

## ● Papers' label and the representative terms

Paper index	Labels	Label compositions			Representative terms
1	$Tc_{172}A_{54}$	$s_{11}$	$ca_{12}$	-	$s_{11}$ : visual sensor + touch sensor + optical detector + arc weaving sensor; $ca_{12}$ : linear interpolation algorithm +TP language; $A_{54}$ : arc welding
2	$Tc_{181}A_{55}$	-	$ca_2$	-	$ca_2$ : kinematic; $A_{55}$ : underwater work
3	$Tc_{237}A_{54}$	$s_{11}$	$ca_{120}$	-	$s_{11}$ : visual sensor + touch sensor + optical detector + arc weaving sensor; $ca_{120}$ : distance estimation; $A_{54}$ : arc welding
4	$Tc_{236}A_{54}$	-	$ca_8$	-	$ca_8$ : tractive thrust; $A_{54}$ : arc welding
5	$Tc_{171}A_{54}$	-	$ca_{13}$	-	$ca_{13}$ : NDT-method; $A_{54}$ : arc welding
6	$Tm_9A_{11}$	$a_4$	$bd_{15}$	$bc_2$	$a_4$ : electro + hydraulic; $bd_{15}$ : wheel mobile lifting single arm; $bc_2$ : automatic; $A_{11}$ : wall construction
7	$Tm_{25}A_{54}$	-	$bd_{67}$	$bc_2$	$bd_{67}$ : frame system; $bc_2$ : automatic; $A_{54}$ : arc welding
8	$Tc_{43}A_{14}$	$s_{125}$	$ca_{120}$	-	$s_{125}$ : ultra-sonic sensor + magnetic sensor + camera; $ca_{120}$ : distance estimation; $A_{14}$ : equipment positioning
9	$Tb_{14}A_{54}$	-	$bm_{14}$	-	$bm_{14}$ : cost + productivity + efficiency; $A_{54}$ : arc welding
10	$Tm_{157}A_{50}$	-	$bd_{52}$	$bc_3$	$bd_{52}$ : mobile vehicle; $bc_3$ : human-robot + collaboration; $A_{50}$ : operation simulation
11	$Tm_{35}A_{21}$	$a_2$	$bd_2$	$bc_2$	$a_2$ : hydraulic; $bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_{21}$ : pipe construction
12	$Tm_{141}A_7$	$a_4$	$bd_{12}$	$bc_2$	$a_4$ : electro + hydraulic; $bd_{12}$ : fixed arm; $bc_2$ : automatic; $A_7$ : excavation
13	$Tc_{97}A_{31}$	-	$ca_{42}$	-	$ca_{42}$ : HyperCard program; $A_{31}$ : slab finishing
14	$Tc_7A_1$	$s_{65}$	$ca_{63}$	-	$s_{65}$ : camera + tactile; $ca_{63}$ : Actuator-level languages; $A_1$ : road construction
15	$Tm_{35}A_7$	$a_2$	$bd_2$	$bc_2$	$a_2$ : hydraulic; $bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_7$ : excavation
16	$Tc_{19}A_{50}$	$s_{33}$	$ca_{36}$	-	$s_{33}$ : force sensor + ultrasonic sensor; $ca_{36}$ : PID position control; $A_{50}$ : operation simulation
17	$Tc_{11}A_{20}$	$s_{34}$	$ca_{36}$	-	$s_{34}$ : force sensor + sonar sensor; $ca_{36}$ : PID position control; $A_{20}$ : spraying
18	$Tc_{97}A_{31}$	-	$ca_{42}$	-	$ca_{42}$ : HyperCard program; $ca_{42}$ : HyperCard program; $A_{31}$ : slab finishing
19	$Tc_{115}A_4$	$s_{76}$	$ca_{95}$	-	$s_{76}$ : distance sensor; $ca_{95}$ : PLC; $ca_{95}$ : PLC; $A_4$ : ferromagnetic surface construction
20	$Tm_{62}A_7$	$a_2$	$bd_2$	$bc_1$	$a_2$ : hydraulic; $bd_2$ : arm, manipulator + mounted; $bc_1$ : remote + operator; $A_7$ : excavation
21	$Tm_{156}A_6$	$a_3$	$bd_{12}$	$bc_1$	$a_3$ : motor; $bd_{12}$ : fixed arm; $bc_1$ : remote + operator; $A_6$ : building inspection
22	$Tm_{123}A_{31}$	$a_2$	$bd_{52}$	$bc_2$	$a_2$ : hydraulic; $bd_{52}$ : mobile vehicle; $bc_2$ : automatic; $A_{31}$ : slab finishing

23	$Tm_{61}A_{29}$	$a_5$	$bd_{27}$	$bc_2$	$a_5$ : pneumatic + motor; $bd_{27}$ : AGV, unmanned ground vehicle; $bc_2$ : automatic; $A_{29}$ : material, sorting, delivery, distribution
24	$Tm_{157}A_{47}$	-	$bd_{52}$	$bc_3$	$bd_{52}$ : mobile vehicle; $bc_3$ : human-robot + collaboration; $A_{47}$ : mining
25	$Tm_{36}A_7$	$a_3$	$bd_{12}$	$bc_2$	$a_3$ : motor; $bd_{12}$ : fixed arm; $bc_2$ : automatic; $A_7$ : excavation
26	$Tc_{82}A_{24}$	-	$ca_{33}$	-	$ca_{33}$ : Brooks' algorithm; $A_{24}$ : machinery path management
27	$Tc_{64}A_{20}$	$s_6$	$ca_{38}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{38}$ : least squares algorithm; $A_{20}$ : spraying
28	$Tc_{97}A_7$	-	$ca_{42}$	-	$ca_{42}$ : HyperCard program; $A_7$ : excavation
29	$Tc_{106}A_{32}$	$s_{39}$	$ca_{52}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{52}$ : longest common subsequence (LCS); $A_{32}$ : machinery navigation
30	$Tc_{80}A_{24}$	$s_{10}$	$ca_{65}$	-	$s_{10}$ : ultrasonic; $ca_{65}$ : path-planning; $A_{24}$ : machinery path management
31	$Tm_{33}A_{20}$	$a_3$	$bd_{21}$	$bc_2$	$a_3$ : motor; $bd_{21}$ : mobile arm; $bc_2$ : automatic; $A_{20}$ : spraying
32	$Tm_{39}A_{22}$	$a_3$	$bd_{55}$	$bc_2$	$a_3$ : motor; $bd_{55}$ : vertically mobile arm; $bc_2$ : automatic; $A_{22}$ : masonry construction
33	$Tm_{142}A_7$	$a_4$	$bd_{12}$	$bc_2$	$a_4$ : electro + hydraulic; $bd_{12}$ : fixed arm; $bc_2$ : automatic; $A_7$ : excavation
34	$Tm_{126}A_6$	$a_5$	$bd_2$	$bc_2$	$a_5$ : pneumatic + motor; $bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_6$ : building inspection
35	$Tm_{36}A_{21}$	$a_3$	$bd_{12}$	$bc_2$	$a_3$ : motor; $bd_{12}$ : fixed arm; $bc_2$ : automatic; $A_{21}$ : pipe construction
36	$Tc_{13}A_{14}$	-	$ca_{115}$	-	$ca_{115}$ : self-positioning algorithm; $A_{14}$ : equipment positioning
37	$Tc_{97}A_{48}$	-	$ca_{42}$	-	$ca_{42}$ : HyperCard program; $A_{48}$ : logistics
38	$Tc_{87}A_{50}$	-	$ca_5$	-	$ca_5$ : PI controller + active control algorithm; $A_{50}$ : operation simulation
39	$Tc_{75}A_{22}$	$s_{74}$	$ca_{73}$	-	$s_{74}$ : ultrasonic sensor + displacement transducers + ranging transducer + laser scanner; $ca_{73}$ : Machine Learning; $A_{22}$ : masonry construction
40	$Tc_{137}A_{45}$	$s_{50}$	$ca_{79}$	-	$s_{50}$ : position sensor + force sensor; $ca_{79}$ : RBF-PID Control; $A_{45}$ : cleaning
41	$Tm_{151}A_{21}$	-	$bd_{52}$	$bc_1$	$bd_{52}$ : mobile vehicle; $bc_1$ : remote + operator; $A_{21}$ : pipe construction
42	$Tm_{40}A_{22}$	$a_2$	$bd_{56}$	$bc_2$	$a_2$ : hydraulic; $bd_{56}$ : rail moving arm; $bc_2$ : automatic; $A_{22}$ : masonry construction
43	$Tm_{40}A_{22}$	$a_2$	$bd_{56}$	$bc_2$	$a_2$ : hydraulic; $bd_{56}$ : rail moving arm; $bc_2$ : automatic; $A_{22}$ : masonry construction
44	$Tm_{19}A_{22}$	$a_2$	$bd_2$	$bc_2$	$a_2$ : hydraulic; $bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_{22}$ : masonry construction
45	$Tm_{98}A_6$	$a_3$	$bd_{19}$	$bc_2$	$a_3$ : motor; $bd_{19}$ : climbing platforms + vacuum grippers + suction; $bc_2$ : automatic; $A_6$ : building inspection
46	$Tm_{13}A_{29}$	$a_3$	$bd_7$	$bc_2$	$a_3$ : motor; $bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_{29}$ : material, sorting, delivery, distribution
47	$Tm_{60}A_{34}$	$a_3$	$bd_{12}$	$bc_2$	$a_3$ : motor; $bd_{12}$ : fixed arm; $bc_2$ : automatic; $A_{34}$ : components assemble
48	$Tm_{22}A_{58}$	$a_3$	$bd_{32}$	$bc_2$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_{58}$ : finishing

49	$Tm_{25}A_{53}$	-	$hd_{67}$	$hc_2$	$hd_{67}$ : frame system; $hc_2$ : automatic; $A_{53}$ : highway construction
50	$Tm_{23}A_{24}$	-	$hd_{32}$	$hc_2$	$hd_{32}$ : wheel mobile; $hc_2$ : automatic; $A_{24}$ : machinery path management
51	$Tc_{51}A_{50}$	$s_{22}$	$ca_{10}$	-	$s_{22}$ : position sensor; $ca_{10}$ : heuristic; $A_{50}$ : operation simulation
52	$Tc_{84}A_{24}$	-	$ca_{103}$	-	$ca_{103}$ : motion planning; $A_{24}$ : machinery path management
53	$Tb_{25}A_{53}$	-	$bm_2$	-	$bm_2$ : technical + economic + efficiency; $A_{53}$ : highway construction
54	$Tm_{124}A_{59}$	$a_2$	$hd_{12}$	$hc_2$	$a_2$ : hydraulic; $hd_{12}$ : fixed arm; $hc_2$ : automatic; $A_{59}$ : object recognition
55	$Tm_{10}A_{11}$	$a_3$	$hd_{16}$	$hc_2$	$a_3$ : motor; $hd_{16}$ : climbing platform + pediculate + gripper; $hc_2$ : automatic; $A_{11}$ : wall construction
56	$Tm_{34}A_{20}$	$a_3$	$hd_{32}$	$hc_2$	$a_3$ : motor; $hd_{32}$ : wheel mobile; $hc_2$ : automatic; $A_{20}$ : spraying
57	$Tm_{49}A_{34}$	-	$hd_{36}$	$hc_2$	$hd_{36}$ : mobile arm, manipulator with wheels; $hc_2$ : automatic; $A_{34}$ : components assemble
58	$Tm_{25}A_{54}$	-	$hd_{67}$	$hc_2$	$hd_{67}$ : frame system; $hc_2$ : automatic; $A_{54}$ : arc welding
59	$Tm_{25}A_{54}$	-	$hd_{67}$	$hc_2$	$hd_{67}$ : frame system; $hc_2$ : automatic; $A_{54}$ : arc welding
60	$Tm_{28}A_{11}$	-	-	$hc_2$	$hc_2$ : automatic; $A_{11}$ : wall construction
61	$Tm_{88}A_{44}$	$a_3$	$hd_2$	$hc_2$	$a_3$ : motor; $hd_2$ : arm, manipulator + mounted; $hc_2$ : automatic; $A_{44}$ : panel installation
62	$Tc_{84}A_{34}$	-	$ca_{103}$	-	$ca_{103}$ : motion planning; $A_{34}$ : components assemble
63	$Tc_{164}A_{50}$	-	$ca_{114}$	-	$ca_{114}$ : behaviour-based system; $A_{50}$ : operation simulation
64	$Tc_{13}A_{14}$	-	$ca_{115}$	-	$ca_{115}$ : self-positioning algorithm; $A_{14}$ : equipment positioning
65	$Tc_{79}A_{22}$	$s_{21}$	$ca_{70}$	-	$s_{21}$ : distance sensor + tilt sensor; $ca_{70}$ : PTP control; $A_{22}$ : masonry construction
66	$Tc_{116}A_{58}$	-	$ca_{70}$	-	$ca_{70}$ : PTP control; $A_{58}$ : finishing
67	$Tc_{78}A_{22}$	$s_1$	$ca_{71}$	-	$s_1$ : laser + ultrasonic + CCD camera; $ca_{71}$ : TCP control; $A_{22}$ : masonry construction
68	$Tc_{27}A_{11}$	-	$ca_{90}$	-	$ca_{90}$ : C++, Java, C# script, C program; $A_{11}$ : wall construction
69	$Tm_1A_1$	$a_2$	$hd_{32}$	$hc_2$	$a_2$ : hydraulic; $hd_{32}$ : wheel mobile; $hc_2$ : automatic; $A_1$ : road construction
70	$Tm_{59}A_{28}$	$a_3$	$hd_{15}$	$hc_2$	$a_3$ : motor; $hd_{15}$ : wheel mobile lifting single arm; $hc_2$ : automatic; $A_{28}$ : ceiling construction
71	$Tm_{127}A_6$	$a_3$	$hd_{36}$	$hc_2$	$a_3$ : motor; $hd_{36}$ : mobile arm, manipulator with wheels; $hc_2$ : automatic; $A_6$ : building inspection
72	$Tm_{41}A_{22}$	$a_5$	$hd_{12}$	$hc_2$	$a_5$ : pneumatic + motor; $hd_{12}$ : fixed arm; $hc_2$ : automatic; $A_{22}$ : masonry construction
73	$Tm_{25}A_{54}$	-	$hd_{67}$	$hc_2$	$hd_{67}$ : frame system; $hc_2$ : automatic; $A_{54}$ : arc welding
74	$Tm_{28}A_{17}$	-	-	$hc_2$	$hc_2$ : automatic; $A_{17}$ : high rise building construction

75	$Tm_{64}A_{50}$	-	$hd_{30}$	$hc_3$	$hd_{30}$ : industrial robot; $hc_3$ : human-robot + collaboration; $A_{50}$ : operation simulation
76	$Tc_{140}A_{46}$	$s_1$	$ca_{120}$	-	$s_1$ : laser + ultrasonic + CCD camera; $ca_{120}$ : distance estimation; $A_{46}$ : machinery mapping
77	$Tc_{170}A_{54}$	$s_{14}$	$ca_{14}$	-	$s_{14}$ : laser; $ca_{14}$ : control travel speed; $A_{54}$ : arc welding
78	$Tc_{117}A_{34}$	$s_{70}$	$ca_{26}$	-	$ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{34}$ : components assemble
79	$Tc_{189}A_{32}$	-	$ca_{26}$	-	$ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{32}$ : machinery navigation
80	$Tc_{189}A_{56}$	-	$ca_{26}$	-	$ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory
81	$Tc_{60}A_{53}$	$s_{14}$	$ca_{46}$	-	$s_{14}$ : laser; $ca_{46}$ : embedded, embedding, controller; $A_{53}$ : highway construction
82	$Tc_{33}A_{12}$	-	$ca_{49}$	-	$ca_{49}$ : genetic algorithms (GA); $A_{12}$ : bridge construction
83	$Tc_{121}A_{26}$	$s_{154}$	$ca_{90}$	-	$s_{154}$ : equivalent sensor; $ca_{90}$ : C++, Java, C# script, C program; $A_{26}$ : remote operating machines
84	$Tc_{42}A_{53}$	$s_{54}$	$ca_{90}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{90}$ : C++, Java, C# script, C program; $A_{53}$ : highway construction
85	$Tc_{205}A_{50}$	-	$ca_{92}$	-	$ca_{92}$ : Virtual Reality; $A_{50}$ : operation simulation
86	$Tc_{29}A_{12}$	$s_{39}$	$ca_{96}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{96}$ : real time navigation; $A_{12}$ : bridge construction
87	$Tm_{11}A_{11}$	$a_3$	$hd_{17}$	$hc_2$	$a_3$ : motor; $hd_{17}$ : lift fixed manipulator; $hc_2$ : automatic; $A_{11}$ : wall construction
88	$Tm_8A_8$	$a_3$	$hd_2$	$hc_3$	$a_3$ : motor; $hd_2$ : arm, manipulator + mounted; $hc_3$ : human-robot + collaboration; $A_8$ : steel construction
89	$Tc_6A_1$	$s_{66}$	$ca_{64}$	-	$s_{66}$ : GPS, position sensor, reference sensor; $ca_{64}$ : iterative algorithms + regression model; $A_1$ : road construction
90	$Tc_5A_1$	$s_{67}$	$ca_{65}$	-	$s_{67}$ : GPS; $ca_{65}$ : path-planning; $A_1$ : road construction
91	$Tc_4A_1$	$s_6$	$ca_{73}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{73}$ : Machine Learning; $A_1$ : road construction
92	$Tc_{31}A_{12}$	$s_{94}$	$ca_{96}$	-	$s_{94}$ : LTK + GPS + pseudofiles + laser + NLS; $ca_{96}$ : real time navigation; $A_{12}$ : bridge construction
93	$Tm_{62}A_{29}$	$a_2$	$hd_2$	$hc_1$	$a_2$ : hydraulic; $hd_2$ : arm, manipulator + mounted; $hc_1$ : remote + operator; $A_{29}$ : material, sorting, delivery, distribution
94	$Tm_{24}A_{17}$	$a_2$	$hd_{67}$	$hc_2$	$a_2$ : hydraulic; $hd_{67}$ : frame system; $hc_2$ : automatic; $A_{17}$ : high rise building construction
95	$Tm_{13}A_8$	$a_3$	$hd_7$	$hc_2$	$a_3$ : motor; $hd_7$ : gantry robot, arm; $hc_2$ : automatic; $A_8$ : steel construction
96	$Tm_{60}A_{54}$	$a_3$	$hd_{12}$	$hc_2$	$a_3$ : motor; $hd_{12}$ : fixed arm; $hc_2$ : automatic; $A_{54}$ : arc welding
97	$Tm_{106}A_{49}$	-	$hd_{49}$	$hc_2$	$hd_{49}$ : robotized crane; $hc_2$ : automatic; $A_{49}$ : transmission tower construction
98	$Tc_{200}A_{56}$	-	$ca_{81}$	-	$ca_{81}$ : predictive force method; $A_{56}$ : remote construction
99	$Tc_{70}A_{38}$	-	$ca_{89}$	-	$ca_{89}$ : trajectory generation algorithm; $A_{38}$ : marking
100	$Tc_{118}A_{34}$	$s_{138}$	$ca_{26}$	-	$s_{138}$ : axis sensors; $ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{34}$ : components assemble

101	$Tc_{226}A_7$	$s_{44}$	$ca_{43}$	-	$s_{44}$ : force sensor + pressure transducers; $ca_{43}$ : inverse kinematic and dynamic models; $A_7$ : excavation
102	$Tc_{57}A_2$	$s_{39}$	$ca_{61}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{61}$ : pixels regression
103	$Tb_9A_{29}$	-	$bm_9$	-	$bm_9$ : material management; $A_{29}$ : material, sorting, delivery, distribution
104	$Tm_{152}A_{56}$	$a_3$	$bd_{67}$	$bc_1$	$a_3$ : motor; $bd_{67}$ : frame system; $bc_1$ : remote + operator; $A_{56}$ : remote construction
105	$Tm_{151}A_{56}$	-	$bd_{52}$	$bc_1$	$bd_{52}$ : mobile vehicle; $bc_1$ : remote + operator; $A_{56}$ : remote construction
106	$Tm_{12}A_{11}$	$a_2$	$bd_7$	$bc_2$	$a_2$ : hydraulic; $bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_{11}$ : wall construction
107	$Tm_{19}A_{12}$	$a_2$	$bd_2$	$bc_2$	$a_2$ : hydraulic; $bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_{12}$ : bridge construction
108	$Tm_{96}A_{45}$	$a_3$	$bd_{34}$	$bc_2$	$a_3$ : motor; $bd_{34}$ : vertical mobile + cleaning head + pressure pump + suction device + filter + tank; $bc_2$ : automatic; $A_{45}$ : cleaning
109	$Tc_{169}A_{12}$	-	$ca_{15}$	-	$ca_{15}$ : off-line teaching system; $A_{12}$ : bridge construction
110	$Tm_{112}A_{54}$	-	$bd_{11}$	$bc_2$	$bd_{11}$ : lifting rail + moved arm + carriage; $bc_2$ : automatic; $A_{54}$ : arc welding
111	$Tm_{32}A_{20}$	$a_2$	$bd_{12}$	$bc_3$	$bd_{12}$ : fixed arm; $A_{20}$ : spraying
112	$Tc_{54}A_{19}$	$s_{118}$	$ca_{115}$	-	$s_{118}$ : camera + sonar sensor + temperature sensor + airflow sensors + laser; $ca_{115}$ : self-positioning algorithm; $A_{19}$ : building maintenance
113	$Tc_{41}A_{14}$	$s_{39}$	$ca_{56}$	-	$s_{39}$ : camera + image + CCD + Kinect; $A_{14}$ : equipment positioning
114	$Tc_{224}A_7$	$s_{45}$	$ca_{89}$	-	$s_{45}$ : force and position sensors + ground penetrating radar (GPR) + laser; $ca_{89}$ : trajectory generation algorithm; $A_7$ : excavation
115	$Tm_{85}A_{42}$	$a_2$	$bd_3$	$bc_1$	$a_2$ : hydraulic; $bd_3$ : crawler; $bc_1$ : remote + operator; $A_{42}$ : disaster restoration
116	$Tm_{128}A_6$	$a_3$	$bd_{70}$	$bc_2$	$a_3$ : motor; $bd_{70}$ : mobility feet, leg, limbed; $bc_2$ : automatic; $A_6$ : building inspection
117	$Tm_{143}A_7$	$a_4$	$bd_{33}$	$bc_2$	$a_4$ : electro + hydraulic; $bd_{33}$ : bucket + arm; $bc_2$ : automatic; $A_7$ : excavation
118	$Tc_{95}A_{30}$	$s_6$	$ca_{100}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{100}$ : markov chains; $A_{30}$ : Mars/Lunar construction
119	$Tc_{124}A_{38}$	$s_{14}$	$ca_{115}$	-	$s_{14}$ : laser; $ca_{115}$ : self-positioning algorithm; $A_{38}$ : marking
120	$Tc_{87}A_{26}$	$s_8$	$ca_5$	-	$s_8$ : pressure sensor; $ca_5$ : PI controller, active control algorithm; $A_{26}$ : remote operating machines
121	$Tc_{144}A_5$	$s_{86}$	$ca_{87}$	-	$s_{86}$ : range sensor + displacement sensor + GPS; $ca_{87}$ : Bug-based algorithm
122	$Tm_{152}A_{56}$	$a_3$	$bd_{67}$	$bc_1$	$a_3$ : motor; $bd_{67}$ : frame system; $bc_1$ : remote + operator; $A_{56}$ : remote construction
123	$Tm_{150}A_{56}$	$a_2$	$bd_1$	$bc_2$	$bd_1$ : humanoid; $bc_2$ : automatic; $A_{56}$ : remote construction
124	$Tm_{113}A_{54}$	$a_3$	$bd_{10}$	$bc_2$	$a_3$ : motor; $bd_{10}$ : traveling crane; $bc_2$ : automatic; $A_{54}$ : arc welding
125	$Tm_{28}A_{11}$	-	-	$bc_2$	$bc_2$ : automatic; $A_{11}$ : wall construction

126	$Tm_{91}A_{56}$	$a_1$	$bd_{67}$	$bc_3$	$a_1$ : pneumatic; $bd_{67}$ : frame system; $bc_3$ : human-robot + collaboration; $A_{56}$ : remote construction
127	$Tm_{55}A_{28}$	$a_3$	$bd_{36}$	$bc_2$	$a_3$ : motor; $bd_{36}$ : mobile arm, manipulator with wheels; $bc_2$ : automatic; $A_{28}$ : ceiling construction
128	$Tc_{187}A_{56}$	-	$ca_{31}$	-	$ca_{31}$ : wireless communication + wireless Lan; $A_{56}$ : remote construction
129	$Tc_{187}A_{56}$	-	$ca_{31}$	-	$ca_{31}$ : wireless communication + wireless Lan; $A_{56}$ : remote construction
130	$Tc_{138}A_{45}$	$s_{33}$	$ca_{43}$	-	$s_{33}$ : force sensor + ultrasonic sensor; $ca_{43}$ : inverse kinematic and dynamic models
131	$Tc_{222}A_7$	$s_{47}$	$ca_{47}$	-	$s_{47}$ : force sensors + laser + GPS + INS; $ca_{47}$ : UML state charts and capsules; $A_7$ : excavation
132	$Tc_{33}A_{12}$	-	$ca_{49}$	-	$ca_{49}$ : genetic algorithms (GA); $A_{12}$ : bridge construction
133	$Tc_{182}A_{55}$	$s_1$	$ca_{62}$	-	$s_1$ : laser + ultrasonic + CCD camera; $ca_{62}$ : image processing; $A_{55}$ : underwater work
134	$Tc_{56}A_2$	$s_{54}$	$ca_{62}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{62}$ : image processing
135	$Tc_{76}A_{24}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{24}$ : machinery path management
136	$Tb_{14}A_{35}$	-	$bm_{14}$	-	$bm_{14}$ : cost + productivity + efficiency; $A_{35}$ : construction activity evaluation
137	$Tm_{117}A_{55}$	$a_1$	$bd_2$	$bc_1$	$a_1$ : pneumatic; $bd_2$ : arm, manipulator + mounted; $bc_1$ : remote + operator; $A_{55}$ : underwater work
138	$Tm_{60}A_{28}$	$a_3$	$bd_{12}$	$bc_2$	$a_3$ : motor; $bd_{12}$ : fixed arm; $bc_2$ : automatic; $A_{28}$ : ceiling construction
139	$Tm_{26}A_8$	-	$bd_{49}$	$bc_2$	$bd_{49}$ : robotized crane; $bc_2$ : automatic; $A_8$ : steel construction
140	$Tm_{14}A_{63}$	-	$bd_7$	$bc_2$	$bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_{63}$ : contour crafting
141	$Tm_{28}A_{11}$	-	-	$bc_2$	$bc_2$ : automatic; $A_{11}$ : wall construction
142	$Tc_{216}A_6$	$s_{54}$	$ca_{102}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{102}$ : MPEG algorithm + pair-wise alignment algorithm + Minimum V variance Matching (MVM) Algorithm
143	$Tc_{26}A_{11}$	$s_{22}$	$ca_{25}$	-	$s_{22}$ : position sensor; $ca_{25}$ : search algorithm; $A_{11}$ : wall construction
144	$Tc_{23}A_{11}$	$s_{23}$	$ca_{26}$	-	$s_{23}$ : rotation angles sensors + vacuum sensors + accelerometers + pressure sensor; $ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{11}$ : wall construction
145	$Tc_{93}A_3$	$s_{39}$	$ca_{36}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{36}$ : PID position control; $ca_{36}$ : PID position control; $A_3$ : building service
146	$Tc_3A_1$	$s_{54}$	$ca_{67}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{67}$ : Kalman Filter Algorithm; $A_1$ : road construction
147	$Tm_{107}A_{56}$	-	-	$bc_1$	$bc_1$ : remote + operator; $A_{56}$ : remote construction
148	$Tm_{65}A_{60}$	$a_1$	$bd_{70}$	$bc_2$	$a_1$ : pneumatic; $bd_{70}$ : mobility feet, leg, limbed; $bc_2$ : automatic; $A_{60}$ : drilling
149	$Tm_{129}A_6$	$a_3$	$bd_{74}$	$bc_2$	$a_3$ : motor; $bd_{74}$ : worm-like, snake-like robot; $bc_2$ : automatic; $A_6$ : building inspection
150	$Tm_{130}A_6$	$a_3$	$bd_{70}$	$bc_2$	$a_3$ : motor; $bd_{70}$ : mobility feet, leg, limbed; $bc_2$ : automatic; $A_6$ : building inspection

151	$Tm_{28}A_{11}$	-	-	$hc_2$	$hc_2$ : automatic; $A_{11}$ : wall construction
152	$Tm_{81}A_{40}$	$a_2$	$bd_{49}$	$hc_3$	$a_2$ : hydraulic; $bd_{49}$ : robotized crane; $hc_3$ : human-robot + collaboration; $A_{40}$ : harbour construction
153	$Tm_7A_{11}$	$a_5$	$bd_{20}$	$hc_3$	$a_5$ : pneumatic + motor; $bd_{20}$ : climbing two platforms + light skeleton + vacuum grippers; $hc_3$ : human-robot + collaboration; $A_{11}$ : wall construction
154	$Tc_{132}A_{42}$	$s_{14}$	$ca_{109}$	-	$s_{14}$ : laser; $ca_{109}$ : stereovision method; $A_{42}$ : disaster restoration
155	$Tc_{232}A_{51}$	$s_{87}$	$ca_{109}$	-	$s_{87}$ : range sensors + distance sensor; $ca_{109}$ : stereovision method; $A_{51}$ : pose estimation
156	$Tc_{55}A_{19}$	$s_{38}$	$ca_{114}$	-	$s_{38}$ : cameras + pressure force sensor; $ca_{114}$ : behaviour-based system; $A_{19}$ : building maintenance
157	$Tc_{22}A_{11}$	$s_{24}$	$ca_{27}$	-	$s_{24}$ : light sensor + infrared proximity sensors; $ca_{27}$ : distributed feedback mechanism; $A_{11}$ : wall construction
158	$Tc_{105}A_{32}$	$s_{142}$	$ca_{31}$	-	$s_{142}$ : light sensors + humidity/temperature sensors + sonar sensors + ultrasonic range sensor + infrared distance measuring sensors + CMOS image sensor; $ca_{31}$ : wireless communication + wireless Lan; $A_{32}$ : machinery navigation
159	$Tc_{154}A_{50}$	-	$ca_{46}$	-	$ca_{46}$ : embedded, embedding, controller; $A_{50}$ : operation simulation
160	$Tc_{145}A_5$	$s_{87}$	$ca_{65}$	-	$s_{87}$ : range sensors + distance sensor; $ca_{65}$ : path-planning; $A_5$ : earthmoving construction
161	$Tc_2A_1$	$s_{68}$	$ca_{68}$	-	$s_{68}$ : GPS + inclinometer; $ca_{68}$ : Msc. Adams and Matlab/Simulink programs; $A_1$ : road construction
162	$Tc_1A_1$	$s_{69}$	$ca_{69}$	-	$s_{69}$ : GPS + laser; $ca_{69}$ : dynamic model; $A_1$ : road construction
163	$Tc_{197}A_{50}$	$s_{81}$	$ca_{79}$	-	$s_{81}$ : angle sensor; $ca_{79}$ : RBF-PID Control; $A_{50}$ : operation simulation
164	$Tc_{27}A_8$	$s_{39}$	$ca_{90}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{90}$ : C++, Java, C# script, C program; $A_8$ : steel construction
165	$Tm_{84}A_{41}$	$a_1$	$bd_{30}$	$hc_1$	$a_1$ : pneumatic; $bd_{30}$ : industrial robot; $hc_1$ : remote + operator; $A_{41}$ : waste collection
166	$Tm_{118}A_{55}$	$a_2$	$bd_3$	$hc_1$	$a_2$ : hydraulic; $bd_3$ : crawler; $hc_1$ : remote + operator; $A_{55}$ : underwater work
167	$Tm_{94}A_{56}$	$a_2$	-	$hc_1$	$a_2$ : hydraulic; $hc_1$ : remote + operator; $A_{56}$ : remote construction
168	$Tm_{18}A_{11}$	$a_3$	$bd_{32}$	$hc_1$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $hc_1$ : remote + operator; $A_{11}$ : wall construction
169	$Tm_{86}A_{42}$	-	$bd_3$	$hc_1$	$bd_3$ : crawler; $hc_1$ : remote + operator; $A_{42}$ : disaster restoration
170	$Tm_{53}A_{23}$	$a_3$	$bd_{66}$	$hc_2$	$a_3$ : motor; $bd_{66}$ : mobile tracked locomotion; $hc_2$ : automatic; $A_{23}$ : on-site rescue
171	$Tm_{51}A_{59}$	-	$bd_{30}$	$hc_2$	$bd_{30}$ : industrial robot; $hc_2$ : automatic; $A_{59}$ : object recognition
172	$Tm_{25}A_{34}$	-	$bd_{67}$	$hc_2$	$bd_{67}$ : frame system; $hc_2$ : automatic; $A_{34}$ : components assemble
173	$Tm_8A_{11}$	$a_3$	$bd_2$	$hc_3$	$a_3$ : motor; $bd_2$ : arm, manipulator + mounted; $hc_3$ : human-robot + collaboration; $A_{11}$ : wall construction
174	$Tm_{89}A_{44}$	-	-	$hc_3$	$hc_3$ : human-robot + collaboration; $A_{44}$ : panel installation
175	$Tc_{215}A_6$	$s_{39}$	$ca_{103}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{103}$ : motion planning; $A_6$ : building inspection

176	$Tc_{93}A_{56}$	$s_{39}$	$ca_{36}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{36}$ : PID position control; $A_{56}$ : remote construction
177	$Tc_{33}A_{50}$	-	$ca_{49}$	-	$ca_{49}$ : genetic algorithms (GA); $A_{50}$ : operation simulation
178	$Tc_{76}A_{52}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $ca_{73}$ : Machine Learning; $A_{52}$ : measurement
179	$Tc_{199}A_{56}$	$s_{39}$	$ca_{80}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{80}$ : augmented reality techniques (AR); $A_{56}$ : remote construction
180	$Tc_{229}A_8$	-	$ca_{91}$	-	$ca_{91}$ : pre-acting control algorithm; $A_8$ : steel construction
181	$Tb_6A_{12}$	-	$bm_6$	-	$bm_6$ : cost + quality; $A_{12}$ : bridge construction
182	$Tm_{38}A_{21}$	$a_2$	$bd_{69}$	$bc_1$	$a_2$ : hydraulic; $bd_{69}$ : platform clamp; $bc_1$ : remote + operator; $A_{21}$ : pipe construction
183	$Tm_{93}A_{44}$	-	$bd_2$	$bc_1$	$bd_2$ : arm, manipulator + mounted; $bc_1$ : remote + operator; $A_{44}$ : panel installation
184	$Tm_1A_1$	$a_2$	$bd_{32}$	$bc_2$	$a_2$ : hydraulic; $bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_1$ : road construction
185	$Tm_{80}A_6$	$a_3$	$bd_{58}$	$bc_2$	$a_3$ : motor; $bd_{58}$ : UAV; $bc_2$ : automatic; $A_6$ : building inspection
186	$Tm_{16}A_{63}$	$a_6$	$bd_{25}$	$bc_2$	$a_6$ : cable driven; $bd_{25}$ : parallel robot; $bc_2$ : automatic; $A_{63}$ : contour crafting
187	$Tm_{146}A_8$	-	$bd_{26}$	$bc_2$	$bd_{26}$ : rail, vertical-moving robot; $bc_2$ : automatic; $A_8$ : steel construction
188	$Tm_{25}A_{63}$	-	$bd_{67}$	$bc_2$	$bd_{67}$ : frame system; $bc_2$ : automatic; $A_{63}$ : contour crafting
189	$Tm_{56}A_{28}$	$a_3$	$bd_{42}$	$bc_3$	$a_3$ : motor; $bd_{42}$ : mobile vehicle + aerial lift + manipulator + vacuum suction device; $bc_3$ : human-robot + collaboration; $A_{28}$ : ceiling construction
190	$Tm_{63}A_6$	$a_3$	$bd_{32}$	$bc_3$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_3$ : human-robot + collaboration; $A_6$ : building inspection
191	$Tm_8A_{11}$	$a_3$	$bd_2$	$bc_3$	$a_3$ : motor; $bd_2$ : arm, manipulator + mounted; $bc_3$ : human-robot + collaboration; $A_{11}$ : wall construction
192	$Tm_8A_{44}$	$a_3$	$bd_2$	$bc_3$	$a_3$ : motor; $bd_2$ : arm, manipulator + mounted; $bc_3$ : human-robot + collaboration; $A_{44}$ : panel installation
193	$Tm_{70}A_{34}$	-	$bd_{60}$	$bc_3$	$bd_{60}$ : truss-type; $bc_3$ : human-robot + collaboration; $A_{34}$ : components assemble
194	$Tm_{90}A_{44}$	-	$bd_{67}$	$bc_3$	$bd_{67}$ : frame system; $bc_3$ : human-robot + collaboration; $A_{44}$ : panel installation
195	$Tc_{168}A_{54}$	-	$ca_{16}$	-	$ca_{16}$ : user datagram protocol (UDP); $A_{54}$ : arc welding
196	$Tc_{89}A_{29}$	$s_{114}$	$ca_{36}$	-	$s_{114}$ : ultrasonic sensors + encoders + IMU + yaw angle sensor + sonar sensors; $ca_{36}$ : PID position control; $A_{29}$ : material, sorting, delivery, distribution
197	$Tc_{119}A_{34}$	$s_{39}$	$ca_{79}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{79}$ : RBF-PID Control; $A_{34}$ : components assemble
198	$Tc_{198}A_{56}$	$s_6$	$ca_{79}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{79}$ : RBF-PID Control; $A_{56}$ : remote construction
199	$Tc_{86}A_{56}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{56}$ : remote construction
200	$Tc_{149}A_{50}$	$s_{89}$	$ca_{90}$	-	$s_{89}$ : liquid based sensor; $ca_{90}$ : C++, Java, C# script, C program; $A_{50}$ : operation simulation



201	$Tb_9A_{29}$	-	$bm_9$	-	$bm_9$ : material management; $A_{29}$ : material, sorting, delivery, distribution
202	$Tm_{122}A_{56}$	$a_1$	$bd_{12}$	$bc_1$	$a_1$ : pneumatic; $bd_{12}$ : fixed arm; $bc_1$ : remote + operator; $A_{56}$ : remote construction
203	$Tm_{95}A_{44}$	$a_3$	$bd_{32}$	$bc_1$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_1$ : remote + operator; $A_{44}$ : panel installation
204	$Tm_2A_1$	$a_3$	$bd_{52}$	$bc_2$	$a_3$ : motor; $bd_{52}$ : mobile vehicle; $bc_2$ : automatic; $A_1$ : road construction
205	$Tm_{13}A_8$	$a_3$	$bd_7$	$bc_2$	$a_3$ : motor; $bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_8$ : steel construction
206	$Tm_{37}A_{21}$	$a_2$	$bd_{25}$	$bc_3$	$bd_{25}$ : parallel robot; $bc_3$ : human-robot + collaboration; $A_{21}$ : pipe construction
207	$Tm_{57}A_{28}$	$a_3$	$bd_{44}$	$bc_3$	$a_3$ : motor; $bd_{44}$ : manipulator + vacuum suction + wheel mobility; $bc_3$ : human-robot + collaboration
208	$Tm_{139}A_{60}$	$a_3$	$bd_{12}$	$bc_3$	$a_3$ : motor; $bd_{12}$ : fixed arm; $bc_3$ : human-robot + collaboration; $A_{60}$ : drilling
209	$Tm_{71}A_{34}$	-	$bd_{45}$	$bc_3$	$bd_{45}$ : wearable; $bc_3$ : human-robot + collaboration; $A_{34}$ : components assemble
210	$Tm_{89}A_{10}$	-	-	$bc_3$	$bc_3$ : human-robot + collaboration; $A_{10}$ : glass installation
211	$Tm_{144}A_8$	$a_2$	$bd_{63}$	$bc_3$	$a_2$ : hydraulic; $bd_{63}$ : scissor-jack manipulator; $bc_3$ : human-robot + collaboration; $A_8$ : steel construction
212	$Tc_{71}A_{22}$	$s_{18}$	$ca_{105}$	-	$s_{18}$ : various sensors + sensor system; $ca_{105}$ : A* algorithm, A-star; $A_{22}$ : masonry construction
213	$Tc_{91}A_{29}$	$s_{113}$	$ca_{111}$	-	$s_{113}$ : rotation angle + encoder sensor + laser, accelerometer; $ca_{111}$ : measures vector value of vertical lifting; $A_{29}$ : material, sorting, delivery, distribution
214	$Tc_{192}A_{56}$	$s_{134}$	$ca_{113}$	-	$s_{134}$ : magnetic stroke sensors + pressure sensors + stereo camera; $ca_{113}$ : velocity control; $A_{56}$ : remote construction
215	$Tc_{104}A_{32}$	$s_{14}$	$ca_{25}$	-	$s_{14}$ : laser; $ca_{25}$ : search algorithm; $A_{32}$ : machinery navigation
216	$Tc_{167}A_{54}$	$s_{14}$	$ca_{32}$	-	$s_{14}$ : laser; $ca_{32}$ : parametric-integrated algorithm, parametric synthesis; $A_{54}$ : arc welding
217	$Tc_{186}A_{56}$	$s_{133}$	$ca_{36}$	-	$s_{133}$ : stereo camera + acceleration sensor; $ca_{36}$ : PID position control; $A_{56}$ : remote construction
218	$Tc_{128}A_{41}$	$s_{81}$	$ca_{59}$	-	$s_{81}$ : angle sensor; $ca_{59}$ : primitive static states; $A_{41}$ : waste collection
219	$Tc_{209}A_6$	$s_{104}$	$ca_{73}$	-	$s_{104}$ : gyro sensor + laser sensor + CCD camera; $ca_{73}$ : Machine Learning; $A_6$ : building inspection
220	$Tb_{10}A_{14}$	-	$bm_{10}$	-	$bm_{10}$ : position + internal + error + force; $A_{14}$ : equipment positioning
221	$Tb_{12}A_{35}$	-	$bm_{12}$	-	$bm_{12}$ : sustainability + performance + environment; $A_{35}$ : construction activity evaluation
222	$Tb_7A_{21}$	-	$bm_7$	-	$bm_7$ : productivity + economic + sensitivity + safety + quality; $A_{21}$ : pipe construction
223	$Tm_3A_1$	$a_1$	$bd_2$	$bc_2$	$a_1$ : pneumatic; $bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_1$ : road construction
224	$Tm_{129}A_6$	$a_3$	$bd_{74}$	$bc_2$	$a_3$ : motor; $bd_{74}$ : worm-like, snake-like robot; $bc_2$ : automatic; $A_6$ : building inspection
225	$Tm_{13}A_8$	$a_3$	$bd_7$	$bc_2$	$a_3$ : motor; $bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_8$ : steel construction
226	$Tm_{26}A_{29}$	-	$bd_{49}$	$bc_2$	$bd_{49}$ : robotized crane; $bc_2$ : automatic; $A_{29}$ : material, sorting, delivery, distribution

227	$Tm_{145}A_8$	$a_3$	$hd_{63}$	$hc_3$	$a_3$ : motor; $hd_{63}$ : scissor-jack manipulator; $hc_3$ : human-robot + collaboration; $A_8$ : steel construction
228	$Tc_{190}A_{56}$	$s_{135}$	$ca_{26}$	-	$s_{135}$ : force sensor + tracker sensor + stereo camera; $ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{56}$ : remote construction
229	$Tc_{160}A_{50}$	-	$ca_{45}$	-	$ca_{45}$ : discrete event simulation model; $A_{50}$ : operation simulation
230	$Tc_{162}A_{50}$	$s_{57}$	$ca_{79}$	-	$s_{57}$ : environmental sensor; $ca_{79}$ : RBF-PID Control; $A_{50}$ : operation simulation
231	$Tc_{198}A_{56}$	$s_6$	$ca_{79}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{79}$ : RBF-PID Control; $A_{56}$ : remote construction
232	$Tc_{199}A_{56}$	$s_{39}$	$ca_{80}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{80}$ : augmented reality techniques (AR); $A_{56}$ : remote construction
233	$Tc_{196}A_{50}$	$s_6$	$ca_{84}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{84}$ : Force feedback control; $A_{50}$ : operation simulation
234	$Tc_{201}A_{50}$	$s_6$	$ca_{86}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{86}$ : master-slave system; $A_{50}$ : operation simulation
235	$Tc_{86}A_{56}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{56}$ : remote construction
236	$Tm_{92}A_{44}$	$a_2$	$hd_{24}$	$hc_2$	$a_2$ : hydraulic; $hd_{24}$ : climbing system; $hc_2$ : automatic; $A_{44}$ : panel installation
237	$Tm_{50}A_{45}$	$a_3$	$hd_{36}$	$hc_2$	$a_3$ : motor; $hd_{36}$ : mobile arm, manipulator with wheels; $hc_2$ : automatic; $A_{45}$ : cleaning
238	$Tm_{66}A_{10}$	$a_3$	$hd_{25}$	$hc_2$	$a_3$ : motor; $hd_{25}$ : parallel robot; $hc_2$ : automatic; $A_{10}$ : glass installation
239	$Tm_{14}A_8$	-	$hd_7$	$hc_2$	$hd_7$ : gantry robot, arm; $hc_2$ : automatic; $A_8$ : steel construction
240	$Tm_{54}A_{26}$	$a_2$	$hd_{61}$	$hc_3$	$a_2$ : hydraulic; $hd_{61}$ : excavator arm + double front ; $hc_3$ : human-robot + collaboration; $A_{26}$ : remote operating machines
241	$Tm_8A_{44}$	$a_3$	$hd_2$	$hc_3$	$a_3$ : motor; $hd_2$ : arm, manipulator + mounted; $hc_3$ : human-robot + collaboration; $A_{44}$ : panel installation
242	$Tc_{214}A_6$	-	$ca_{104}$	-	$ca_{104}$ : integral monitoring system; $A_6$ : building inspection
243	$Tc_{211}A_6$	$s_{109}$	$ca_{107}$	-	$s_{109}$ : GPS + camera; $ca_{107}$ : random walk algorithm; $A_6$ : building inspection
244	$Tc_{49}A_{17}$	$s_{157}$	$ca_{112}$	-	$s_{157}$ : Zigbee sensors + laser finder; $ca_{112}$ : Ubiquitous Sensor Network; $A_{17}$ : high rise building construction
245	$Tc_{164}A_{50}$	-	$ca_{114}$	-	$ca_{114}$ : behaviour-based system; $A_{50}$ : operation simulation
246	$Tc_{20}A_{11}$	-	$ca_{28}$	-	$ca_{28}$ : motion simulation; $A_{11}$ : wall construction
247	$Tc_{24}A_{40}$	$s_8$	$ca_{38}$	-	$s_8$ : pressure sensor; $ca_{38}$ : least squares algorithm; $A_{40}$ : harbour construction
248	$Tc_{155}A_{52}$	$s_{108}$	$ca_{62}$	-	$s_{108}$ : camera + LED + light; $ca_{62}$ : image processing; $A_{52}$ : measurement
249	$Tc_{94}A_{30}$	$s_{109}$	$ca_{62}$	-	$s_{109}$ : GPS + camera; $ca_{62}$ : image processing; $A_{30}$ : Mars/Lunar construction
250	$Tb_{10}A_{52}$	-	$bm_{10}$	-	$bm_{10}$ : position + internal + error + force; $A_{52}$ : measurement
251	$Tb_4A_9$	-	$bm_4$	-	$bm_4$ : motion + force + transmissibility; $A_9$ : tunnel construction
252	$Tb_5A_{10}$	-	$bm_5$	-	$bm_5$ : safety + posture load + working environment + risk exposure time+ safety; $A_{10}$ : glass installation

253	$Tm_{119}A_{56}$	$a_2$	-	$hc_1$	$a_2$ : hydraulic; $hc_1$ : remote + operator; $A_{56}$ : remote construction
254	$Tm_{68}A_{33}$	$a_2$	$bd_{45}$	$hc_2$	$a_2$ : hydraulic; $bd_{45}$ : wearable; $hc_2$ : automatic; $A_{33}$ : reduce lifting workload
255	$Tm_{20}A_{12}$	$a_3$	$bd_{57}$	$hc_2$	$a_3$ : motor; $bd_{57}$ : wire, cable climb; $hc_2$ : automatic; $A_{12}$ : bridge construction
256	$Tm_{10}A_{19}$	$a_3$	$bd_{16}$	$hc_2$	$a_3$ : motor; $bd_{16}$ : climbing platform + pediculate + gripper; $hc_2$ : automatic
257	$Tm_4A_{20}$	$a_3$	$bd_2$	$hc_2$	$a_3$ : motor; $bd_2$ : arm, manipulator + mounted; $hc_2$ : automatic; $A_{20}$ : spraying
258	$Tm_{97}A_{45}$	$a_5$	$bd_{26}$	$hc_2$	$a_5$ : pneumatic + motor; $bd_{26}$ : rail, vertical-moving robot; $hc_2$ : automatic; $A_{45}$ : cleaning
259	$Tm_{148}A_8$	$a_6$	$bd_{24}$	$hc_2$	$a_6$ : cable driven; $bd_{24}$ : climbing system; $hc_2$ : automatic; $A_8$ : steel construction
260	$Tm_{26}A_{17}$	-	$bd_{49}$	$hc_2$	$bd_{49}$ : robotized crane; $hc_2$ : automatic; $A_{17}$ : high rise building construction
261	$Tm_{28}A_{17}$	-	-	$hc_2$	$hc_2$ : automatic; $A_{17}$ : high rise building construction
262	$Tm_{28}A_{19}$	-	-	$hc_2$	$hc_2$ : automatic; $A_{19}$ : building maintenance
263	$Tm_{28}A_{38}$	-	-	$hc_2$	$hc_2$ : automatic
264	$Tm_{153}A_6$	$a_3$	$bd_2$	-	$bd_2$ : arm, manipulator + mounted; $A_6$ : building inspection
265	$Tm_{82}A_{41}$	$a_2$	$bd_{61}$	$hc_2$	$a_2$ : hydraulic; $bd_{61}$ : excavator arm + double front; $hc_2$ : automatic; $A_{41}$ : waste collection
266	$Tc_{25}A_9$	$s_{39}$	$ca_{115}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{115}$ : self-positioning algorithm; $A_9$ : tunnel construction
267	$Tc_{13}A_{38}$	-	$ca_{115}$	-	$ca_{115}$ : self-positioning algorithm; $A_{38}$ : marking
268	$Tc_{13}A_{54}$	-	$ca_{115}$	-	$ca_{115}$ : self-positioning algorithm; $A_{54}$ : arc welding
269	$Tc_{125}A_{38}$	-	$ca_{119}$	-	$ca_{119}$ : error modification; $A_{38}$ : marking
270	$Tc_{165}A_{54}$	$s_{16}$	$ca_{19}$	-	$s_{16}$ : CCD camera + stereo sensor; $A_{54}$ : arc welding
271	$Tc_{189}A_{56}$	-	$ca_{26}$	-	$ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{56}$ : remote construction
272	$Tc_{10}A_{11}$	$s_{25}$	$ca_{29}$	-	$s_{25}$ : infrared distance sensors + camera; $ca_{29}$ : planning stigmergy + Linux-based computer; $A_{11}$ : wall construction
273	$Tc_{68}A_{22}$	$s_{72}$	$ca_3$	-	$s_{72}$ : camera + proximity sensor + F/T sensor $ca_3$ : analytical model; $A_{22}$ : masonry construction
274	$Tc_{184}A_{56}$	-	$ca_{62}$	-	$ca_{62}$ : image processing; $A_{56}$ : remote construction
275	$Tc_{48}A_{17}$	$s_{119}$	$ca_{67}$	-	$s_{119}$ : optical (IR) sensor; $ca_{67}$ : Kalman Filter Algorithm; $A_{17}$ : high rise building construction
276	$Tc_{100}A_{32}$	$s_{14}$	$ca_{73}$	-	$s_{14}$ : laser; $ca_{73}$ : Machine Learning; $A_{32}$ : machinery navigation
277	$Tc_{191}A_{56}$	-	$ca_{84}$	-	$ca_{84}$ : Force feedback control; $A_{56}$ : remote construction
278	$Tc_{86}A_{25}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{25}$ : grasp soft objects

cable driven

279	$Tc_{86}A_{25}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{25}$ : grasp soft objects
280	$Tc_{86}A_{25}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{25}$ : grasp soft objects
281	$Tc_{35}A_{12}$	$s_{14}$	$ca_{90}$	-	$s_{14}$ : laser; $ca_{90}$ : C++, Java, C# script, C program; $A_{12}$ : bridge construction
282	$Tb_{11}A_{56}$	-	$bm_{11}$	-	$bm_{11}$ : grasping + force + perception; $A_{56}$ : remote construction
283	$Tm_{115}A_{55}$	$a_3$	$bd_4$	$bc_2$	$a_3$ : motor; $bd_4$ : arm + slider pulley; $bc_2$ : automatic; $A_{55}$ : underwater work
284	$Tm_{27}A_{28}$	$a_3$	$bd_{46}$	$bc_2$	$a_3$ : motor; $bd_{46}$ : wheel + magnetic gripper; $bc_2$ : automatic; $A_{28}$ : ceiling construction
285	$Tm_{129}A_6$	$a_3$	$bd_{74}$	$bc_2$	$a_3$ : motor; $bd_{74}$ : worm-like, snake-like robot; $bc_2$ : automatic; $A_6$ : building inspection
286	$Tm_{22}A_6$	$a_3$	$bd_{32}$	$bc_2$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_6$ : building inspection
287	$Tm_{28}A_{38}$	-	-	$bc_2$	$bc_2$ : automatic; $A_{38}$ : marking
288	$Tm_{63}A_3$	$a_3$	$bd_{32}$	$bc_3$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_3$ : human-robot + collaboration; $A_3$ : building service
289	$Tm_{64}A_{10}$	-	$bd_{30}$	$bc_3$	$bd_{30}$ : industrial robot; $bc_3$ : human-robot + collaboration; $A_{10}$ : glass installation
290	$Tc_{84}A_{29}$	-	$ca_{10}$	-	$ca_{10}$ : heuristic algorithm, heuristics; $A_{29}$ : material, sorting, delivery, distribution
291	$Tc_{109}A_{32}$	-	$ca_{112}$	-	$ca_{112}$ : Ubiquitous Sensor Network; $A_{32}$ : machinery navigation
292	$Tc_{53}A_{19}$	$s_{54}$	$ca_{116}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{116}$ : segmentation approach; $A_{19}$ : building maintenance
293	$Tc_{18}A_{11}$	$s_{26}$	$ca_{30}$	-	$s_{26}$ : shock sensor + infrared ray sensor + laser sensor, magnetic sensor; $ca_{30}$ : encoder failure detection algorithm; $A_{11}$ : wall construction
294	$Tc_{157}A_{50}$	-	$ca_{37}$	-	$ca_{37}$ : intelligent beacon; $A_{50}$ : operation simulation
295	$Tc_{62}A_{20}$	$s_{37}$	$ca_{40}$	-	$s_{37}$ : ultrasonic sensor + 2D LIDAR; $ca_{40}$ : collision avoidance algorithms, feed forward control algorithms; $A_{20}$ : spraying
296	$Tc_{33}A_{24}$	-	$ca_{49}$	-	$ca_{49}$ : genetic algorithms (GA); $A_{24}$ : machinery path management
297	$Tc_{87}A_{37}$	$s_8$	$ca_5$	-	$s_8$ : pressure sensor; $ca_5$ : PI controller, active control algorithm; $A_{37}$ : timer construction
298	$Tc_{96}A_{31}$	-	$ca_{54}$	-	$ca_{54}$ : inverse position equation; $A_{31}$ : slab finishing
299	$Tc_{27}A_{56}$	-	$ca_{90}$	-	$ca_{90}$ : C++, Java, C# script, C program; $A_{56}$ : remote construction
300	$Tc_{114}A_{34}$	$s_{54}$	$ca_{95}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{95}$ : PLC; $A_{34}$ : components assemble
301	$Tb_{10}A_{35}$	-	$bm_{10}$	-	$bm_{10}$ : position + internal + error + force; $A_{35}$ : construction activity evaluation
302	$Tm_{107}A_5$	-	-	$bc_1$	$bc_1$ : remote + operator; $A_5$ : earthmoving construction
303	$Tm_{13}A_{29}$	$a_3$	$bd_7$	$bc_2$	$bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_{29}$ : material, sorting, delivery, distribution
304	$Tm_{140}A_{63}$	$a_6$	$bd_{57}$	$bc_2$	$a_6$ : cable driven; $bd_{57}$ : wire, cable climb; $bc_2$ : automatic; $A_6$ : building inspection; $A_{63}$ : contour crafting

305	$Tm_{51}A_7$	-	$hd_{30}$	$hc_2$	$hd_{30}$ : industrial robot; $hc_2$ : automatic; $A_7$ : excavation
306	$Tm_{147}A_8$	$a_2$	$hd_7$	$hc_3$	$a_2$ : hydraulic; $hd_7$ : gantry robot, arm; $hc_3$ : human-robot + collaboration; $A_8$ : steel construction
307	$Tm_{149}A_{10}$	$a_3$	$hd_{62}$	$hc_3$	$a_3$ : motor; $hd_{62}$ : caterpillar + 6-DOF manipulator + vacuum pad; $hc_3$ : human-robot + collaboration; $A_{10}$ : glass installation
308	$Tm_8A_8$	$a_3$	$hd_2$	$hc_3$	$a_3$ : motor; $hd_2$ : arm, manipulator + mounted; $hc_3$ : human-robot + collaboration; $A_8$ : steel construction
309	$Tm_{58}A_{28}$	-	$hd_{44}$	$hc_3$	$hd_{44}$ : manipulator + vacuum suction + wheel mobility; $hc_3$ : human-robot + collaboration; $A_{28}$ : ceiling construction
310	$Tm_{64}A_{10}$	-	$hd_{30}$	$hc_3$	$hd_{30}$ : industrial robot; $hc_3$ : human-robot + collaboration; $A_{10}$ : glass installation
311	$Tc_{34}A_{29}$	$s_{39}$	$ca_{112}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{112}$ : Ubiquitous Sensor Network; $A_{29}$ : material, sorting, delivery, distribution
312	$Tc_{156}A_{50}$	$s_{39}$	$ca_{26}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{26}$ : fusion fuzzy, fuzzy logic, fuzzy set theory; $A_{50}$ : operation simulation
313	$Tc_{160}A_{50}$	-	$ca_{45}$	-	$ca_{45}$ : discrete event simulation model; $A_{50}$ : operation simulation
314	$Tc_{160}A_{50}$	-	$ca_{45}$	-	$ca_{45}$ : discrete event simulation model; $A_{50}$ : operation simulation
315	$Tc_{58}A_2$	$s_{64}$	$ca_{60}$	-	$s_{64}$ : force + laser; $ca_{60}$ : workflow method; $A_2$ : titling placing
316	$Tc_{185}A_{56}$	$s_{136}$	$ca_{62}$	-	$s_{136}$ : camera + position + pressure; $ca_{62}$ : image processing; $A_{56}$ : remote construction
317	$Tc_{66}A_{21}$	$s_{39}$	$ca_{62}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{62}$ : image processing; $A_{21}$ : pipe construction
318	$Tc_{21}A_{34}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{34}$ : components assemble
319	$Tc_{228}A_8$	$s_{92}$	$ca_{92}$	-	$s_{92}$ : robust sensor + pressure sensors + force sensors; $ca_{92}$ : Virtual Reality; $A_8$ : steel construction
320	$Tc_{30}A_{12}$	$s_{39}$	$ca_{98}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{98}$ : tree-Based algorithm; $A_{12}$ : bridge construction
321	$Tc_{113}A_{34}$	-	$ca_{98}$	-	$ca_{98}$ : tree-Based algorithm; $A_{34}$ : components assemble
322	$Tm_{137}A_{55}$	$a_2$	$hd_2$	$hc_1$	$a_2$ : hydraulic; $hd_2$ : arm, manipulator + mounted; $hc_1$ : remote + operator; $A_{55}$ : underwater work
323	$Tm_{131}A_6$	$a_3$	$hd_{71}$	$hc_2$	$a_3$ : motor; $hd_{71}$ : wheel + platform + caterpillar; $hc_2$ : automatic; $A_6$ : building inspection
324	$Tm_{121}A_{57}$	$a_3$	$hd_{83}$	$hc_2$	$a_3$ : motor; $hd_{83}$ : furniture system, terminal wall system; $hc_2$ : automatic; $A_{57}$ : improve home living environment
325	$Tm_{47}A_5$	$a_3$	$hd_{58}$	$hc_2$	$a_3$ : motor; $hd_{58}$ : UAV; $hc_2$ : automatic; $A_5$ : earthmoving construction
326	$Tm_4A_6$	$a_3$	$hd_2$	$hc_2$	$a_3$ : motor; $hd_2$ : arm, manipulator + mounted; $hc_2$ : automatic; $A_6$ : building inspection
327	$Tm_{31}A_2$	-	$hd_1$	$hc_2$	$hd_1$ : humanoid; $hc_2$ : automatic; $A_2$ : titling placing
328	$Tm_{26}A_{10}$	-	$hd_{49}$	$hc_2$	$hd_{49}$ : robotized crane; $hc_2$ : automatic; $A_{10}$ : glass installation
329	$Tm_{46}A_{34}$	-	$hd_{58}$	$hc_2$	$hd_{58}$ : UAV; $hc_2$ : automatic; $A_{34}$ : components assemble
330	$Tm_{105}A_{47}$	$a_2$	$hd_2$	$hc_3$	$a_2$ : hydraulic; $hd_2$ : arm, manipulator + mounted; $hc_3$ : human-robot + collaboration; $A_{47}$ : mining

331	$Tm_{72}A_{34}$	-	$bd_{42}$	$bc_3$	$bd_{42}$ : mobile vehicle + aerial lift + manipulator + vacuum suction device; $bc_3$ : human-robot + collaboration; $A_{34}$ : components assemble
332	$Tc_{67}A_{21}$	-	$ca_{101}$	-	$ca_{101}$ : robust algorithm; $A_{21}$ : pipe construction
333	$Tc_{111}A_{32}$	$s_{143}$	$ca_{105}$	-	$s_{143}$ : GPS + IMU; $ca_{105}$ : A* algorithm, A-star; $A_{32}$ : machinery navigation
334	$Tc_{40}A_{14}$	$s_{127}$	$ca_{113}$	-	$s_{127}$ : 3D sensor; $ca_{113}$ : velocity control; $A_{14}$ : equipment positioning
335	$Tc_{158}A_{52}$	$s_6$	$ca_{113}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{113}$ : velocity control; $A_{52}$ : measurement
336	$Tc_{108}A_{34}$	$s_{54}$	$ca_{118}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{118}$ : SLAM; $A_{34}$ : components assemble
337	$Tc_{135}A_{54}$	$s_{39}$	$ca_{20}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{20}$ : vision based gesture estimation, CARLoS Scenario; $A_{54}$ : arc welding
338	$Tc_{61}A_{20}$	$s_{39}$	$ca_{41}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{41}$ : timing algorithm; $A_{20}$ : spraying
339	$Tc_{85}A_{25}$	-	$ca_{50}$	-	$ca_{50}$ : kinematic connection; $A_{25}$ : grasp soft objects
340	$Tc_{21}A_{22}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{22}$ : masonry construction
341	$Tc_{199}A_{56}$	$s_{39}$	$ca_{80}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{80}$ : augmented reality techniques (AR); $A_{56}$ : remote construction
342	$Tc_{202}A_{56}$	$s_{136}$	$ca_{86}$	-	$s_{136}$ : camera + position + pressure; $ca_{86}$ : master-slave system; $ca_{86}$ : master-slave system; $A_{56}$ : remote construction
343	$Tb_{12}A_{35}$	-	$bm_{12}$	-	$bm_{12}$ : sustainability + performance + environment; $A_{35}$ : construction activity evaluation
344	$Tm_{30}A_{19}$	$a_2$	$bd_{57}$	$bc_2$	$a_2$ : hydraulic; $bd_{57}$ : wire, cable climb; $bc_2$ : automatic; $A_{19}$ : building maintenance
345	$Tm_{116}A_{55}$	$a_3$	$bd_5$	$bc_2$	$a_3$ : motor; $bd_5$ : multi-fingered, hand + gear + belt; $bc_2$ : automatic; $A_{55}$ : underwater work
346	$Tm_{121}A_{57}$	$a_3$	$bd_{83}$	$bc_2$	$a_3$ : motor; $bd_{83}$ : furniture system, terminal wall system; $bc_2$ : automatic; $A_{57}$ : improve home living environment
347	$Tm_2A_6$	$a_3$	$bd_{52}$	$bc_2$	$a_3$ : motor; $bd_{52}$ : mobile vehicle; $bc_2$ : automatic; $A_6$ : building inspection
348	$Tm_{52}A_{29}$	$a_6$	$bd_{13}$	$bc_2$	$a_6$ : cable driven; $bd_{13}$ : mobile platform + arm, manipulator; $bc_2$ : automatic; $A_{29}$ : material, sorting, delivery, distribution
349	$Tm_{43}A_{22}$	-	$bd_{54}$	$bc_2$	$bd_{54}$ : vacuum gripper + arm; $bc_2$ : automatic; $A_{22}$ : masonry construction
350	$Tm_{29}A_{28}$	$a_3$	$bd_{45}$	$bc_3$	$bd_{45}$ : wearable; $bc_3$ : human-robot + collaboration; $A_{28}$ : ceiling construction
351	$Tc_{136}A_{14}$	$s_{126}$	$ca_{108}$	-	$s_{126}$ : laser + camera + tempo sonics; $ca_{108}$ : positioning system; $A_{14}$ : equipment positioning
352	$Tc_{177}A_{56}$	$s_6$	$ca_{20}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{20}$ : vision based gesture estimation, CARLoS Scenario; $A_{56}$ : remote construction
353	$Tc_{122}A_{54}$	-	$ca_{21}$	-	$ca_{21}$ : optimizing welding sequence; $A_{54}$ : arc welding
354	$Tc_{180}A_{55}$	-	$ca_3$	-	$ca_3$ : analytical model; $A_{55}$ : underwater work
355	$Tc_{45}A_{18}$	$s_{39}$	$ca_{44}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{44}$ : 3D printer control; $A_{18}$ : large-scale building construction
356	$Tc_{148}A_{29}$	$s_{85}$	$ca_{73}$	-	$s_{85}$ : pressure sensor + speed sensor + proximity sensors; $ca_{73}$ : Machine Learning; $A_{29}$ : material, sorting, delivery, distribution

357	$Tc_{76}A_{34}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{34}$ : components assemble
358	$Tc_{21}A_{22}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{22}$ : masonry construction
359	$Tc_{195}A_{56}$	-	$ca_{78}$	-	$ca_{78}$ : torque measure methods; $A_{56}$ : remote construction
360	$Tc_{203}A_{56}$	$s_{39}$	$ca_{86}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{86}$ : master-slave system; $A_{56}$ : remote construction
361	$Tc_{218}A_{61}$	-	$ca_9$	-	$ca_9$ : performance test, evaluation; $cc$
362	$Tc_{28}A_{12}$	$s_{96}$	$ca_{99}$	-	$s_{96}$ : camera + accelerometers; $ca_{99}$ : dedicated smart sensors; $A_{12}$ : bridge construction
363	$Tb_6A_{12}$	-	$bm_6$	-	$bm_6$ : cost + quality; $A_{12}$ : bridge construction
364	$Tm_{108}A_5$	$a_2$	$bd_{32}$	$bc_1$	$a_2$ : hydraulic; $bd_{32}$ : wheel mobile; $bc_1$ : remote + operator; $A_5$ : earthmoving construction
365	$Tm_{136}A_6$	$a_3$	$bd_{19}$	$bc_1$	$a_3$ : motor; $bd_{19}$ : climbing platforms + vacuum grippers + suction; $bc_1$ : remote + operator; $A_6$ : building inspection
366	$Tm_{120}A_{56}$	$a_3$	$bd_{32}$	$bc_1$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_1$ : remote + operator; $A_{56}$ : remote construction
367	$Tm_{110}A_{50}$	$a_4$	$bd_{52}$	$bc_1$	$a_4$ : electro + hydraulic; $bd_{52}$ : mobile vehicle; $bc_1$ : remote + operator; $A_{50}$ : operation simulation
368	$Tm_{44}A_{22}$	$a_6$	$bd_{26}$	$bc_2$	$a_6$ : cable driven; $bd_{26}$ : rail, vertical-moving robot; $bc_2$ : automatic; $A_{22}$ : masonry construction
369	$Tm_{109}A_{37}$	-	$bd_{78}$	$bc_2$	$bd_{78}$ : collaborative, multi, team, multiple; $bc_2$ : automatic; $A_{37}$ : timer construction
370	$Tm_{109}A_{50}$	-	$bd_{78}$	$bc_2$	$bd_{78}$ : collaborative, multi, team, multiple; $bc_2$ : automatic; $A_{50}$ : operation simulation
371	$Tm_{14}A_{37}$	-	$bd_7$	$bc_2$	$bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_{37}$ : timer construction
372	$Tm_{23}A_{29}$	-	$bd_{32}$	$bc_2$	$bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_{29}$ : material, sorting, delivery, distribution
373	$Tm_{74}A_{34}$	$a_3$	$bd_9$	$bc_3$	$a_3$ : motor; $bc_3$ : human-robot + collaboration; $A_{34}$ : components assemble
374	$Tm_{29}A_{29}$	$a_3$	$bd_{45}$	$bc_3$	$a_3$ : motor; $bd_{45}$ : wearable; $bc_3$ : human-robot + collaboration; $A_{29}$ : material, sorting, delivery, distribution
375	$Tm_{73}A_{34}$	-	$bd_{30}$	$bc_3$	$bd_{30}$ : industrial robot; $bc_3$ : human-robot + collaboration; $A_{34}$ : components assemble
376	$Tc_{83}A_{24}$	$s_{39}$	$ca_{105}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{105}$ : A* algorithm, A-star; $A_{24}$ : machinery path management
377	$Tc_{110}A_{32}$	$s_{14}$	$ca_{110}$	-	$s_{14}$ : laser; $ca_{110}$ : Iterative Closest Point (ICP) algorithm; $ca_{110}$ : Iterative Closest Point (ICP) algorithm; $A_{32}$ : machinery navigation
378	$Tc_{234}A_{52}$	$s_6$	$ca_{114}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{114}$ : behaviour-based system; $A_{52}$ : measurement
379	$Tc_{16}A_{58}$	-	$ca_{32}$	-	$ca_{32}$ : parametric-integrated algorithm, parametric synthesis; $A_{58}$ : finishing
380	$Tc_{238}A_{55}$	-	$ca_4$	-	$ca_4$ : estimate ego-position; $A_{55}$ : underwater work
381	$Tc_{44}A_{16}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{16}$ : concrete printing
382	$Tc_{44}A_{16}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{16}$ : concrete printing

383	$Tc_{44}A_{16}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{16}$ : concrete printing
384	$Tc_{44}A_{16}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{16}$ : concrete printing
385	$Tc_{87}A_{55}$	$s_8$	$ca_5$	-	$s_8$ : pressure sensor; $ca_5$ : PI controller, active control algorithm; $A_{55}$ : underwater work
386	$Tc_{217}A_{60}$	-	$ca_{57}$	-	$ca_{57}$ : C-K Theory; $A_{60}$ : drilling
387	$Tc_{176}A_{55}$	$s_6$	$ca_6$	-	$s_6$ : torque/force sensor + force sensor; $ca_6$ : pure-pursuit method; $A_{55}$ : underwater work
388	$Tc_{77}A_{22}$	-	$ca_{72}$	-	$ca_{72}$ : Particle Swarm Optimization (PSO) algorithms; $A_{22}$ : masonry construction
389	$Tc_{223}A_{50}$	$s_{43}$	$ca_{73}$	-	$s_{43}$ : joint sensor; $ca_{73}$ : Machine Learning; $ca_{73}$ : Machine Learning; $A_{50}$ : operation simulation
390	$Tc_{73}A_8$	$s_{14}$	$ca_{75}$	-	$s_{14}$ : laser; $ca_{75}$ : IFC + BIM; $A_8$ : steel construction
391	$Tc_{21}A_3$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_3$ : building service
392	$Tc_{120}A_{34}$	$s_{127}$	$ca_{82}$	-	$s_{127}$ : 3D sensor; $ca_{82}$ : Generalized Resolution Correlative Scan Matching (GRCSM); $A_{34}$ : components assemble
393	$Tc_{204}A_{56}$	$s_{137}$	$ca_{86}$	-	$s_{137}$ : position sensors + magnetic stroke sensors + pressure sensors; $ca_{86}$ : master-slave system; $ca_{86}$ : master-slave system; $A_{56}$ : remote construction
394	$Tc_{27}A_{34}$	-	$ca_{90}$	-	$ca_{90}$ : C++, Java, C# script, C program; $A_{34}$ : components assemble
395	$Tc_{221}A_{62}$	$s_{39}$	$ca_{94}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{94}$ : Raspberry Pi; $A_{62}$ : fire curtain testing
396	$Tc_{98}A_{32}$	$s_{82}$	$ca_{96}$	-	$s_{82}$ : laser + lidar; $ca_{96}$ : real time navigation; $ca_{96}$ : real time navigation; $A_{32}$ : machinery navigation
397	$Tb_1A_{11}$	-	$bm_1$	-	$bm_1$ : environmental + life cycle Assessment (LCA); $A_{11}$ : wall construction
398	$Tm_{104}A_{45}$	$a_3$	$bd_{35}$	$bc_1$	$bd_{35}$ : bucket + arm; $bc_1$ : remote + operator; $A_{45}$ : cleaning
399	$Tm_{138}A_6$	$a_3$	$bd_2$	$bc_1$	$bd_2$ : arm, manipulator + mounted; $bc_1$ : remote + operator; $A_6$ : building inspection
400	$Tm_{65}A_{30}$	$a_1$	$bd_{70}$	$bc_2$	$a_1$ : pneumatic; $bd_{70}$ : mobility feet, leg, limbed; $bc_2$ : automatic; $A_{30}$ : Mars/Lunar construction
401	$Tm_{45}A_{22}$	$a_3$	$bd_{59}$	$bc_2$	$a_3$ : motor; $bd_{59}$ : scissor lift + aerial bucket + manipulator arm; $bc_2$ : automatic; $A_{22}$ : masonry construction
402	$Tm_{47}A_6$	$a_3$	$bd_{58}$	$bc_2$	$a_3$ : motor; $bd_{58}$ : UAV; $bc_2$ : automatic; $A_6$ : building inspection
403	$Tm_{22}A_{15}$	$a_3$	$bd_{32}$	$bc_2$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_{15}$ : building quality assessment
404	$Tm_{22}A_6$	$a_3$	$bd_{32}$	$bc_2$	$a_3$ : motor; $bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_6$ : building inspection
405	$Tm_{16}A_{11}$	$a_6$	$bd_{25}$	$bc_2$	$a_6$ : cable driven; $bd_{25}$ : parallel robot; $bc_2$ : automatic; $A_{11}$ : wall construction
406	$Tm_{15}A_{11}$	-	$bd_{23}$	$bc_2$	$bd_{23}$ : mobile + light + manipulator + rail; $bc_2$ : automatic; $A_{11}$ : wall construction
407	$Tm_{67}A_{60}$	-	$bd_{75}$	$bc_2$	$bd_{75}$ : clamping manipulator; $bc_2$ : automatic; $A_{60}$ : drilling
408	$Tm_{111}A_{52}$	-	$bd_{16}$	$bc_2$	$bd_{16}$ : climbing platform + pediculate + gripper; $bc_2$ : automatic; $A_{52}$ : measurement



409	$Tm_{46}A_6$	-	$hd_{58}$	$hc_2$	$hd_{58}$ : UAV; $hc_2$ : automatic; $A_6$ : building inspection
410	$Tm_{23}A_{15}$	-	$hd_{32}$	$hc_2$	$hd_{32}$ : wheel mobile; $hc_2$ : automatic; $A_{15}$ : building quality assessment
411	$Tm_{77}A_9$	-	$hd_2$	$hc_2$	$hd_2$ : arm, manipulator + mounted; $hc_2$ : automatic; $A_9$ : tunnel construction
412	$Tm_{28}A_6$	-	-	$hc_2$	$hc_2$ : automatic; $A_6$ : building inspection
413	$Tm_{75}A_{34}$	$a_5$	$hd_7$	$hc_3$	$hd_7$ : gantry robot, arm; $A_{34}$ : components assemble
414	$Tm_{64}A_3$	-	$hd_{30}$	$hc_3$	$hd_{30}$ : industrial robot; $hc_3$ : human-robot + collaboration; $A_3$ : building service
415	$Tc_{99}A_{32}$	$s_{109}$	$ca_{103}$	-	$s_{109}$ : GPS + camera; $ca_{103}$ : motion planning; $A_{32}$ : machinery navigation
416	$Tc_{84}$	-	$ca_{103}$	-	$ca_{103}$ : motion planning; $A_{24}$ : machinery path management
417	$Tc_{84}A_{33}$	-	$ca_{103}$	-	$ca_{103}$ : motion planning; $A_{33}$ : reduce lifting workload
418	$Tc_{84}A_{45}$	-	$ca_{103}$	-	$ca_{103}$ : motion planning; $A_{45}$ : cleaning
419	$Tc_{142}A_{46}$	$s_{14}$	$ca_{110}$	-	$s_{14}$ : laser; $ca_{110}$ : Iterative Closest Point (ICP) algorithm; $A_{46}$ : machinery mapping
420	$Tc_{174}A_{55}$	-	$ca_{113}$	-	$ca_{113}$ : velocity control; $A_{55}$ : underwater work
421	$Tc_{107}A_{32}$	$s_{29}$	$ca_{118}$	-	$s_{29}$ : camera + laser + lidar; $ca_{118}$ : SLAM; $A_{32}$ : machinery navigation
422	$Tc_{38}A_{32}$	$s_{39}$	$ca_{118}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{118}$ : SLAM; $A_{32}$ : machinery navigation
423	$Tc_{38}A_{32}$	$s_{39}$	$ca_{118}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{118}$ : SLAM; $A_{32}$ : machinery navigation
424	$Tc_{233}A_{43}$	$s_6$	$ca_{17}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{17}$ : admittance control; $A_{43}$ : joint filling
425	$Tc_{17}A_{11}$	$s_{28}$	$ca_{31}$	-	$s_{28}$ : alignment sensor + brake check sensor + obstacle detecting sensors + laser sensors + ultrasonic sensor + HMR sensor; $ca_{31}$ : wireless communication + wireless Lan; $A_{11}$ : wall construction
426	$Tc_{225}A_7$	$s_{48}$	$ca_{31}$	-	$s_{48}$ : work environment sensors + GPS + IMU + lidar; $ca_{31}$ : wireless communication + wireless Lan; $A_7$ : excavation
427	$Tc_{45}A_{18}$	$s_{39}$	$ca_{44}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{44}$ : 3D printer control; $A_{18}$ : large-scale building construction
428	$Tc_{50}A_{18}$	$s_{48}$	$ca_{44}$	-	$s_{48}$ : work environment sensors + GPS + IMU + lidar; $ca_{44}$ : 3D printer control; $A_{18}$ : large-scale building construction
429	$Tc_{178}A_{55}$	$s_6$	$ca_5$	-	$s_6$ : torque/force sensor + force sensor; $ca_5$ : PI controller, active control algorithm; $A_{55}$ : underwater work
430	$Tc_{103}A_{32}$	$s_{109}$	$ca_{73}$	-	$s_{109}$ : GPS + camera; $ca_{73}$ : Machine Learning; $A_{32}$ : machinery navigation
431	$Tc_{150}A_{50}$	$s_{146}$	$ca_{73}$	-	$s_{146}$ : Kinect + accelerometers + IMUs; $ca_{73}$ : Machine Learning; $A_{50}$ : operation simulation
432	$Tc_{127}A_{39}$	$s_{158}$	$ca_{73}$	-	$s_{158}$ : depth sensor + colour sensors + camera; $ca_{73}$ : Machine Learning; $A_{39}$ : hazard detection
433	$Tc_{32}A_{51}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{51}$ : pose estimation
434	$Tc_{32}A_{59}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{59}$ : object recognition

435	$T_{c32}A_6$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_6$ : building inspection
436	$T_{c76}A_{36}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{36}$ : diagnosis detection
437	$T_{c76}A_{36}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{36}$ : diagnosis detection
438	$T_{c73}A_{22}$	$s_{14}$	$ca_{75}$	-	$s_{14}$ : laser; $ca_{75}$ : IFC + BIM; $A_{22}$ : masonry construction
439	$T_{c37}A_{13}$	$s_{29}$	$ca_{75}$	-	$s_{29}$ : camera + laser + lidar; $ca_{75}$ : IFC + BIM; $A_{13}$ : construction monitoring
440	$T_{c21}A_{15}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{15}$ : building quality assessment
441	$T_{c21}A_{15}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{15}$ : building quality assessment
442	$T_{c21}A_{63}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{63}$ : contour crafting
443	$T_{c21}A_9$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_9$ : tunnel construction
444	$T_{c198}A_{55}$	$s_6$	$ca_{79}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{79}$ : RBF-PID Control; $A_{55}$ : underwater work
445	$T_{c12}A_{43}$	$s_{129}$	$ca_{82}$	-	$s_{129}$ : optical + ultrasonic + laser; $ca_{82}$ : Generalized Resolution Correlative Scan Matching (GRCSM); $A_{43}$ : joint filling
446	$T_{c12}A_{43}$	$s_{129}$	$ca_{82}$	-	$s_{129}$ : optical + ultrasonic + laser; $ca_{82}$ : Generalized Resolution Correlative Scan Matching (GRCSM); $A_{43}$ : joint filling
447	$T_{c69}A_{22}$	-	$ca_{82}$	-	$ca_{82}$ : Generalized Resolution Correlative Scan Matching (GRCSM); $A_{22}$ : masonry construction
448	$T_{c203}A_{56}$	$s_{39}$	$ca_{86}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{86}$ : master-slave system; $A_{56}$ : remote construction
449	$T_{c86}A_{34}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{34}$ : components assemble
450	$T_{c173}A_{55}$	$s_6$	$ca_9$	-	$s_6$ : torque/force sensor + force sensor; $ca_9$ : performance test, evaluation; $A_{55}$ : underwater work
451	$Tb_{14}A_{35}$	-	$bm_{14}$	-	$bm_{14}$ : cost + productivity + efficiency; $A_{35}$ : construction activity evaluation
452	$Tb_{15}A_{16}$	-	$bm_{15}$	-	$bm_{15}$ : mental workload; $A_{16}$ : concrete printing
453	$Tm_{99}A_{45}$	$a_3$	$hd_{37}$	$hc_2$	$a_3$ : motor; $hd_{37}$ : reconfigurable + platform; $hc_2$ : automatic; $A_{45}$ : cleaning
454	$Tm_{154}A_6$	$a_3$	$hd_{46}$	$hc_2$	$a_3$ : motor; $hd_{46}$ : wheel + magnetic gripper; $hc_2$ : automatic; $A_6$ : building inspection
455	$Tm_{98}A_{45}$	$a_3$	$hd_{19}$	$hc_2$	$a_3$ : motor; $hd_{19}$ : climbing platforms + vacuum grippers + suction; $hc_2$ : automatic; $A_{45}$ : cleaning
456	$Tm_{133}A_6$	$a_3$	$hd_3$	$hc_2$	$a_3$ : motor; $hd_3$ : crawler; $hc_2$ : automatic; $A_6$ : building inspection
457	$Tm_2A_6$	$a_3$	$hd_{52}$	$hc_2$	$a_3$ : motor; $hd_{52}$ : mobile vehicle; $hc_2$ : automatic
458	$Tm_{22}A_6$	$a_3$	$hd_{32}$	$hc_2$	$a_3$ : motor; $hd_{32}$ : wheel mobile; $hc_2$ : automatic; $A_6$ : building inspection
459	$Tm_4A_6$	$a_3$	$hd_2$	$hc_2$	$a_3$ : motor; $hd_2$ : arm, manipulator + mounted; $hc_2$ : automatic; $A_6$ : building inspection
460	$Tm_{42}A_{22}$	$a_6$	$hd_{53}$	$hc_2$	$a_6$ : cable driven; $hd_{53}$ : wireless gripper, winch; $hc_2$ : automatic; $A_{22}$ : masonry construction

461	$Tm_{44}A_{22}$	$a_6$	$bd_{26}$	$bc_2$	$a_6$ : cable driven; $bd_{26}$ : rail, vertical-moving robot; $bc_2$ : automatic; $A_{22}$ : masonry construction
462	$Tm_{16}A_{11}$	$a_6$	$bd_{25}$	$bc_2$	$a_6$ : cable driven; $bd_{25}$ : parallel robot; $bc_2$ : automatic; $A_{11}$ : wall construction
463	$Tm_{76}A_{34}$	$a_6$	$bd_{25}$	$bc_2$	$a_6$ : cable driven; $bd_{25}$ : parallel robot; $bc_2$ : automatic; $A_{34}$ : components assemble
464	$Tm_{114}A_{54}$	-	$bd_{14}$	$bc_2$	$bd_{14}$ : changeable cell; $bc_2$ : automatic; $A_{54}$ : arc welding
465	$Tm_{132}A_6$	-	$bd_{72}$	$bc_2$	$bd_{72}$ : Hammering; $bc_2$ : automatic; $A_6$ : building inspection
466	$Tm_{132}A_6$	-	$bd_{72}$	$bc_2$	$bd_{72}$ : Hammering; $bc_2$ : automatic; $A_6$ : building inspection
467	$Tm_6A_{11}$	-	$bd_{13}$	$bc_2$	$bd_{13}$ : mobile platform + arm, manipulator; $bc_2$ : automatic; $A_{11}$ : wall construction
468	$Tm_5A_{11}$	-	$bd_{27}$	$bc_2$	$bd_{27}$ : AGV, unmanned ground vehicle; $bc_2$ : automatic; $A_{11}$ : wall construction
469	$Tm_{46}A_{22}$	-	$bd_{58}$	$bc_2$	$bd_{58}$ : UAV; $bc_2$ : automatic; $A_{22}$ : masonry construction
470	$Tm_{23}A_{30}$	-	$bd_{32}$	$bc_2$	$bd_{32}$ : wheel mobile; $bc_2$ : automatic; $A_{30}$ : Mars/Lunar construction
471	$Tm_{77}A_6$	-	$bd_2$	$bc_2$	$bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_6$ : building inspection
472	$Tm_{28}A_{19}$	-	-	$bc_2$	$bc_2$ : automatic; $A_{19}$ : building maintenance
473	$Tm_{28}A_{28}$	-	-	$bc_2$	$bc_2$ : automatic; $A_{28}$ : ceiling construction
474	$Tm_{125}A_6$	$a_3$	$bd_{73}$	$bc_3$	$a_3$ : motor; $bd_{73}$ : magnetic wheel; $bc_3$ : human-robot + collaboration; $A_6$ : building inspection
475	$Tc_{212}A_6$	$s_{54}$	$ca_{106}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{106}$ : point cloud data control; $A_6$ : building inspection
476	$Tc_{131}A_{36}$	$s_{39}$	$ca_{110}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{110}$ : Iterative Closest Point (ICP) algorithm; $A_{36}$ : diagnosis detection
477	$Tc_9A_{11}$	$s_{29}$	$ca_{118}$	-	$s_{29}$ : camera + laser + lidar; $ca_{118}$ : SLAM; $A_{11}$ : wall construction
478	$Tc_{123}A_{24}$	$s_{48}$	$ca_{118}$	-	$s_{48}$ : work environment sensors + GPS + IMU + lidar; $ca_{118}$ : SLAM; $A_{24}$ : machinery path management
479	$Tc_{108}A_{24}$	$s_{54}$	$ca_{118}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{118}$ : SLAM; $A_{24}$ : machinery path management
480	$Tc_{139}A_{54}$	$s_{19}$	$ca_{22}$	-	$s_{19}$ : 3D laser + camera + torch sensor + galvanometer scanner; $ca_{22}$ : BIM+ Augmented Reality+Human-Machine Interfaces (IMUs); $A_{54}$ : arc welding; $A_{22}$ : masonry construction
481	$Tc_{133}A_{33}$	$s_{39}$	$ca_{22}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{22}$ : BIM+ Augmented Reality+Human-Machine Interfaces (IMUs); $A_{33}$ : reduce lifting workload
482	$Tc_{159}A_{54}$	-	$ca_{23}$	-	$ca_{23}$ : power line communication net; $A_{54}$ : arc welding
483	$Tc_{14}A_{11}$	$s_{31}$	$ca_{34}$	-	$s_{31}$ : tactile senses + force sensor; $ca_{34}$ : Anderson Passive control theory; $A_{11}$ : wall construction
484	$Tc_{44}A_{11}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{11}$ : wall construction
485	$Tc_{44}A_{18}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{18}$ : large-scale building construction

486	$T_{c60}A_2$	$s_{14}$	$ca_{46}$	-	$s_{14}$ : laser; $ca_{46}$ : embedded, embedding, controller; $A_2$ : titling placing
487	$T_{c60}A_{29}$	$s_{14}$	$ca_{46}$	-	$s_{14}$ : laser; $ca_{46}$ : embedded, embedding, controller; $A_{29}$ : material, sorting, delivery, distribution
488	$T_{c90}A_{29}$	$s_{39}$	$ca_{58}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{58}$ : soft additive fabrication; $A_{29}$ : material, sorting, delivery, distribution
489	$T_{c102}A_{32}$	$s_{39}$	$ca_{66}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{66}$ : geodetical method; $A_{32}$ : machinery navigation
490	$T_{c32}A_{15}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{15}$ : building quality assessment
491	$T_{c32}A_{32}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{32}$ : machinery navigation
492	$T_{c32}A_{32}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{32}$ : machinery navigation
493	$T_{c32}A_{50}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{50}$ : operation simulation
494	$T_{c32}A_{51}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{51}$ : pose estimation
495	$T_{c4}A_{50}$	$s_6$	$ca_{73}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{73}$ : Machine Learning; $A_{50}$ : operation simulation
496	$T_{c76}A_{22}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{22}$ : masonry construction
497	$T_{c76}A_{28}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{28}$ : ceiling construction
498	$T_{c76}A_{33}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{33}$ : reduce lifting workload
499	$T_{c76}A_{36}$	-	$ca_{73}$	-	$ca_{73}$ : Machine Learning; $A_{36}$ : diagnosis detection
500	$T_{c206}A_{58}$	$s_{19}$	$ca_{75}$	-	$s_{19}$ : 3D laser + camera + torch sensor + galvanometer scanner; $ca_{75}$ : IFC + BIM; $A_{58}$ : finishing
501	$T_{c92}A_{30}$	$s_{54}$	$ca_{75}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{75}$ : IFC + BIM; $A_{30}$ : Mars/Lunar construction
502	$T_{c92}A_{38}$	$s_{54}$	$ca_{75}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{75}$ : IFC + BIM; $A_{38}$ : marking
503	$T_{c21}A_{37}$	-	$ca_{75}$	-	$ca_{75}$ : IFC + BIM; $A_{37}$ : timer construction
504	$T_{c193}A_{56}$	$s_{140}$	$ca_{77}$	-	$s_{140}$ : pressure sensor + electronic compass + displacement transducers; $ca_{77}$ : digital signal processing (DSP) controller; $A_{56}$ : remote construction
505	$T_{c163}A_{50}$	$s_{84}$	$ca_{79}$	-	$s_{84}$ : GPS + lidar + camera + angle sensors + distance sensors + force sensor + depth sensor + radar, ultrasonic sensors + IMU; $ca_{79}$ : RBF-PID Control; $A_{50}$ : operation simulation
506	$T_{c69}A_{43}$	$s_{54}$	$ca_{82}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{82}$ : Generalized Resolution Correlative Scan Matching (GRCSM); $A_{43}$ : joint filling
507	$T_{c69}A_{43}$	$s_{54}$	$ca_{82}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{82}$ : Generalized Resolution Correlative Scan Matching (GRCSM); $A_{43}$ : joint filling
508	$T_{c235}A_{50}$	-	$ca_{83}$	-	$ca_{83}$ : finite element method; $ca_{83}$ : finite element method; $A_{50}$ : operation simulation
509	$T_{c146}A_5$	$s_{84}$	$ca_{85}$	-	$s_{84}$ : GPS + lidar + camera + angle sensors + distance sensors + force sensor + depth sensor + radar, ultrasonic sensors + IMU; $ca_{85}$ : iterative learning control + fuzzy logic controller; $A_5$ : earthmoving construction

510	$Tc_{146}A_5$	$s_{84}$	$ca_{85}$	-	$s_{84}$ : GPS + lidar + camera + angle sensors + distance sensors + force sensor + depth sensor + radar, ultrasonic sensors + IMU; $ca_{85}$ : iterative learning control + fuzzy logic controller; $A_5$ : earthmoving construction
511	$Tc_{86}A_{16}$	-	$ca_{86}$	-	$ca_{86}$ : master-slave system; $A_{16}$ : concrete printing
512	$Tc_{87}A_{10}$	$s_6$	$ca_{89}$	-	$s_6$ : torque/force sensor + force sensor; $ca_{89}$ : trajectory generation algorithm; $A_{10}$ : glass installation
513	$Tb_3A_{22}$	-	$bm_3$	-	$bm_3$ : efficiency; $A_{22}$ : masonry construction
514	$Tm_{87}A_{42}$	$a_2$	$bd_{61}$	$bc_1$	$a_2$ : hydraulic; $bd_{61}$ : excavator arm + double front; $bc_1$ : remote + operator; $A_{42}$ : disaster restoration
515	$Tm_{86}A_{42}$	-	$bd_3$	$bc_1$	$bd_3$ : crawler; $bc_1$ : remote + operator; $A_{42}$ : disaster restoration
516	$Tm_{135}A_6$	$a_1$	$bd_{15}$	$bc_2$	$a_1$ : pneumatic; $bd_{15}$ : wheel mobile lifting single arm; $bc_2$ : automatic; $A_6$ : building inspection
517	$Tm_{69}A_{60}$	$a_2$	$bd_{76}$	$bc_2$	$a_2$ : hydraulic; $bd_{76}$ : scissor lifter + omnidirectional wheels; $bc_2$ : automatic; $A_{60}$ : drilling
518	$Tm_{101}A_{45}$	$a_3$	$bd_{38}$	$bc_2$	$a_3$ : motor; $bd_{38}$ : reconfigurable + vertical + climbing; $bc_2$ : automatic; $A_{45}$ : cleaning
519	$Tm_{100}A_{45}$	$a_3$	$bd_{39}$	$bc_2$	$a_3$ : motor; $bd_{39}$ : reconfigurable + locomotive wheel; $bc_2$ : automatic; $A_{45}$ : cleaning
520	$Tm_{103}A_{45}$	$a_3$	$bd_{40}$	$bc_2$	$a_3$ : motor; $bd_{40}$ : caterpillar wheel + commercial impeller, + vacuum suction; $bc_2$ : automatic; $A_{45}$ : cleaning
521	$Tm_{102}A_{45}$	$a_3$	$bd_{41}$	$bc_2$	$a_3$ : motor; $bd_{41}$ : parallel manipulator, frame; $bc_2$ : automatic; $A_{45}$ : cleaning
522	$Tm_{79}A_{38}$	$a_3$	$bd_{79}$	$bc_2$	$a_3$ : motor; $bd_{79}$ : omnidirectional wheel; $bc_2$ : automatic; $A_{38}$ : marking
523	$Tm_{79}A_{38}$	$a_3$	$bd_{79}$	$bc_2$	$a_3$ : motor; $bd_{79}$ : omnidirectional wheel; $bc_2$ : automatic; $A_{38}$ : marking
524	$Tm_{134}A_6$	$a_3$	$bd_{13}$	$bc_2$	$a_3$ : motor; $bd_{13}$ : mobile platform + arm, manipulator; $bc_2$ : automatic; $A_6$ : building inspection
525	$Tm_{48}A_{22}$	$a_3$	$bd_{36}$	$bc_2$	$a_3$ : motor; $bd_{36}$ : mobile arm, manipulator with wheels; $bc_2$ : automatic; $A_{22}$ : masonry construction
526	$Tm_{17}A_{11}$	$a_6$	$bd_{28}$	$bc_2$	$a_6$ : cable driven; $bd_{28}$ : Hexapod-Shaped; $bc_2$ : automatic; $A_{11}$ : wall construction
527	$Tm_{16}A_{22}$	$a_6$	$bd_{25}$	$bc_2$	$a_6$ : cable driven; $bd_{25}$ : parallel robot; $bc_2$ : automatic; $A_{22}$ : masonry construction
528	$Tm_{46}A_6$	-	$bd_{58}$	$bc_2$	$bd_{58}$ : UAV; $bc_2$ : automatic; $A_6$ : building inspection
529	$Tm_{51}A_{22}$	-	$bd_{30}$	$bc_2$	$bd_{30}$ : industrial robot; $bc_2$ : automatic; $A_{22}$ : masonry construction
530	$Tm_{14}A_{44}$	-	$bd_7$	$bc_2$	$bd_7$ : gantry robot, arm; $bc_2$ : automatic; $A_{44}$ : panel installation
531	$Tm_{77}A_{37}$	-	$bd_2$	$bc_2$	$bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_{37}$ : timer construction
532	$Tm_{77}A_{37}$	-	$bd_2$	$bc_2$	$bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_{37}$ : timer construction
533	$Tm_{77}A_{41}$	-	$bd_2$	$bc_2$	$bd_2$ : arm, manipulator + mounted; $bc_2$ : automatic; $A_{41}$ : waste collection
534	$Tm_{28}A_{30}$	-	-	$bc_2$	$bc_2$ : automatic; $A_{30}$ : Mars/Lunar construction
535	$Tm_{21}A_{13}$	-	$bd_{31}$	$bc_3$	$bd_{31}$ : UGV + UAV; $bc_3$ : human-robot + collaboration; $A_{13}$ : construction monitoring

536	$T_{c208}A_{59}$	$s_{54}$	$ca_{110}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{110}$ : Iterative Closest Point (ICP) algorithm; $A_{59}$ : object recognition
537	$T_{c213}A_6$	$s_{79}$	$ca_{110}$	-	$s_{79}$ : lidar + camera; $ca_{110}$ : Iterative Closest Point (ICP) algorithm; $A_6$ : building inspection
538	$T_{c101}A_{32}$	$s_{144}$	$ca_{118}$	-	$s_{144}$ : camera + angle + lidar + GPS; $ca_{118}$ : SLAM; $A_{32}$ : machinery navigation
539	$T_{c101}A_{45}$	$s_{144}$	$ca_{118}$	-	$s_{144}$ : camera + angle + lidar + GPS; $ca_{118}$ : SLAM; $A_{45}$ : cleaning
540	$T_{c38}A_{46}$	$s_{39}$	$ca_{118}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{118}$ : SLAM; $A_{46}$ : machinery mapping
541	$T_{c123}A_{11}$	$s_{48}$	$ca_{118}$	-	$s_{48}$ : work environment sensors + GPS + IMU + lidar; $ca_{118}$ : SLAM; $A_{11}$ : wall construction
542	$T_{c36}A_{12}$	$s_{79}$	$ca_{118}$	-	$s_{79}$ : lidar + camera; $ca_{118}$ : SLAM; $ca_{118}$ : SLAM; $A_{12}$ : bridge construction
543	$T_{c39}A_{14}$	-	$ca_{118}$	-	$ca_{118}$ : SLAM; $A_{14}$ : equipment positioning
544	$T_{c16}A_{11}$	-	$ca_{32}$	-	$ca_{32}$ : parametric-integrated algorithm + parametric synthesis; $A_{11}$ : wall construction
545	$T_{c46}A_{16}$	$s_{144}$	$ca_{44}$	-	$s_{144}$ : camera + angle + lidar + GPS; $ca_{44}$ : 3D printer/printing; $A_{16}$ : concrete printing
546	$T_{c44}A_{16}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{16}$ : concrete printing
547	$T_{c44}A_{22}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{22}$ : masonry construction
548	$T_{c44}A_{22}$	-	$ca_{44}$	-	$ca_{44}$ : 3D printer control; $A_{22}$ : masonry construction
549	$T_{c33}A_{24}$	-	$ca_{49}$	-	$ca_{49}$ : genetic algorithms (GA); $A_{24}$ : machinery path management
550	$T_{c85}A_{50}$	-	$ca_{50}$	-	$ca_{50}$ : kinematic connection; $A_{50}$ : operation simulation
551	$T_{c129}A_{41}$	$s_{54}$	$ca_{64}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{64}$ : iterative algorithms + regression model; $A_{41}$ : waste collection
552	$T_{c116}A_{34}$	-	$ca_{70}$	-	$ca_{70}$ : PTP control; $A_{34}$ : components assemble
553	$T_{c188}A_{56}$	$s_{139}$	$ca_{73}$	-	$s_{139}$ : stereo camera + acceleration sensors + a gyro sensor; $ca_{73}$ : Machine Learning; $A_{56}$ : remote construction
554	$T_{c188}A_{56}$	$s_{139}$	$ca_{73}$	-	$s_{139}$ : stereo camera + acceleration sensors + a gyro sensor; $ca_{73}$ : Machine Learning; $A_{56}$ : remote construction
555	$T_{c153}A_{50}$	$s_{18}$	$ca_{73}$	-	$s_{18}$ : various sensors + sensor system; $ca_{73}$ : Machine Learning; $A_{50}$ : operation simulation
556	$T_{c32}A_{12}$	$s_{39}$	$ca_{73}$	-	$s_{39}$ : camera + image + CCD + Kinect; $ca_{73}$ : Machine Learning; $A_{12}$ : bridge construction
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561	$T_{c130}A_{41}$	$s_{54}$	$ca_{73}$	-	$s_{54}$ : laser + cameras + Kinect; $ca_{73}$ : Machine Learning; $A_{41}$ : waste collection

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357	Site automation: automated/robotic on-site factories
358	Simulation of automated construction using wire robots
359	Support system for slope shaping based on a teleoperated construction robot
360	Support system for teleoperation of slope shaping by a construction robot

361	A realisation of a construction scale robotic system for 3d printing of complex formwork
362	Smart automation system dedicated to in frastructure and construction
363	Bridge maintenance automation
364	Key challenges in automation of earth-moving machines
365	Design and analysis of climbing robot based on construction surface inspection
366	Prototyping a remotely-controlled machine for concrete surface grinding operations
367	An electro-hydraulic servo controller for construction robot using system-on-chip device
368	Automated construction of masonry buildings using cable- driven parallel robots
369	Study on parts processing of the traditional wooden construction method using articulated robot
370	Local search on trees and a framework for automated construction using multiple identical robots
371	Robotic timber construction - expanding additive fabrication to new dimensions
372	Autonomous construction with compliant building material
373	Automation of modular assembly of structural frames for buildings
374	Applications of supernumerary robotic limbs to construction works: case studies
375	Human-machine interaction for intuitive programming of assembly tasks in construction
376	A cable-driven robot for architectural constructions: a visual-guided approach for motion control and path-planning
377	Automatic interpretation of unordered point cloud data for UAV navigation in construction (navigation)
378	Using local force measurements to guide construction by distributed climbing robots
379	Robotic system for plaster and finishing works on the construction site
380	Development of a remotely controlled semi-underwater heavy carrier robot for unmanned construction works
381	Smcspo based 3d printing simulator control for building construction
382	Development of 3d printing simulator nozzle system using PID control for building construction
383	Automation of robotic concrete printing using feedback control system
384	Classification of building systems for concrete 3d printing
385	Active control for rock grinding works of an underwater construction robot consisting of hydraulic rotary and linear actuators
386	A method based on c-k theory for fast ster development: the case of a drilling robot design

387	Development of the control algorithm for longitudinal motion of underwater construction robot with trenching
388	A stochastic learning approach for construction of brick structures with a ground robot
389	Online learning control of hydraulic excavators based on echo-state networks
390	Beam for the steel fabrication industry robotic systems
391	Model-based development of robotic systems and services in construction robotics
392	Scene understanding for adaptive manipulation in robotized construction work
393	A master-slave control method with gravity compensation for a hydraulic teleoperation construction robot
394	Robotic fabrication of freeform foam structures with quadrilateral and puzzle shaped panels
395	Pyroshield - a hvac fire curtain testing robot
396	Target-focused local workspace modeling for construction automation applications
397	Potential benefits of digital fabrication for complex structures: environmental assessment of a robotically fabricated concrete-wall
398	Development of a wall-climbing platform with modularized wall-cleaning units
399	Autonomous robotic system with tunnel inspection tool positioning
400	Three types of robot builder for the unsupervised construction of mars habitats
401	Robotic mechanical design for brick-laying automation
402	Wall contact by octo-rotor uav with one dof manipulator for bridge inspection
403	Development of a novel post-construction quality assessment robot system
404	Design and construction of an inspection robot for the sewage pipes
405	Autonomous big-scale additive manufacturing using cable-driven robots
406	Ja-wa - a wall construction system using unilateral material application with a mobile robot
407	Industrial robots application in the construction of buildings and structures
408	Towards force-aware robot collectives for on-site construction
409	Construction inspection with unmanned aerial vehicle [bauwerksinspektion mit unbemannten flugsystemen]
410	A novel building post-construction quality assessment robot: design and prototyping
411	Construction techniques used to automatically pass standard box girders through special passenger-line tunnels
412	Bottom-up cognitive analysis of bionic inspection robot for construction site

413	Design of modular re-configurable robotic system for construction and digital fabrication
414	On-site robotic construction assistance for assembly using a-priori knowledge and human-robot collaboration
415	Automated localization of uavs in gps-denied indoor construction environments using fiducial markers
416	Construction equipment collision-free path planning using robotic approach
417	A robotic wearable exoskeleton for construction worker's safety and health
418	Identification of usage scenarios for robotic exoskeletons in the context of the Hong Kong construction industry
419	Mapping and localization module in a mobile robot for insulating building crawl spaces
420	Study on down-cutting ladder trencher of an underwater construction robot for seabed application
421	Slam-driven intelligent autonomous mobile robot navigation for construction applications
422	Building an integrated mobile robotic system for real-time applications in construction
423	Vision-based integrated mobile robotic system for real-time applications in construction
424	Implementation of admittance control on a construction robot using load cells
425	The study on the integrated control system for curtain wall building façade cleaning robot
426	Modular data communication methods for a robotic excavator
427	Large-scale 3d printing by a team of mobile robots
428	Map - a mobile agile printer robot for on-site construction
429	Active control strategy for trenching work of track-based underwater construction robot
430	The autonomous vehicle celina as educational platform on final works in computer science
431	Real-time simulation of construction workers using combined human body and hand tracking for robotic construction worker system
432	Multimodal trip hazard affordance detection on construction sites
433	Stacked hourglass networks for markerless pose estimation of articulated construction robots
434	Industrial robot control with object recognition based on deep learning
435	Automated defect classification in sewer closed circuit television inspections using deep convolutional neural networks
436	Synthesis of the ac and DC drives fault diagnosis method for the cyber-physical systems of building robots
437	A cyber-physical system of diagnosing electric drives of building robots
438	Concept studies of automated construction using cable-driven parallel robots



439	Design of robot based work progress monitoring system for the building construction site
440	BIM plus robot creates a new era of building construction
441	UAV-enabled site-to-BIM automation: aerial robotic- and computer vision-based development of as-built/as-is BIMs and quality control
442	Perspectives on a BIM-integrated software platform for robotic construction through contour crafting
443	Information modeling of an underground laboratory for the r&d of mining automation and tunnel construction robotics
444	Dynamics modeling and structural analysis of underwater construction robot
445	Workpiece modeling for adaptive robotized construction work
446	Adaptive perception and modeling for robotized construction joint filling
447	Enhancing perceived safety in human-robot collaborative construction using immersive virtual environments
448	Teleoperated construction robot using visual support with drones
449	Foam custom single task construction robot
450	A propulsion performance test of underwater construction robot light work ro-v in circulation water channel
451	Improved productivity, efficiency and cost savings following implementation of drone technology in the surveying industry
452	Framework for human performance analysis in unmanned aircraft system (UAS) operations in dynamic construction environment
453	Floor cleaning robot with reconfigurable mechanism
454	Development of a robot for boiler tube inspection
455	Glass facade cleaning robot with passive suction cups and self-locking trapezoidal lead screw drive
456	Automatic inspection of embankment by crawler-type mobile robot
457	Automatic traveling method for the self-propelled tunnel inspection system
458	Localisation of a mobile robot for bridge bearing inspection
459	Tunnel structural inspection and assessment using an autonomous robotic system
460	Cu-brick cable-driven robot for automated construction of complex brick structures: from simulation to hardware realisation
461	Process analysis of cable-driven parallel robots for automated construction
462	Cable-driven parallel robot for curtain wall modules automatic installation
463	On the improvements of a cable-driven parallel robot for achieving additive manufacturing for construction
464	A changeable jig-less welding cell for subassembly of construction machinery

465	Robotic inspection tests of tunnel lining concrete with crack light-section device on variable guide frame
466	Concrete inspection systems using hammering robot imitating sounds of workers
467	Robotic application of foam concrete onto bare wall elements - analysis, concept and robotic experiments
468	Improvement of the mobile robot location dedicated for habitable house construction by 3d printing
469	Feasibility study for drone-based masonry construction of real-scale structures
470	Planetary lego: designing a construction block from a Regolith derived feedstock for in situ robotic manufacturing
471	Automatic multi-image stitching for concrete bridge inspection by combining point and line features
472	Smart construction robot technology to improve construction and safety in outer walls of high-rise buildings
473	Automation of the execution of monolithic reinforced ceilings
474	A semi-autonomous mobile robot for bridge inspection
475	Construction and usage of three-dimensional data for road structures using terrestrial laser scanning and UAV with photo grammetry
476	Framework for automated registration of UAV and UGV point clouds using local features in images
477	Monocular vision-based parameter estimation for mobile robotic painting
478	Implementation of an augmented reality AR workflow for human robot collaboration in timber prefabrication
479	An occupancy grid mapping enhanced visual slam for real-time locating applications in indoor GPS-denied environments
480	Collaborative welding system using BIM for robotic reprogramming and spatial augmented reality
481	Towards mobile projective AR for construction co-robots
482	Construction of the remote welding system based on power line communication
483	Man-machine cooperation of building robot based on interactive force information
484	3d printing for construction based on a complex wall of polymer-foam and concrete
485	Large-scale digital concrete construction – conprint3d concept for on-site, monolithic 3d-printing
486	Measuring and positioning system design of robotic floor-tiling
487	Tip localization analysis for mobile manipulator in construction field
488	Soft additive fabrication processes: material indeterminacy in 3d printing
489	Vision-based obstacle removal system for autonomous ground vehicles using a robotic arm
490	Computer vision for real-time extrusion quality monitoring and control in robotic construction

491	Real-time scene segmentation using a light deep neural network architecture for autonomous robot navigation on construction sites
492	Lnsnet: lightweight navigable space segmentation for autonomous robots on construction sites
493	Vision-based estimation of excavator manipulator pose for automated grading control
494	A vision-based marker-less pose estimation system for articulated construction robots
495	Analytical design of an underwater construction robot on the slope with an up-cutting mode operation of a cutter bar
496	Automated brick pattern generator for robotic assembly using machine learning and images
497	Teaching robots to perform construction tasks via learning from demonstration
498	Semantic relation detection between construction entities to support safe human-robot collaboration in construction
499	Formulation of the optimization problem of the cyber-physical diagnosis system configuration level for construction mobile robots
500	Automatic acquisition of point clouds of construction sites and its application in autonomous interior finishing robot
501	Robotic construction & prototyping of a 3d-printed mars surface habitat
502	An automated system for projection of interior construction layouts
503	Game simulation to support construction automation in modular construction using BIM and robotics technology-stage 1
504	Flexible virtual fixtures for human-excavator cooperative system
505	Youwasps: towards autonomous multi-robot mobile deposition for construction
506	Planning and execution for geometrically adaptive BIM-driven robotized construction processes
507	Autonomous motion planning and task execution in geometrically adaptive robotized construction work
508	Dynamic analysis of high precision construction cable-driven parallel robots
509	Development of an earthmoving machinery autonomous excavator development platform
510	Robotic autonomous systems for earthmoving in military applications
511	Determinants of adoption of robotics in precast concrete production for buildings
512	Trajectory adaptation for an impedance controlled cooperative robot according to an operator's force
513	The analysis of factors influencing on efficiency of applying mobile bricklaying robots and tools for such analysis
514	Dual-arm construction robot with remote-control function
515	Efforts to unmanned construction for post-disaster restoration and reconstruction
516	Control of a hyper-redundant robot for quality inspection in additive manufacturing for construction (inspection)

517	A novel holonomic mobile manipulator robot for construction sites
518	Self-reconfigurable façade-cleaning robot equipped with deep-learning-based crack detection based on convolutional neural networks
519	Four-wheel steering and driving mechanism for a reconfigurable floor cleaning robot
520	Design and modelling of a modular window cleaning robot
521	Parallel 2-dof manipulator for wall-cleaning applications
522	Mobile robot for marking free access floors at construction sites
523	Development of automated mobile marking robot system for free access floor
524	Quicabot: quality inspection and assessment robot
525	Labview based brick laying robot
526	Design, modelling and simulation of novel hexapod-shaped passive damping system for coupling cable robot and end effector in curtain wall module installation application
527	Investigation of robot systems in masonry construction [baubetriebliche untersuchung von robotersystemen im mauerwerksbau]
528	Indoor visualization experiments at building construction site using high safety UAV
529	Automatic brick masonry system and its application in on-site construction
530	Towards automated installation of reinforcement using industrial robots
531	Robotic fabrication of nail laminated timber
532	Adaptive automation strategies for robotic prefabrication of parametrized mass timber building components
533	Construction waste recycling robot for nails and screws: computer vision technology and neural network approach
534	In-situ construction method for lunar habitation: Chinese super mason
535	User interfaces for human-robot interaction in field robotics
536	An autonomous robotic platform for automatic extraction of detailed semantic models of buildings
537	Lidar-equipped UAV path planning considering potential locations of defects for bridge inspection
538	An integrated UGV-UAV system for construction site data collection
539	Construction of slam algorithm for window cleaning robot moving along window frame
540	A scene-adaptive descriptor for visual slam-based locating applications in built environments
541	Cooperative aerial-ground multi-robot system for automated construction tasks
542	Automated defect quantification in concrete bridges using robotics and deep learning

543	Development of construction robots using crazyflie
544	Robotic 3d clay printing of prefabricated non-conventional wall components based on a parametric-integrated design
545	Inspecting manufacturing precision of 3d printed concrete parts based on geometric dimensioning and tolerancing
546	Automation in the construction of a 3d-printed concrete wall with the use of a lintel gripper
547	Bricklaying robot moving algorithms at a construction site
548	Additive manufacturing of cantilever - from masonry to concrete 3d printing
549	Generalized task allocation and route planning for robots with multiple depots in indoor building environments
550	The problem of manipulation and angular orientation of gripping devices of construction robots
551	Optimization of grasping efficiency of a robot used for sorting construction and demolition waste
552	Generic design aided robotically facade pick and place in construction site dataset
553	A general approach for automating teleoperated construction machines
554	Direct-visual-operation support system for unmanned construction
555	Robot construction simulation using deep reinforcement learning+b21b4:b22b6b4:b20b4:b24bb4:b20
556	Measurement for cracks at the bottom of bridges based on tethered creeping unmanned aerial vehicle
557	Proximity prediction of mobile objects to prevent contact-driven accidents in co-robotic construction
558	Augmented drawn construction symbols: a method for ad hoc robotic fabrication
559	Teaching robots to perform quasi-repetitive construction tasks through human demonstration
560	Deep learning of grasping detection for a robot used in sorting construction and demolition waste
561	Vision-based robotic system for on-site construction and demolition waste sorting and recycling
562	Structural stay-in-place formwork for robotic in situ fabrication of non-standard concrete structures: a real scale architectural demonstrator
563	Complete coverage path planning using reinforcement learning for Tetromino based cleaning and maintenance robot
564	What lies beneath: material classification for autonomous excavators using proprioceptive force sensing and machine learning
565	Agent based modeling to optimize workflow of robotic steel and concrete 3d printers
566	Combining the robot operating system with building information modeling for robotic applications in construction logistics
567	BIM-based task-level planning for robotic brick assembly through image-based 3d modeling
568	Bond properties of reinforcing bar penetrations in 3d concrete printing

569	Sampling robot for primary circuit pipelines of decommissioned nuclear facilities
570	A comprehensive performance evaluation of different mobile manipulators used as displaceable 3d printers of building elements for the construction industry
571	Determining a numerical efficiency indicator for a mobile bricklaying robot
572	Life cycle cost analysis of the steel pipe pile head cutting robot
573	Controller area network standard for unmanned ground vehicles hydraulic systems in construction applications
574	Flexible and transportable robotic timber construction platform – TIM
575	Automated manufacturing for timber-based panelised wall systems
576	Development of an automatic sorting robot for construction and demolition waste
577	Construction of land base station for UAV maintenance automation
578	Robotic spray coating of self-sensing metakaolin geopolymer for concrete monitoring
579	Automation of the construction process by using a hinged robot with interchangeable nozzles
580	A Planning System for Robot Construction Tasks
581	Development of a survey and inspection robot system for underwater construction works