Cover letter for the resubmission of the conditionally accepted paper "An efficient acyclic contact planner for multiped robots"

First of all, we would like to thank all the Reviewers and the associate editor (AE) for considering our resubmission. In particular we thank them for the quick response they provided. We are glad to find them satisfied with our modifications, and made our best to answer to the remaining comments as well as possible. In the following lines, we will quote all the remaining comments and answer to explain how exactly we updated the paper to address them.

1 Answers to the associate editor

quote: **The C++/Java-style code listings are unnecessary and do not conform to journal standards. The authors rewrite their pseudocode to use rigorous mathematical notation. Suggest replacing "object.attribute" with "Attribute(object)", and describing the attributes of the objects in the text.**

answer: We rewrote Algorithm 1, 2 and 3 accordingly to the recommendations of the Associate Editor, which we thank for the comment that allowed us to spot a typo in pseudocode. Furthermore, it also allowed us to reduce the length of the pseudocode.

quote: **The URLs in the paper seem rather brittle and are not suitable for archival purposes. Two URLs point to specific branches of various Github repositories, and another refers to the documentation of a Blender tool. The authors should create a static web page for their software which is guaranteed to persist for years to come...**

answer: Thanks for the comment. In fact, the github urls are not pointing to branches, but to release versions of the code, presented as zip files, which make them permanent links. However, we agree with the Associate Editor that regrouping all the data and information on a single web page is relevant. So, we uploaded the source code to the first author website (`http://stevetonneau.fr/files/publications/isrr15/tro_install.html`), and provided all the required information to install the material in it. The user has the choice to download the code either from the github permanent link or directly from the author's website.

quote: **... and to refer to the underlying method used by the Blender tool.**

answer: Regarding the decimate tool from Blender, we proceeded as follows : in the new version of paper, we mention a SIGGRAPH paper as one option to reduce mesh complexity, and mention that equivalent methods are proposed by many 3D authoring tools, such as Blender which we used. Then, in the static web page, we remind this piece of information and provide a permanent link to the version of Blender we used, along with the documentation that explains how to use the decimate tool.

added text in paper: *The resulting polytope can contain a very large number of faces. A last step is thus to simplify it using an incremental decimation method[38]. Variations of this method are commonly implemented in most authoring tools. For our experiments we used the Blender decimate tool. Details of its use can be found in the static webpage associated with this paper* `http://stevetonneau.fr/files/publications/isrr15/tro_install.html#decimate`.

2 Answers to Reviewer 1

quote: **First of all, I would like to thank the authors for the significant improvements to the paper. The contributions are much clearer, the algorithms are better described, and I believe that my initial concerns about the paper have been addressed. In particular, I would like to thank the authors for the detailed inline responses.**

answer: We in turn thank the reviewer, who significantly helped us improving the paper with her / his comments.

quote: **It looks like that sentence was not actually removed from the paper (referring to the sentence "optimization-based approaches only converge locally")**

answer: Indeed, the sentence was somehow not removed from our latest version. We apologize for that, and guarantee that this time it was indeed removed!

quote: **The dual reformulation of the LP in (11) in Sect. VI is fine, but is a perfectly standard procedure (that, in fact, many LP solvers will perform internally automatically). It would be sufficient to mention that the dual problem is solved without giving its full formulation. Whether the authors include the formulation is up to them.**

answer: Thanks for the comment. Indeed, using the dual formulation is quite common for LP solvers. However, after computing the dual in our case, it turns out that some of the constraints can be solved trivially, which allows to reduce the dimensionality of the problem, resulting in (11). We experimentally verified that this form is faster to solve with respect to the one from equation (10). For this reason, we believe that equation (11) is worth mentioning, and prefer to leave it, since it was given as an option by the reviewer. Finally, we removed the reference to the Slater's conditions since we agree with the reviewer that the procedure is standard.

removed text from the paper: *Indeed, from Slater's conditions [33], we know that the optimal values of an LP and its dual are equal.*

3 Answers to Reviewer 2

quote: **All the issues I raised in the first review have been addressed in the revised version. I'm satisfied with most of the answers and the changes made to the paper. In particular the novelty of the paper with respect to the conference works is clarified. I appreciate also the new structure of the manuscript that integrates material previously relegated to the Appendices into the main body. Now, this work seems to be self contained enough for a journal.**

answer: Thanks for the comment. We agree with the reviewer that the paper is clearer this way, thanks to her / his comments.

quote: **1. I understand the point of view of the authors who focus on multi-contact planning and would like to refer only briefly to previous work in motion planning for multi-legged, statically-stable robots. In principle that is OK, but I suggest to extend the paragraph added at the end of Section I.A by few sentences that clarify what are the advantages of your motion planning system with respect to these older approaches. You are focusing on humanoids, for which these gains are pretty obvious, but what about multi-legged robots ? As an inspiration I recommend this youtube video showing a simulated hexapod that does something similar to your HyQ simulated example** `https://www.youtube.com/watch?v=Xio1TbjAK8O`

answer: Thanks for the comment. We added the following paragraph in the Section.

added text in paper: *The following state of the art focuses on contributions proposed for humanoid robots, although our method is also demonstrated on quadruped robots such as HyQ, for which related work also exists [6]. With robots using more than two legs for locomotion, different gait modes can be used to cross cluttered environments, allowing them to remain in a cyclic context. In these works collision avoidance is often treated as a height issue (assuming that all the obstacles are on the "ground", and so are the contacts, which prevents from going under a table, or using a wall as contact location for instance). While these approaches are efficient in many cases, we focus on the most generic case, where obstacles are not only on the ground, and cyclic locomotion might not be a solution.*

quote: **While the answer about the environment model is satisfying, I think that you should no only refer to the FCL library in a footnote, but to cite the paper that explains how it works.**

answer: Thanks for the suggestion. The citation has indeed been included, as reference [32]

quote: **In Tab. V you refer to the computation time in units - seconds, minutes and hours. If so, you should be more specific as to the source(s) of the numbers you give in that table. I understand the fact that it is practically impossible to have a fair comparison in that point, and the whole community is working toward changing this situation (as you explain). But you should write explicitly that you took the numbers from the respective papers, or from your re-implementation of the algorithms you consider (I think it is not the case). Well, the papers [8], [17], [18] are quite old, and comparing the computation times achieved on the computers available 10 years ago and nowadays isn't convincing.**

answer: Thanks for the comment. Indeed, we did not reimplement the solutions, so we modified the paper to state explicitely that the times indicated are those found in the original papers. Although we agree that the times do not stand as proofs, we still believe that the order of magnitude of the time computations remains significant, because an algorithm that took hours to compute 10 years ago is unlikely to perform in less than a few seconds on a modern computer, especially since our implementation is single threaded, and does not take any advantages of recent advances such as GPU programming. In any case, the reviewer is right when he says that this section should be clarified. Thus, we removed our over-statement "*Table V presents the computation times for these scenarios, clearly demonstrating that our approach is order of magnitude faster than previous works*" and added the following comment in Section VIII E.

added text in paper: *Table V presents the computation times for these scenarios. Since no implementation of the previous methods is available, we had no choice but to indicate the times directly taken from their corresponding papers. In the case of older contributions such as [8], [17], [18], because of the technological progress, it appears that our results would have*

been more meaningful if the benchmarks were run on a modern computer. However, since the computation times differ of several orders of magnitude, we believe that these results clearly show the computational benefits of our method.

quote: **I found few typos, but I believe that these would be removed in the final editing process. The issues raised above are not essentia to the quality of the contribution, but you can consider addressing these as an attempt to improve the paper.**

answer: Thanks again for the comment. We made a last pass on the paper and indeed found a few remaining typos (negligeable -> negligible, implicitely -> implicitly, Euclidian -> Euclidean, travelled -> traveled, convervative -> conservative). More importantly we believe that we addressed all the remaining comments of the reviewer and hope that this will further improve the paper.