CMU Highly Mobile Platform, 199-201 HRP robot series, 198 Husqvarna AB, 275–276 Hybrid Assistive Limb (HAL), 204-205

inspection robots. *See* service, maintenance, and inspection robots

Institute for Advanced Architecture of Catalonia (IAAC), 57

Institute of Control Technology for Machine Tools and Manufacturing Systems, 67–68

integrated on-site manufacturing, 291-301

climbing robots and, 293-294

factory approach, 299-301

on-site logistics, 292-293

robot oriented design (ROD), 297

simulation and real-time monitoring, 295–297 single-task construction robots and, 291–292,

297-299

site-cover technology, 295

interior finishing robots, 215–236

automatic rendering machine, 233

for ceiling and wall panel installation, 223

ceiling handling robots, 216

interior panel-handling root, 226–227

light-weight manipulator for ceiling and wall panel installation, 222

mini crane robot, "Kalcatta", LM15-1, 218

mobile and modular interior finishing robit kit, 229-230

mobile drilling robot, 235-236

mobile material handling robot "Boardman", 231

mobile plasterboard handling robot, 216–218 mobile robot for installation of heavy

components, 228–229 multi-purpose construction robots (LH series),

218–222

plumbing part positioning robot, 226 Trackbot and Studbot robots for installation of partition-wall framing, 234–235

wallpapering robot, 227

interior panel-handling root, 226–227

International Association for Automation and Robotics in Construction, 7

Irma3D (Intelligent Robot for Mapping

Applications in 3D), 14, 15–17

Iturralde, Kepa, 175

Jacobs University Bremen gGmbH, 17

Jae Myung Huh, 261

Japan Industrial Robot Association (JARA),

2

Japan Robot Association (JARA), 3-4

Japan Society of Civil Engineers (JSCE), 3-4

Japanese Research Institute, 65

Japanese Robot Association, 7

"Jet Scrapper" facade delamination robot, 279

"KABEDOHA" facade element inspection robot, 250

Kajima Corporation, 3–4, 13, 29, 40, 45, 46, 84, 99–100, 108, 110–111, 114–115, 121–122, 157–161, 190–192, 193–194, 218–222, 244–245, 282

"Kalcatta", LM15-1, mini crane robot, 218

Karlsruhe University, 68

Kawada Corporation, 154, 198

Kawasaki Heavy Industries, Ltd., Robot Division,

3-4, 151-152, 155

Khoshnevis, Behrokh, 50-53, 55-57

kinematic structures, 10-13

Komatsu, 3-4, 13, 34-35, 117-118, 176-177,

216-222, 226, 227, 228-229, 267, 276

Konoike Construction Co. Ltd., 26, 82-83

Korea University, 261

Kranendonk Production Systems, 178-179

Kumagai Gumi Corporation, 165-166, 186-187

Kumar, V., 126–128

Kwangwoon University, 141

"Ladybird" robot for non-destructive ground sub-surface surveying, 270

large-scale prefabrication (LSP), 1

laser scanners, 15

LCS OPTIROC, 179–180

Lee, Seunghoon, 208–209

Lemes de Aguiar, Mateus, 72–73

Leonard Wood Institute, 18

Levy, David, 234–235

LH series multi-purpose construction robots,

218-222

Li, Shuguang, 137-139

Lindner/TUM, 229-230

Lindsey, Q., 126-128

Linner, Thomas, 175 Lipson, Hod, 135–139

Lissmac, 68

location orientation manipulator, 61-62

Lockheed Martin, 206-208

LOM 110 screeding robot, 93-94

Lomar SRL, 93–94



Index 331

Lower Extremity Exoskeleton Robot for Concrete Placing (HEXAR-PL), 208-209 Maeda, 3-4, 13 Maeda Corporation, 117-118 MAI® International GmbH, 89 maintenance robots. See service, maintenance, and inspection robots Malcius, M., 95 Measurement in Motion, 17 Mellinger, D., 126-128 METI, 198 Microsoft HoloLens, 212-214 Mighty Shackle Ace crane-end effector, 143-144 Mighty-Jack robotic crane-end effector, 139-140 Min Sung Kang, 261 mini crane robot, "Kalcatta", LM15-1, 218 minibuilders, 57 Ministry of Construction (MOC), 3-4 Ministry of Industry and Trade (MITI), 3-4 Missouri University of Science and Technology, 18 Mitsubishi, 3-4, 78-79 Mitsui, 29 mobile robots, 14-18 concrete distribution robot, 83 concrete exterior floor finishing robot, 106 concrete floor finishing robots, 99-100 Flat-KN, 101-102 Surf Robo, 102-104 concrete floor levelling and screeding robot, 106 drilling robot, 235-236 floor finishing robot, 96, 104-105, 108 floor troweling robot, 96-99 for installation of heavy components, 228-229 material handling robot "Boardman", 231 modular interior finishing robot kit, 229-230 plasterboard handling robot, 216-218 tiling machine, 179-180 modular maintenance and rescue robot system, modular multi robotic on-site delivery and working platform system, 122 Molecubes, 135-137 MSTC, 198 multi-purpose construction robots (LH series), 218-222 multi-purpose travelling vehicle (MTV), 271 Muncys, M., 95 Murata, S., 131-133 Myeong Su Gil, 208-209, 261 NASA Innovative Advanced Concept (NIAC) project, 55-57 NASA Langley Research Center, 62

National Institute of Standards and Technology

National Robotics Engineering Center (NREC),

New Energy and Industrial Technology Development Organization (NEDO), 287-290 Nigl, Franz, 137-139 Nihon Bisoh Co. Ltd., 13, 263-266 NIST Robocrane, 142-143 nLink AS, 235-236 nr21 DESIGN GmbH, 252-253 Obayashi Corporation, 3-4, 6, 13, 42, 78-79, 87, 104-105, 109-110, 115-117, 144, 145, 146,147, 152–153, 243–244, 247, 250, 282–283 Oculus, 212-214 Ohio University, 54-55 Ohmoto Gumi, 25 Ömer Hacýömeroglu, 286-287 On-site Construction Robots (OSCR), 70-71 on-site logistics, 292-293 on-site manufacturing (ONM), 291-301 climbing robots and, 293-294 factory approach, 299-301 on-site logistics, 292–293 robot oriented design, 297 simulation and real-time monitoring, 295-297 single-task construction robots and, 291–292, 297-299 site-cover technology, 295 on-site material handling systems, 166-167 on-site material robot "Garapagos", 276 on-site overhead logistics system, 121 OSR-1 automatic balustrade and facade painting system, 194-195 overhead rail guided digging robots, 25, 29 Palo Alto Research Center (PARC), 130 Peri, 50 Phoenix Aerial systems, 19 plasterboard handling robot, mobile, 216-218 Platform System ACS P, 50 plumbing part positioning robot, 226 PolyBot, 130 post and beam structures, robot for installation of, post-building-demolition/post-disaster cleanup robot, 281-282 quadcopters, 126-128 rail-guided automatic on-ground logistics, 121-122 building facade maintenance robot, 261 facade cleaning robot, 263-266 facade cleaning robot "Canadian Crab", 255-256 ground level concrete distributor, 84 overhead digging robots, 25, 29 overhead logistics system, 119

real-time monitoring systems, 295-297

reinforcement production and positioning robots,

automated crane for rebar positioning, 43-44

(NIST), 142-143

199–201 NEDO, 198



332 Index

reinforcement production and positioning	built-in-rail guided building facade
robots (cont.)	maintenance robot, 261
for on-site shaping of reinforcement bars, 42–43 for positioning of heavy bar, 40	CAFE semi-automated cost effective cleaning system, 254–255
for positioning of heavy reinforcement bars, 45	desk and chair arrangement robot, 270–271
for positioning of vertical reinforcement bars, 46	facade cleaning robot "RobuGlass", 256–257
reinforcing bar fabrication robot, 40–41	facade cleaning robots for large glass facade of
reinforcing bar fabrication robot, 40	public buildings, 259–260
Rethink Robots, 201–202	facade element inspection robot
RiCOPTER maximum take-off mass (MTOM), 21	"KABEDOHAN", 250
Riegl, 20	facade inspection robot, 244–245, 246–247,
RIEGL laser scanners, 15	248–250
RIWEA (Robot for the Inspection of Wind	facade maintenance robot, 247
Turbine Rotor Blades), 250–252	fire fighting robot, 268
ROB Technologies AG, 179–180	"Ladybird" robot for non-destructive ground
Robocon mobile floor troweling robot, 96	sub-surface surveying, 270
Robocrane, 142–143	modular maintenance and rescue robot system,
Robosoft, 256–257	267
robot composition	multi-purpose travelling vehicle (MTV), 271
basics of, ix, 8	rail guided facade cleaning robot "Canadian
future research, 13	Crab", 255–256
STCRs and, 8–9	rail guided face cleaning robots, 263–266
robot oriented design (ROD), 1, 297	RIWEA (Robot for the Inspection of Wind
robotic construction lift, 111–113	Turbine Rotor Blades), 250–252
robotic dumper, 35 Robotics & Intelligent Construction Automation	tile facade inspection robot, 243–244 universal firefighting and handling robot,
Lab, 15	268–269
robotized conventional construction machines,	Seunghoon Lee, 261
31–38	Shimizu Corporation, 3–4, 30, 101–102, 106, 113,
add-on modules for upgrading, 35–36	129–130, 139–140, 143–144, 148–149,
AutoMine product family, 38	184–186, 194–195, 198, 223–224, 238–240,
autonomous construction equipment, 34–35	255–256, 271, 277, 297, 302
robotic dumper, 35	Shinryo Corporation, 273–274
Volvo Construction Equipment concept	Shiraishi, 25
machines, 32	"Shuttle System" for facade element installation,
Robots and Automated Machines in Construction	168–169
catalogue, 7	SIKA Technology AG, 179–180
ROBOTSYSTEM, 268–269	Silver, Mike, 70–71
"RobuGlass" facade cleaning robot, 256–257	simulation systems, 295–297
ROCCO (Robot Construction System for	single-task construction robots (STCRs)
Computer Integrated Construction), 68	analysis and classification network, 6–8
roof cover installation robot, 165–166	analysis of composition of, 8–13
Rust Belt Robotics Lab, 70–71	categories of, 14–23
S	bricklaying robots, 62–77
Samsung, 13, 141, 168, 212–214	concrete distribution robots, 77–84
Sandvik Mining and Construction, 38 Sang Ho Kim, 261	concrete finishing robots, 94–99, 108 concrete levelling and compaction robots,
"SB-Multi Coater" facade painting robot, 184–186	86–94
Schena, Bruce, 234–235	crane-end effectors, 139–146
screeding robot LOM 110, 93–94	earth and foundation work robots, 23–31
SCX Special Projects Ltd., 266–267	exoskeletons, wearable robots and assistive
Sekisui Heim M1 prefabricated system, 1, 297	devices, 202–214
Semi-Automated Masonry System (SAM) is,	facade coating and painting robots, 184–196
75–77	facade installation robots, 155–175
service, maintenance, and inspection robots,	fireproof coating robots, 237–243
243–274	humanoid construction robots, 196–202
peration system inspection robot 272_273	interior finishing robots 215–236

252-253

Bespoke Access Solution, 266–267

bio-inspired facade inspection robot "C-Bot",

reinforcement production and positioning

renovation and recycling robots, 274–290

robots, 39-46



Index 333

robotized conventional construction machines, 31-38 service, maintenance, and inspection robots, 243-274 site logistics robot, 109-123 steel welding robots, 146-155 swarm robotics and self-assembling building structures, 128-139 tile setting and floor finishing robots, 175 comparison of kinematic structures of, 10-13 development of, 302-303 future research, 13 history and development of, 2-4 Molecubes, 135-137 on-site manufacturing and, 291-292, 297-299 overview, 1-2 robot composition and, 8-9 strengths and weaknesses of, 4-6 symbols and representations of, 9 SIRIUS facade cleaning robot platform, 257-259 site logistics robot, 109-123 AGV for construction sites, 114-115 AGV-based integrated on-site logistics system, automated construction lift, 109-110 automated horizontal/vertical on-site logistics system, 118 automated mini logistics unit, 123 automated on-site delivery system, 115-117 automated on-site logistics system, 117-118 automated vertical material delivery lift, modular multi robotic on-site delivery and working platform system, 122 on-site overhead logistics system, 121 rail-guided automatic on-ground logistics, 121-122 rail-guided overhead logistics system, 119 robotic construction lift, 111-113 site-covers. 295 "Six linked X type rebar automatic bender unit", 42 Slocum, Alex, 234-235 SMART (Shimizu Manufacturing System by Advanced Robotics Technology), 292, smart glasses, 212-214 So Ra Park, 261 Solid Material Assembly System (SMAS), 65 SSR series fireproof coating robots, 238–240 stationary concrete distribution, 78-79 steel welding robots, 146-155 AUWEL 3 small sized column welding robot, 154 steel assembly welding robot, 155 steel beam welding robot, 147, 153-154 steel column welding robot, 148-149, 152-153 WELMA steel column welding robot, 149-151 structured environment (SE), 1

structure-reconfiguring robots, 137-139 Studbot robot for installation of partition-wall framing, 234–235 Sung Min Moon, 261 Sung Won Kim, 261 Supernumerary Robotic Limbs (SRLs), 210-212 Surf Robo mobile concrete floor finishing robot, 102-104 swarm robotics and self-assembling building structures, 128-139 automatic modular assembly system, 131-133 Molecubes, 135-137 PolyBot, 130 space construction robotics, 129-130 structure-reconfiguring robots, 137-139 TERMES (termite-inspired robot construction team), 133-135 Tachi, Susumu, 297 Tachi Laboratory, 268 Taisei Corporation, 3-4, 13, 40, 187-189, 226-227, 246-247, 283-286 Takenaka Corporation, 13, 43, 80, 81-82, 86-87, 92-93, 102-104, 106, 118, 123, 196, 248-250, 279, 287-290 Tambakevicius, E., 95 Tambakevicius, M., 95 Technische Universität München, 175 Terada, Y., 131-133 TERMES (termite-inspired robot construction team), 133-135 Thalmic Labs, 212-214 Tiger-Stone, 180-184 tile facade inspection robot, 243–244 tile setting and floor finishing robots, 175 for installation of tiles to facades, 176-177 mobile robotic tiling machine, 179-180 for paving floors with ceramic tiles, 178–179 TMSUK, 281-282 TN-Fukkun fireproof coating robot, 241 Toda, 3-4, 241, 278 Tokimec, 96 Tokyo Institute of Technology, 131-133 Tokyo Skytree, 6 Tokyu Construction Co., Ltd., 27, 83, 192, 222, 223, Toyota Motor Corp., 297 Trackbot robot for installation of partition-wall

framing, 234–235 truss structures, robotic assembly of, 62 Universal Robots, 214 Universidad Politecnica de Madrid, 254–255 University at Buffalo, 70–71 University of Pennsylvania, 126–128 University of Stuttgart, 67–68 University of Tokyo, 3–4, 268 University of Würzburg, 17 unmanned aerial vehicles (UAVs), 18–23

Urakami, 189



334 Index

U.S. National Centre for Manufacturing Science, 206–208

Valentoniene, K., 95 Vanku B. V., 180–184 vertical reinforcement bars, positioning and joining of, 46 Volvo Construction Equipment, 32 Vuzix, 212–214

Wachsmann, Konrad, 61–62
Wacker Neuson, 35
Walking Assist device with Bodyweight Support
System, 209–210
wallpapering robot, 227
Wan Soo Kim, 208–209
WASCOR (Waseda Construction Robot Group),
1, 3–4, 292, 296, 297
Waseda University, 3–4
water blasting robot, 282

wearable robots. See exoskeletons, wearable robots and assistive devices welding robots, 146–155

AUWEL 3 small sized column welding robot, 154
steel assembly welding robot, 155
steel beam welding robot, 147, 153–154
steel column welding robot, 148–149, 152–153
WELMA steel column welding robot, 149–151
WELMA steel colum welding robot, 149–151
WINSPEC air volume measuring robot, 273–274
Wyss Institute for Biologically Inspired

Yasukawa, 198 Yim, Mark, 130 Yong Seok Lee, 261

Ziegler, Andy, 234–235 Zuykov, Viktor, 135–137

Engineering, 133–135