May 20, 2019

Response to the reviewers report

The following are your comments on our manuscript "A re-examination of the role of friction in the original Social Force Model".

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Referee (1)

The paper deals with the well known Helbing's social force
model for simulating pedestrian dynamics. By means of some
numerical simulations and comparisons with real data, the
author improves the model unveiling, at the same time, the
role of the friction coefficient. The author also shows
that the role of the friction coefficient is basically
the same of that of the relaxation time.

The paper is fine and I think it can be published, provided
some corrections are made. More precisely, I think that the
paper is not well organized and the message is difficult to
follow. I strongly suggest to include Appendix A in the main
text. Section 3 ("Numerical simulations") should be named
somethink like "Setting and parameters". Section 4 ("Results"),
which should be the core of the paper, is by far too long.
Subsection 4.1 ("Hypotheses") is fine but does not contain
"results". Subsection 4.2 contains numerical results, but
they are not new.

Other comments:

1) Section 1: the author could add the reference to two
papers which introduced the SF idea much before Helbing.

[A] S. Okazaki, A study of pedestrian movement in architectural
space, Part 1: pedestrian movement by the application of
magnetic model. Trans. A.I.J. 283, 111{119 (1979).

[B] K. Hirai, K. Tarui, A simulation of the behavior of a
crowd in panic, Proceedings of the 1975 International
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Conference on Cybernetics Society (1975), pp. 409-411.

2) End of page 6: "it is well known that the seminal
version..." A reference should be added.

3) p.10: you cannot refer to $\mathcal A$ and \mathcal K$
like you do. The most important equations of Appendix A must
be introduced here.

4) p.14: Fig.1 is not present.

5) Caption Fig.9: k is k_i or k_w?

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Response to Referee (1):

The following comments are outlined in the same order as appearing in the
reviewer's report.

The reviewer suggests a reorganization of the manuscript in order to improves
the lecture.

Also, the reviewer made other comments.

1) The reviewer cites some research that introduced the SF idea much before
Helbing *et al.*. We included the citations mentioned by the reviewer and the
following comment in the revised manuscript (see the beginning of Section
1).

In the last decades, many microscopic models for crowd dynamics have
been developed. One of the first models was developed by Hirai and
Tarui (1975) introducing the class of force based models [2]. These
models represent the interaction between pedestrians and their
environment using different kinds of forces inspired in physical systems.
For example, Okazaki (1979) modeled the movement the pedestrians
as the motion of a magnetized object within a magnetic field

2) The reviewer points out that we have to include a reference at the end of
page 6. We added the corresponding cite.

3) —

4) The reviewer indicates that Fig.1 is not present. We clarified the fact that the Fig. 1 has a dashed circle that represent the measurement region corresponding to the fundamental diagram measurements.

5) In Fig. 9, κ means κ_i and also κ_w. We replaced κ by $\kappa_i = \kappa_w$ to make the caption more clear.

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Referee (2)

The paper studies the impact of the friction parameter in the
original SFM.

At first I thought this is a work concerned with the calibration
of a parameter in an old model for a special case: corridors.
This sounds very specific and not so overwhelmingly interesting,
right? However, I think this paper contains some nice ideas and
results that are certainly interesting for the community if
written and presented adequately. In my opinion the very best
part of the paper comes in the last 2/3 of the manuscript.
Only here, the paper starts to show interesting analysis and
results, I would describe as original. I think the authors
would be better off focusing more on the content in Appendix A
and B. This nice normalization, is good. from there work with
Eq. (A.3) and go on with the clustering analysis. The analysis
shown in Fig. 6 is also interesting. Here, I wish the authors
could shed more light on the famous boundary effects, so
controversially discussed in the literature.

Here are some specific comments to the text:

1) Reading the introduction, I believe the authors know very good
the works done by Helbing and some of his co-authors, especially
Johansson. Most of the references in the text are citing these two
(Ref. 2 most of all). I believe, it would be good to broaden a
bit the literature review in the introduction to more recent
works as well. At last, during the last 10 years some positive
development in the community could be observed, right?

2) I also suggest to reduce the obvious enthusiasm of the authors
and dispense with the use of superlatives like "a wonderful
summary" or "a seminal work" (repeated many times). By the way,
Ref. 16 is from 2007. A more recent review of empirical data
can be found here doi : 10.1007/978 - 3 - 642 - 27737 - 5_706 - 1"
Empirical Results of Pedestrian and Evacuation Dynamics"

3) The very first paragraph in the paper is not quite accurate in
my opinion. The force social force model ever presented was

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published in K. Hirai and K.Tarui in 1975 (a simulation of the behavior of a crowd in panic, Proc. of the 1975 International Conference on Cybernetics and Society. (1975) 409-411). The model was not called SFM, but it is a force-model that "nicely bridges the socio-psychology with Newtonian dynamics".

4) It is not clear to me why the SFM explains why the faster-is-slower effect happens. It can be produces, yes, but it does not explain why. Please clarify or reformulate.

5) In general the authors write "Helbing and co-workers". I suggest to use the more formal et al. This is also more necessary in the references. There sometimes the authors use all names of the authors and sometimes only the first author followed by et al. Please also check some errors in some names (K\"oster, L\"ohner, . . .)

6) Equations are missing punctuation.

7) Section 3: Why is the length of the corridor L=28m while the width is w=40m. This sounds strange and I'm not sure if it is necessary to have some big values for w.

8) Section 3: Why are the details about the implementation (C++, LAMMPS) necessary? I think unless the authors are intending to open-source their code (which would be nice by the way) there is no need to mention these details. Also the authors mention a LAMMPS built in function calculating the clusters. What is this function?

9) Section 4: Here the authors cite a lot of other works, especially from 2 and 36, but they do not give their own opinion, in regard of the new findings. Again just a reminder Ref 2 is 10 years old. For new findings see Loehner PED 2016 in Hefei.

10) Page 10: vd is the desired speed not the "anxiety level".

11) Page 14: "In our case, pedestrians near the walls are the ones with the lower velocity". Is this a know empirical fact? Why is it so? Maybe the authors could explain more this phenomenon.

12) I think Fig. 4 and 5 can be safely removed and just replaced
with Fig. 6. The normalisation here is nice.

13) The interesting phenomenon the authors show in page 23 was not
well analysed and explained. Why is it for high k pedestrians
stick together more? Intuitively I would think that high k means
high repulsive forces which means that pedestrians stay away
from each other not other way around.

14) In Appendix A the two Parameters in Eq. A.3 are not discussed.
Instead the focus is still on tau and k. How is this good? Why do
you normalize the model, come up with two parameters only then
to continue discussing the parameters in the un-normalized
model?

To summarize, I think this paper can be published. However,
some heavy restructuring and deeper analysis on the points of
interests may be necessary.

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Response to referee (2):

The following comments are outlined in the same order as appearing in the
reviewer's report.

1) —

2) The reviewer suggests to dispense the use of sentences like "a wonderful
summary" or a "seminal work". In order to avoid these ... sentences, we
replaced it by more appropriate words throughout the manuscript.

On the other side, we acknowledged the citation introduced by the reviewer
and we included in the revised manuscript.

3) The reviewer points out that the first paragraph of the manuscript is not
quite accurate. Also, indicates that the Social Force model was introduced

much before Helbing *et al.*.

Section 1.0 (Introduction) has been improved taking into account his (her) comments and, also, the reviewer's **#1** ones (see above).

4) The reviewer asks why we said that the SFM explains the faster is slower effect.

5) The reviewer suggests to chance some sentences, like "and co-workers" by the more formal *et al.*.

We acknowledge this issue and made the corresponding changes in the revised manuscript.

6) —

7) The reviewer wants to know the reasons for the analyzed corridor dimensions.

In order to have a complete analysis of the role of the friction in the simulations, we analyzed a wide range of corridor widths (from 2 m to 40 m).

8) The reviewer asks why we mentioned many details of the implementation despite we do not open source our code.

In order to allows the reader a better inside of the simulation process, we considered important points out many details about it implementation despite we do not open source our code.

Furthermore, the reviewer wants to know about the LAMMPS built in function for computing the clusters.

We included in Section *Simulation software* the name of the LAMMPS built in function and we explained how this function works.

9) —

10) We acknowledge this issue and made the corresponding change in the manuscript.

11) —

12) —

13) The reviewer want to know why as κ-value increases, the more pedestrian's stick together. Apparently, the reviewer misunderstand the meaning of κ.

We are glad to explain this misunderstanding. κ is the coefficient of the friction force and, therefore, is not related with the repulsive force $\mathbf{f}_s$. Thus, as κ increases, the more pedestrian's stick together due the nature of the frictional force. Also, we wants to remark that the friction force is tangential to the center of mass between two pedestrians, while the social force is normal to it.

14) —

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Referee (3)

The authors discussed the role of friction in SFM. The topic is interesting and worthy studying. However, there are issues that should be addressed before processing to a possible publication of this work.

1. Nonstandard reference issues:

(1) Numerical order. For instance, \[10, 12, 8]" (Introduction, page 5, paragraph 1).
(2) The format of References is inconsistent.

2. The format of unit is nonstandard. For instance, \Pm- 2 " (Fig.2) and \p/m 2" (Fig. 3).

3. Numerical simulations, page 8, paragraph 3: The desired velocity for each pedestrian was 1 m/s. Whether the desired velocity has an effect on the result?

4. Clusters, page 22, paragraph 2: In an enhanced friction scenario the individuals find it harder to detach from each other. Then why are possibilities of pedestrian belong to a small cluster and giant cluster almost equal? Why does a bimodal distribution occur in Figs. 9(d)-(f)?

5. Why does not the velocity profile report any relevant difference as the corridor widens, while the fundamental diagram does?

6. Numerical simulations, page 7, last paragraph: Initially, the individuals were randomly distributed along the corridor, and the corridor with periodic boundary conditions. Whether the initial distribute and boundary conditions may have an effect on simulations?

7. English writing should be improved.

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Response to referee (3):

The following comments are outlined in the same order as appearing in the reviewer's report.

1-2) We acknowledge these issues and made the corresponding change in the manuscript.

3) —

4)

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Your consideration of this revised manuscript for publication in *Safety Science* is greatly appreciated. Please find attached the new version.

Sincerely