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Welcome Scott B. Nokleby

Details

Role: Author

Paper No. JMR-15-1044 Current Status: Paper rejected Action Required:

Title: An Automatic Switching Approach to Teleoperation of Mobile-Manipulator Systems Using Virtual Fixtures (Research Paper)

Journal: Mechanisms and Robotics Vijay Kumar *(Editor)* Marcia K. O'Malley *(AE)*

Authors

Name	Company	Author Order	Role	Copyright Received
Wrock, Michael	University of Ontario Institute of Technology	1	Lead Author	01 Mar 2015
Nokleby, Scott B.		2	Co-Author	01 Mar 2015

Expand All

Abstract **Paper:** Draft Paper

Author Comments

Reviewer Comments

Reviewer 1:

Paper Profile

Originality	Marginal
Significance	Poor
Scientific relevance	Marginal
Completeness	Marginal
Acknowledgment of the Work of others by References	Marginal
Organization	Acceptable
Clarity of Writing	Acceptable
Clarity of Tables, Graphs, and Illustrations	Acceptable
In your opinion, is the technical treatment plausible and free of technical errors?	Yes
Have you checked the equations?	Yes
Are you aware of prior publication or presentation of this work?	No
Is the work free of commercialism?	Yes
Is the title brief and descriptive?	Yes
Does the abstract clearly indicate objective, scope, and results?	No

Recommendation

This paper is Not Acceptable (Objections noted in comments) . The quality of the paper is Inferior.

This paper describes a controller for a mobile manipulator system (mobile platform and 3-dof arm) using automatic control mode switching and virtual fixtures with the goal of improving ease of use for novice operators.

The discussion in this paper is very high level, with no clear application stated. The background, while well written, is unfocused because it covers the field of teleoperation and virtual fixtures quite broadly, and therefore much of the information included seems irrelevant to the problem at hand. Further, specific details

of related work are not discussed, which is necessary to explain how existing systems are unable to address the problem at hand. Therefore, it is unclear what the contribution is, which parts of the controller are novel, and how the system/controller would be applied in real world use. A much clearer problem statement is required---what application(s) are you targeting, and what are the specific pitfalls of other controllers that you are trying to address? This would also then inform the experiment design.

Some questions and concerns about the setup and experiment design:
- Given the use of the OptiTrack, it seems that the authors are assuming a fully instrumented environment, with easy human access. This is only the case for certain specific applications.
- What does the operator actually see while completing the task? Since there is no camera on the robot, one assumes that the operator is either watching the robot directly or watching a computer screen view of the room, but I don't see this stated anywhere.
- The actual experimental procedure is unclear. Did subjects receive any training? How many times did they complete the task? In 4.4, "The testing methodology consisted of the operator performing one run without using virtual fixtures, followed by a run using the virtual fixtures." suggests that they completed the task once for each control mode. But later "Out of a total of one hundred test runs" contradicts that.
- Description of experiment design indicates that the conditions were always encountered in the same order. For initial experiments: one joystick, then two joysticks. For final experiments: without virtual fixtures, then with virtual fixtures. This introduces order effects which cannot be distinguished from effects of the controlled variable.
- Since the initial experiment compared one joystick with virtual fixtures to two joysticks without virtual fixtures, it is unclear what is the contribution of one vs. two joysticks and with vs. without virtual fixtures to performance changes. Comparing with and without virtual fixtures in the second experiment helps, but a better experiment design would be a 2-by-2 design, with one factor being number of joysticks and one factor being use of virtual fixtures.
- How did the operators know where the "wall" was when the virtual fixtures were off?

Overall, I think that the concept is sound and the ideas are useful, but without proper context it is difficult to determine the relevance of the work and the effectiveness of the implementation.

Reviewer 2:

Paper Profile

Originality	Marginal
Significance	Marginal
Scientific relevance	Marginal
Completeness	Poor
Acknowledgment of the Work of others by References	Marginal
Organization	Acceptable
Clarity of Writing	Good
Clarity of Tables, Graphs, and Illustrations	Acceptable
In your opinion, is the technical treatment plausible and free of technical errors?	Yes
Have you checked the equations?	Yes
Are you aware of prior publication or presentation of this work?	No
Is the work free of commercialism?	Yes
Is the title brief and descriptive?	Yes
Does the abstract clearly indicate objective, scope, and results?	Yes

Recommendation

This paper is Not Acceptable (Revision required; resubmit as Tech. Brief) . The quality of the paper is Inferior.

In this paper, the authors propose a method for commanding a kinematically redundant MMS with a controller that autonomously switches between teleoperation modes and utilizes virtual fixtures for protecting regions of the workspace. The 'automatic switching'

comes from a three state architecture including manipulation and transportation modes. The virtual fixtures are based on elastic forces generated away from forbidden regions. There are some interesting aspects to the research presented in this paper; however, there are some major issues.

Major comments

My main concern about this work is the premise that the alternative to what's proposed is a two joystick system where one controls the base and one controls the manipulator. This seems to be a flawed comparison to me. The tasks being performed are, fundamentally, reliant on 3 DOFs. Therefore, I cannot see why one would need more than a single haptic device. It seems that this is a redundant control task, in which it would make much more sense for the user to just control the manipulator's end-effector and have the robot resolve the redundancy automatically. Perhaps the method proposed in this paper is superior to the redundancy controllers, but I feel that that should have been the experimental comparison. Indeed, the authors discuss redundancy resolution in the introduction; but they disregard them based on computational cost and singularities, citing two papers from the 80s. Computers and research have come a long way since them, and I believe that the redundancy resolution required here could quite easily be achieved today without these issues.

In addition to this, my other concern is that the experiments do not seem to validate the research very well and results are inconclusive with regards what is tested. It is unclear why the experiments were divided into two? The tasks seem to be almost exactly the same. The 'off target manipulation mode' does not seem to be used in the experiments. It would seem much more sensible to have one set of experiments which quantifies task time and virtual fixture performance of all of the control states. Moreover, some of the conclusions that are drawn from the results seem dubious. In the last paragraph of page 14 the authors say that the single joystick has a steeper learning curve, I cannot see this in the four sets of results and would need some kind of quantification. Also, implying that limits for the two joystick setup based on a single expert user is not very robust.

Minor comments

Quite a lot of the paper (particularly the introduction) reads quite like a thesis. It means the paper takes quite a lot of effort to read through before any of the real technical detail is found. Much of the early part of the paper could be distilled to focus on the directly relevant technical information. For example, the paragraph on ROS could be much shorter. I think all that's needed is why ROS was selected.

The authors review a good number of papers for the redundancy resolution, but they only (self) cite one paper regarding virtual fixtures. This should be expanded and some of the pertinent work (particularly the founding paper) should be cited.

Even as someone familiar with them, the example of virtual fixtures on page three is not very easy to follow.

References are needed for the second paragraph on page three.

Page 3. I do not agree that impedance and admittance devices can perform the 'same task with equal functionality' under the given assumptions. For this to be possible, the impedance device would essentially need infinite/very high stiffness, not just high force.

Page 7, last line, section 3.2 should be 3.3.

Page 8, first paragraph. The authors seem to be misusing the work 'backdrivable'. Perhaps they mean something like bilateral?

I would not really class the joystick centering forces as part of the virtual fixtures, as they are presented in section 3.3.

Section 3.3.2 could use some general equations for the virtual fixture functionality.

I cannot understand the orientation control in equation (4). This equation would seem to fix the base orientation to 0 degrees. Perhaps there is a mistake?

It would be clearer to present the math using vectors, and also to enforce some convention for differentiating between vectors and scalars.

How does the dead band fit into equation (5)?

Is M in equation (6) a force? The math is confusing as M is used as something called 'haptic information' somewhere else.

A finite state diagram would be helpful in describing the control modes in section 3.4.

Perhaps the 'pseudo-transportation mode' could be explained as an independent state rather than as part of the near-target manipulation.

Some comparison of the mean/variance results for single and double joystick control in table 2 would help an overall comparison.

The number of decimal places in table 2 implies a level of accuracy I think the experiments probably did not produce.

It is strange that way that the 'new system' with the Opti-Track is presented, but then not used for the first set of experiments.

Why are the virtual fixture results not presented for the first set of experiments?

It would be interesting to see the virtual fixture penetration variance/depth/time/velocity in table 4.

What effect would increasing the VF thickness have on the performance? Could this overcome the tracking accuracy problems?

Reviewer 3:

Paper Profile

Originality	Marginal
Significance	Poor
Scientific relevance	Poor
Completeness	Poor
Acknowledgment of the Work of others by References	Marginal
Organization	Acceptable
Clarity of Writing	Acceptable
Clarity of Tables, Graphs, and Illustrations	Acceptable
In your opinion, is the technical treatment plausible and free of technical errors?	No
Have you checked the equations?	Yes
Are you aware of prior publication or presentation of this work?	No
Is the work free of commercialism?	Yes
Is the title brief and descriptive?	Yes
Does the abstract clearly indicate objective, scope, and results?	Yes

Recommendation

This paper is Not Acceptable (Revision and resubmittal required) . The quality of the paper is Inferior.

This paper does a nice job with introduction and motivation. The primary limitation of this work is that the results are not particularly compelling (learning curves for one hand vs. two, trajectories with and without virtual fixtures, etc.), nor is it clear how they extend to other platforms, control architectures, or tasks. It is not clear to what extent the choice of low-cost & simple hardware may have introduced artifacts affecting the sort of psycho-physical questions that the paper apparently aims to explore. I also find the inclusion of the "first round" test data cumbersome. Is there anything critical to learn here other than to motivate the "second round" revisions? If so, it needs to be stated clearly. Otherwise, I suggest omitting it, cleaning up the methods, results, etc.

Minor corrections I would suggest, by page number:
2: A square Jacobian is no guarantee of invertibility;
"leading to lowered manipulability" phrase should be definitive and direct;
Claims regarding the relative accuracy, power use, and speed of base vs. arm should be clearly tied to this particular implementation. If the claim is meant to apply broadly, provide evidence or citation(s)
3: Citations needed in the paragraphs dealing with virtual fixtures;
Examples of ruler and card swipe may be interpreted as same – both may seem to serve as guidance fixtures;
The sentence, "Being a two-way…" does not reflect a clear understanding of impedence vs. admittance designs;
7: The language in the main paragraph is confusing. Is the point not simply that the best choice of body-centric vs. world coordinates depends on whether the user is viewing the platform from a stationary or mounted viewpoint?
9: The choice of essentially equivalent stimuli for workspace and forbidden region boundaries seems likely to confuse user;
The friction "on" mode, as implemented here seems odd. Explain why you choose to attempt infinite friction;
Similarly, why are the virtual walls dictated by the local coordinates driving the manipulator, and world coordinates otherwise? In general these will thus be mis-aligned.
10: Eliminating "however" from, "force is felt, however additional…" seems to correctly capture what you are trying to say
11: Apparent contradiction: (7) defines a velocity control, you say the force centers the joystick not the arm, yet you also say that the wall repulsive force has the same direction as the centering force, which would not be true in general.
12: "Two of these shortcomings [are]…"
13: No units in Table 2

Associate Editor Recommendation

Review of your paper, JMR-15-1044 (Research Paper), An Automatic Switching Approach to Teleoperation of Mobile-Manipulator Systems Using Virtual Fixtures, has been completed and my recommendation has been sent to the Editor.

The next step is for the Editor to make a decision. An email from the Editor informing you of this decision will be the next email communication that you receive.

The detailed comments of the reviewers and my recommendation will be available to you through your author account when the Editor makes their decision.

Thank you for submitting your work to the Journal of Mechanisms and Robotics.

View AE Comment file

Editor Comments

Review has been completed on your paper, JMR-15-1044 (Research Paper), An Automatic Switching Approach to Teleoperation of Mobile-Manipulator Systems Using Virtual Fixtures.

Based on the comments received, the evaluation returned, and the recommendation of the Associate Editor, I regret to inform you that your paper has been declined for publication in the Journal of Mechanisms and Robotics. Please see the AE's detailed comments for the rationale for this decision.

Thank you for your interest and efforts in taking the time to submit this material.

⊞ Full Status and Dates

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