Proposal Status | MAIN

Organization: Michigan State University

Review #1

Proposal Number:	0707789
Performing Organization:	Michigan State University
NSF Program:	Applied Mathematics
Principal Investigator:	Zeidan, Vera M
Proposal Title:	Dynamic Optimization: Time Scales and Nonsmooth Analysis
Rating:	Excellent

REVIEW:

What is the intellectual merit of the proposed activity?

The main part of the proposed work centers on developing ({\em launching"}) a new field of optimal control over generalized (closed) time-sets that interpolate between continuous-time and discrete-time systems.

While this reviewer is generally very wary about efforts to ever further generalize existing theories to every abstract setting imaginable, the PI makes a convincing case that the proposed effort is highly meritorious. While the envisioned applications are only sketched in very broad terms, the literature review and the stated objective of better understanding the differences between discrete and continuous time optimal control as special cases of the new theory, swayed this reviewer to the point of being truly intrigued by this endeavor.

The PI is well-known as an expert analyst. The general program of which features need to be addressed and developed appears well-thought out.
While very ambitious, the well-established long track-record of significant contributions by the PI lends credence to this work being doable, and likely leading to major new insights.

The second part of the proposed work focuses on extensions of nonsmooth analysis methods in optimal control.
While familiar with the basic theory, this reviewer does not feel comfortable to judge the merits of the proposed extensions of the theory, but gives the PI the benefit of the doubt (based on past contributions, and good judgment when selecting projects to work on in the past).

What are the broader impacts of the proposed activity?

This work is of a highly theoretical nature and its immediate impact, especially of the second part, will naturally be limited to the (sizeable) community of experts in nonsmooth analysis. However, the first part of the project, on {\em time scales} is bound to bring some fresh wind into the mathematical community, likely encourage many researchers to think out-of-the-box and reconsider past paradigms of which models are most suitable for and demanded by diverse areas of applications.

Still, this reviewer would like to see the PI going more outside her community (graduate classes, conferences in her area, \ldots), and more vigorously try to both bring her theoretical results to applications, and in turn, learn from the more applied scientists about their needs. As abstract as most of the work especially in part II is, when properly disseminated, it likely could have a much larger audience and find broader applications.

Summary Statement

This is a very ambitious proposal.
Initially this reviewer was worried that this highly technical work is mainly about pushing the boundaries of the domains on which classical results apply just a little bit further, into ever more abstract settings.
However, he quickly became enamored by the decidedly fresh wind, and enthusiasm of the PI for launching such an intriguing whole new field! Together with her outstanding record of past contributions, this makes for a very promising project, which may have major impacts.

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Review #2

Proposal Number:	0707789
Performing Organization:	Michigan State University
NSF Program:	Applied Mathematics
Principal Investigator:	Zeidan, Vera M
Proposal Title:	Dynamic Optimization: Time Scales and Nonsmooth Analysis
Rating:	Excellent

REVIEW:

What is the intellectual merit of the proposed activity?

This is an excellent proposal devoted to new topics in applied mathematics, particularly in control theory, infinite-dimensional optimization, and variational analysis involving generalized differentiation. Professor Zeidan is a world well-recognized leading expert in all these areas who has made a number of principal contributions, and now she suggests to develop new ideas in both the variational theory and applications. In my opinion, the intellectual level/merit of the proposed reseach is very high.

What are the broader impacts of the proposed activity?

THe proposed research concerns fundamental areas of applied mathematics whose developements are extremely important for various practical fileds particularly including engineering, robotic, and economics. I am sure that the results and methodology she proposes to develop (and will definitely do it) would be of a broad impact for practical applications. Of course, they are also very important for training of her graduate students and postdoctoral associates.

Summary Statement

I do not hesitate to strongly recommend funding.

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Organization: Michigan State University

Review #3

Proposal Number:	0707789
Performing Organization:	Michigan State University
NSF Program:	Applied Mathematics
Principal Investigator:	Zeidan, Vera M
Proposal Title:	Dynamic Optimization: Time Scales and Nonsmooth Analysis
Rating:	Very Good

REVIEW:

What is the intellectual merit of the proposed activity?

This proposal contains several interesting ideas. The idea of studying variational problems using general "time scales" rather than ordinary time intervals is very good and definitely worth pursuing. The study of generalized Jacobians for maps from infinite-dimensional spaces to infinite-dimensional spaces,
extending a concept proposed by the PI for Lipschitz maps with a finite-dimensional range, is also a promising idea, and the extension
of this to generalized Hessians is badly needed.

This reviewer would like to encourage the PI to be more ambitious and work with even more general time sets, by letting the time set T be an arbitrary totally ordered set, or at least, if T is going to be a subset of the real line, allowing T not to be closed. (One example showingh how this extra generality could be useful is
Sussmann's paper on the "reflected brachistochrone", in Proc. 6th
IFAC NOLCOS Symposium, 2004, Vol. 2, pp.609-704, where he studies an optimal control propblem with a right-hand side that is Holder continuous but not Lipschitz and shows how, for this problem, the "good" choice of time set turns out to be a compact interval
minus one of its interior points.) Similarly, for impulsive
controls, the PI should seek to establish contact with the work
of Bressan and Rampazzo.

What are the broader impacts of the proposed activity?

The search for a general calculus of variations including the discrete-time case as well as the one of continuous time, and using various notions of generalized derivatives, is an endeavor on which there is a lot of activity these days. The PI's work, if successful, should have an impact in the whole field, by clarifying the precise nature of the most abstract formulations needed. For example, it
would clarify what is the correct notion of time set to be used, and which concepts of generalized derivative are likely to lead to good theorems. This should be of help to all other people working on these problems, and ought to have applications to the theory of hybrid systems.

Summary Statement

Zeidan is an excellent mathematician, and she has a solid track record of very serious work on important technical problems. The things she proposes here to do should be done, and the work deserves to be supported.