Informed Guided Rapidly-exploring Random Trees*-Connect for Near-Optimal Path Planning

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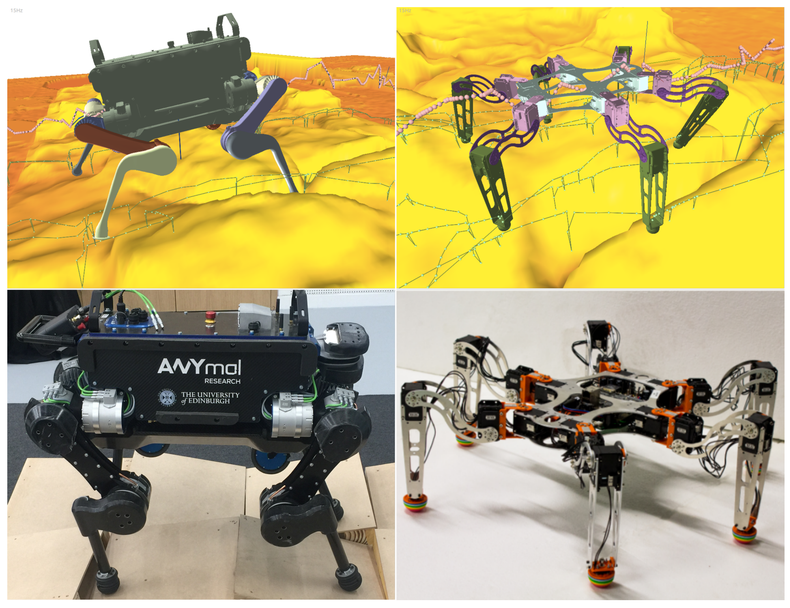
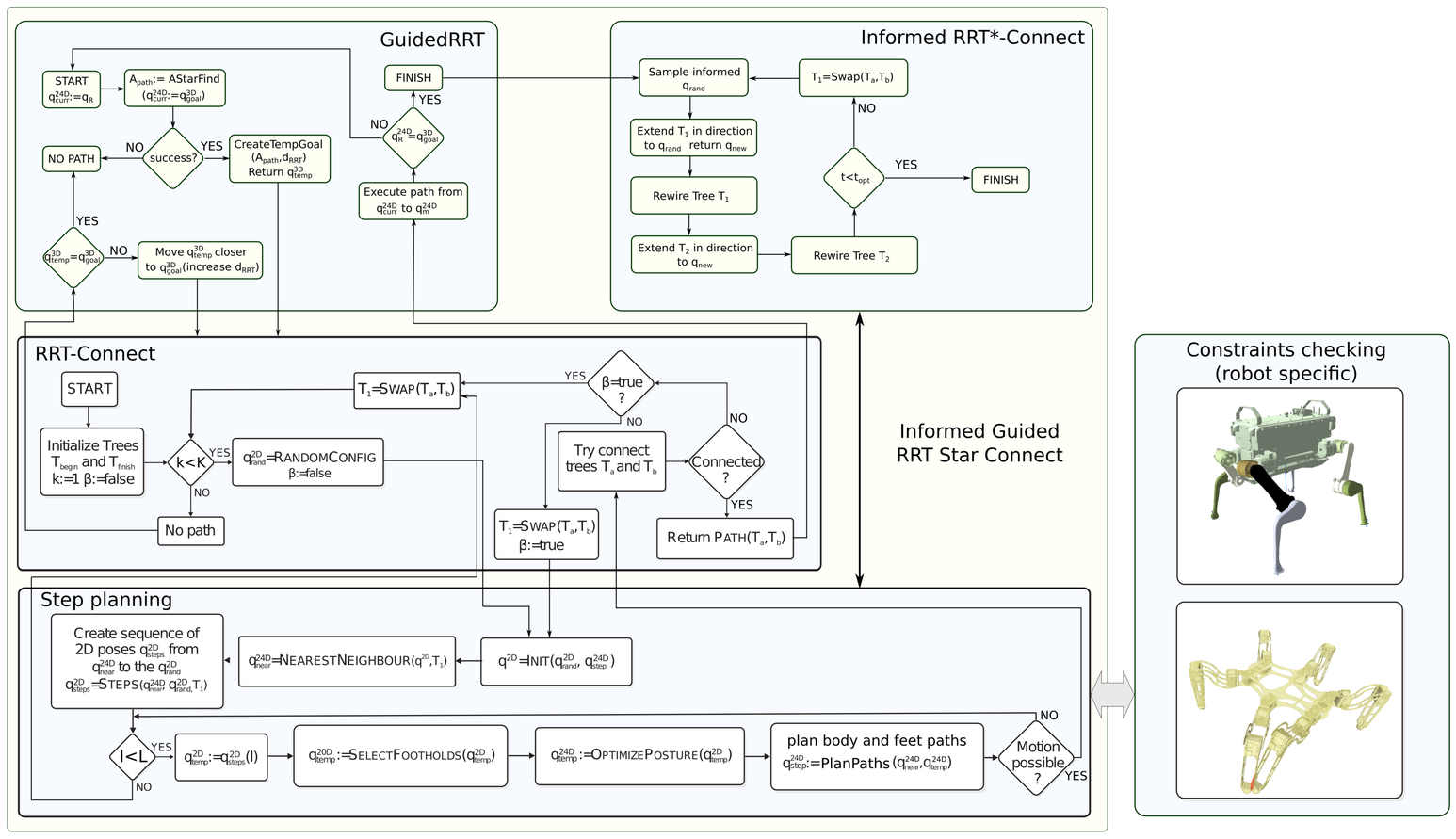
Problem

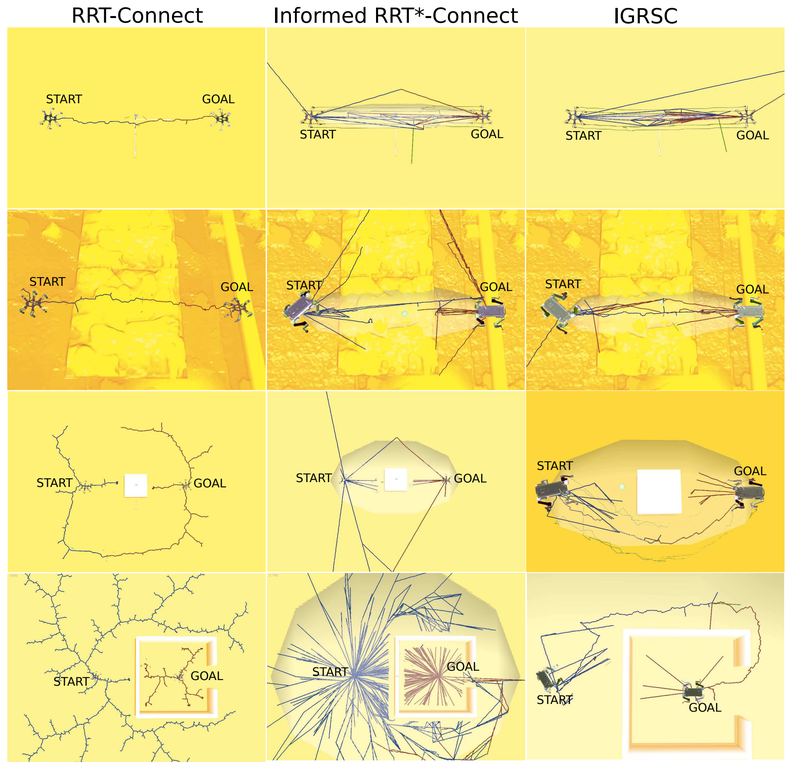


The goal of this research is to plan feasible paths for legged robots walking on irregular terrain, taking into account motion constraints (collisions, static stability, robot workspace) in high-dimensional search space.

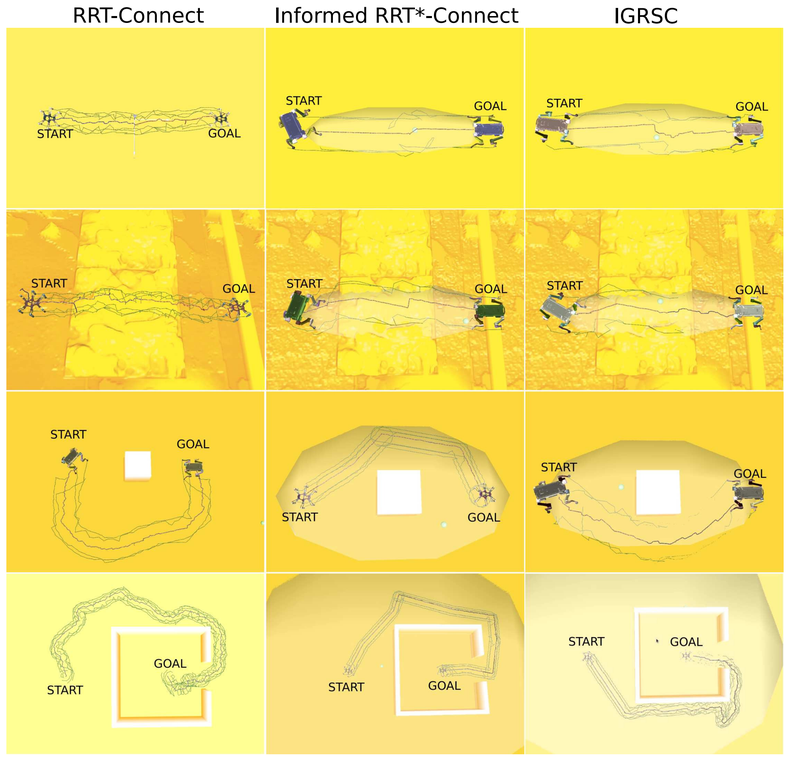
Motion planning concept



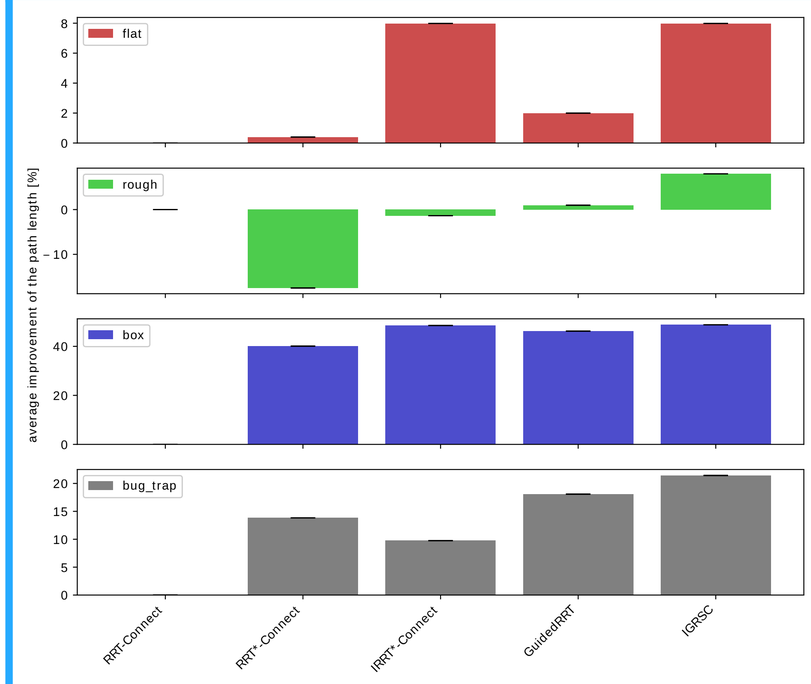
Results – example trees



Results – example paths



Results - path length



Path length improvement compared to the results given by the RRT-Connect.

Results – path planning for the Messor II and ANYmal robots

Success rate (succ), average planning time $\overline{t}_p$ and obtained path length $\overline{p}$ on the Messor II robot. The line splits asymptomatically complete methods and methods that optimize the path during the second stage of planning

	flat					rough terrain					box					bug trap				
	succ	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]	*succ*	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]	*succ*	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]	*succ*	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]
RRT-Connect [1]	1.0	**3.4**	**0.3**	5.01	0.10	1.0	**7.0**	**2.3**	5.14	0.11	1.0	90.5	19.2	10.45	1.79	0.2	443.5	83.9	17.64	1.04
GuidedRRT [4]	1.0	5.3	0.2	4.91	0.08	1.0	8.6	1.5	5.09	0.10	1.0	**7.2**	**2.0**	5.62	0.11	1.0	**110.9**	**160.8**	14.45	0.66
RRT*-Connect [2]	1.0	187.0	3.1	4.99	0.49	1.0	285.8	64.2	6.04	2.20	1.0	194.2	8.2	6.26	0.69	0.9	422.4	103.3	15.20	0.52
IRRT*-Connect [3]	1.0	**186.2**	**1.2**	**4.61**	**0.01**	1.0	308.79	232.3	5.21	1.60	1.0	188.9	4.7	5.38	0.07	1.0	340.2	100.9	15.92	1.97
IGRSC (our)	1.0	**187.2**	**0.4**	**4.61**	**0.02**	1.0	**196.9**	**9.8**	**4.73**	**0.05**	1.0	**188.0**	**1.2**	**5.35**	**0.12**	1.0	**233.8**	**20.0**	**13.86**	**0.50**

Success rate (succ), average planning time $\overline{t}_p$ and obtained path length $\overline{p}$ on the ANYmal robot.

	flat					rough terrain					box					bug trap				
	succ	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]	*succ*	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]	*succ*	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]	*succ*	$\overline{t}_p$ [s]	σ_t [s]	$\overline{p}$ [m]	σ_p [m]
RRT-Connect [1]	1.0	**3.1**	**0.2**	5.06	0.06	1.0	10.4	13.5	5.34	0.59	1.0	87.4	19.2	10.19	1.65	0.5	478.7	88.0	19.82	1.22
GuidedRRT [4]	1.0	5.6	0.2	5.01	0.09	1.0	**10.8**	**3.1**	5.12	0.20	1.0	**13.9**	**12.0**	5.97	0.31	0.6	**199.6**	**166.1**	16.87	0.51
RRT*-Connect [2]	1.0	240.6	156.9	4.86	0.22	1.0	227.4	68.6	5.32	0.58	0.8	281.3	99.7	6.82	1.20	0.2	606.7	14.0	16.15	0.85
IRRT*-Connect [3]	1.0	199.4	26.5	4.66	0.07	1.0	264.0	91.9	4.79	0.06	1.0	200.2	8.0	6.96	2.47	0.1	500.3	0.0	16.51	0.00
IGRSC (our)	1.0	**187.0**	**0.4**	**4.63**	**0.02**	1.0	**189.8**	**1.7**	**4.74**	**0.05**	1.0	**196.2**	**14.3**	**5.65**	**0.16**	0.6	**321.7**	**63.6**	**16.01**	**1.12**

Acknowledgements

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