Using MATLAB to create cheap and accessible virtual laboratories

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Overview

1. Why Laboratories?
2. Obstacles to laboratories
3. Virtual and remote laboratories
4. Designing and using virtual laboratories
5. Conclusions

Why Laboratories?

It is known that authentic learning helps students relate their learning to the real world and therefore improves:

1. Motivation
2. Understanding.

Departments have a duty to provide a good number of relevant laboratories.

Students expect this and indeed complain where they perceive too much delivery has been abstract as opposed to based on real equipment.

Obstacles to laboratory provision

Laboratory activities are expensive to purchase (or build) and maintain.

With many universities using centralised timetabling and pool lecture theatres, timetabling itself of laboratory sessions can be difficult.

1. Two timetabled laboratory sessions a week per cohort is a realistic maximum.
2. Due to kit and space restrictions, students will not be able to attend every session.
3. More regular access requires more space and/or more equipment.

Virtual and remote laboratories

Solutions are needed to remove the timetabling and space restrictions.

Allow students to access laboratories outside of the normal timetable and/or outside the normal rooms.

- Health and safety is a good reason why there is unlikely to be much access allowed to laboratory rooms outside of normal hours (although extended days are sometimes discussed).
- An obvious solution is to allow remote access.
- Virtual laboratories are a half way house; these are pseudo real, but easy to make available 24/7.

Remote laboratories

Not the main topic today, although the author does feel these are a good idea to be pursued.

1. Creating a robust remote access laboratory is not trivial or cost free.
2. If students are expected to do a remote activity, it must be reliable. However, what if it breaks at 5.30pm and hence cannot be attended too until the next day.
3. Technicians cannot monitor a remote laboratory regularly most of the time and thus, failures are not detected quickly.
4. All 200 students usually try to access in the same narrow window.

Strong evidence that remote laboratories are effective, but only if reliable. Students are unforgiving of unavoidable breakages or other access restrictions.

Virtual Laboratories

- Much more reliable than remote access to hardware.
- Easy to make available 24/7.
- Can be relatively cheap to produce and maintain.
- Versatile. One can easily embed numerous different learning outcomes and activities.
- Etc.

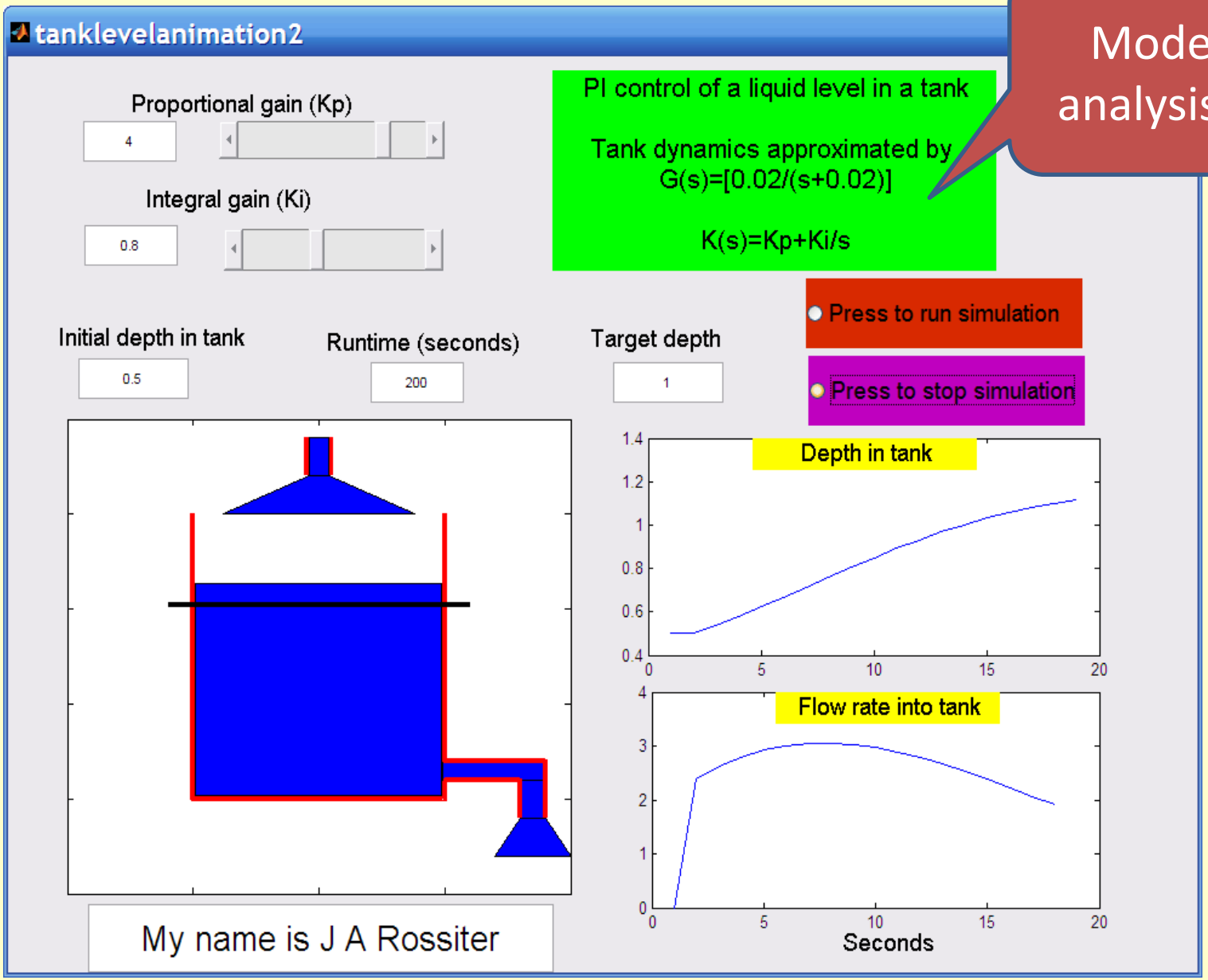
NOT a replacement for access to real hardware, but can play a significant role in the learning process (e.g. see Tri-lab concept)

MATLAB for virtual laboratories

- Many authors have created excellent virtual laboratories available on the internet.
- Coding behind these requires substantial expertise and time, something most academics will not have.
- This paper looks at a proposal which enables ordinary academics to do something quick, simple but effective without the need for web expertise.
- There is an assumption that students have good access to MATLAB, which is the case in most UK universities.
- Use animation effects to make more realistic.

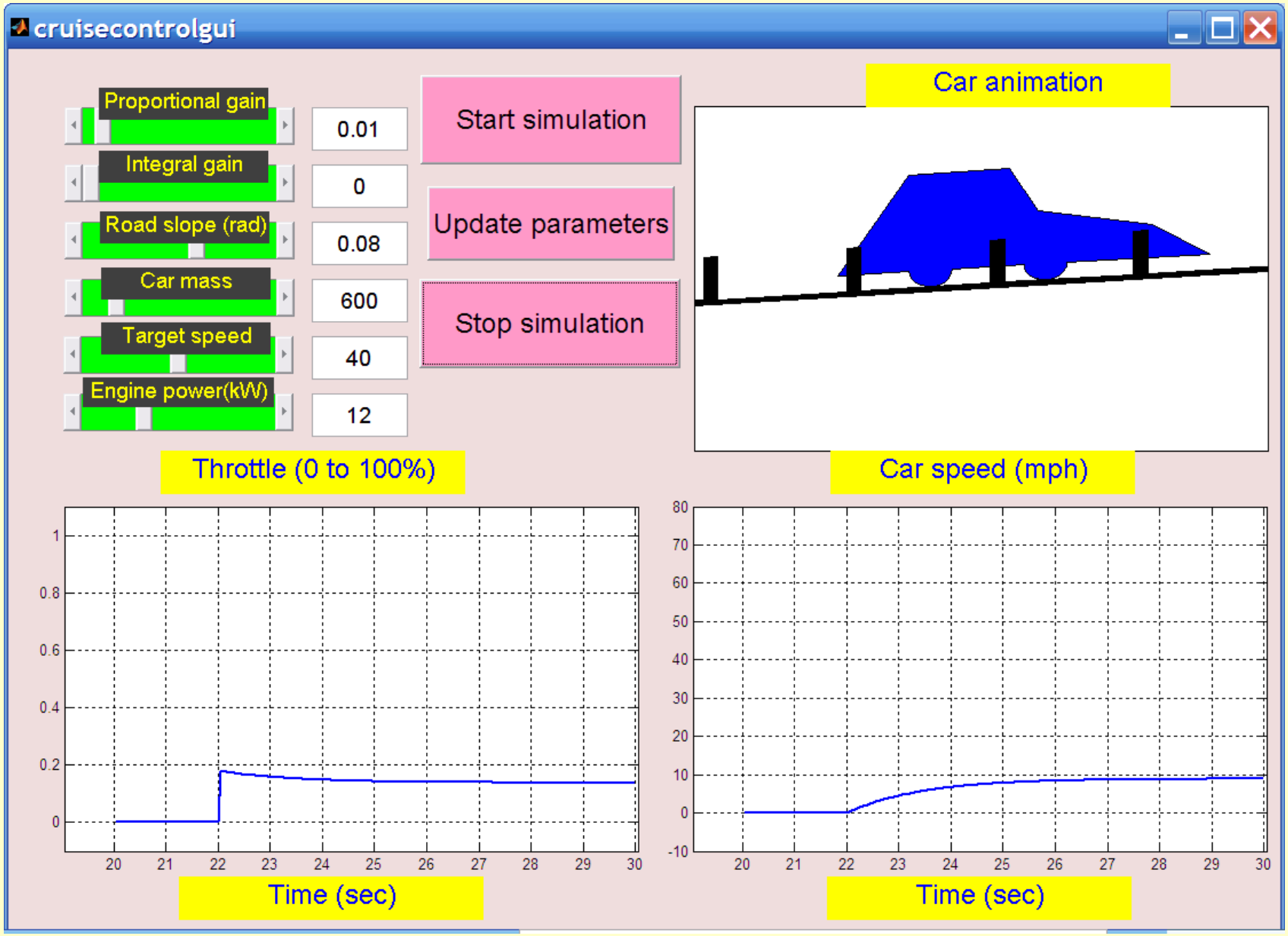
EXAMPLES OF SOME MATLAB VIRTUAL LABORATORIES

Tank level control

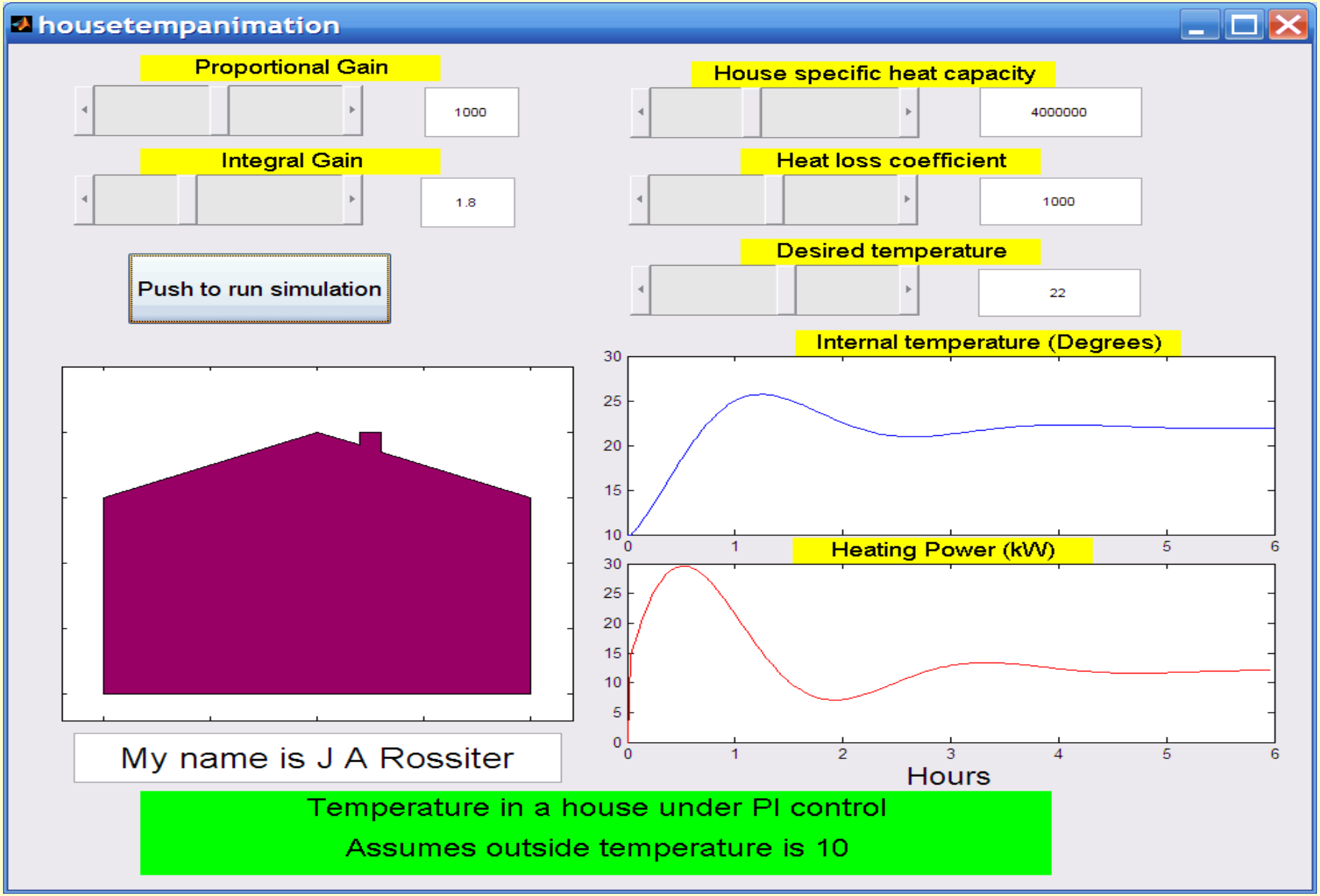


Modelling and analysis required.

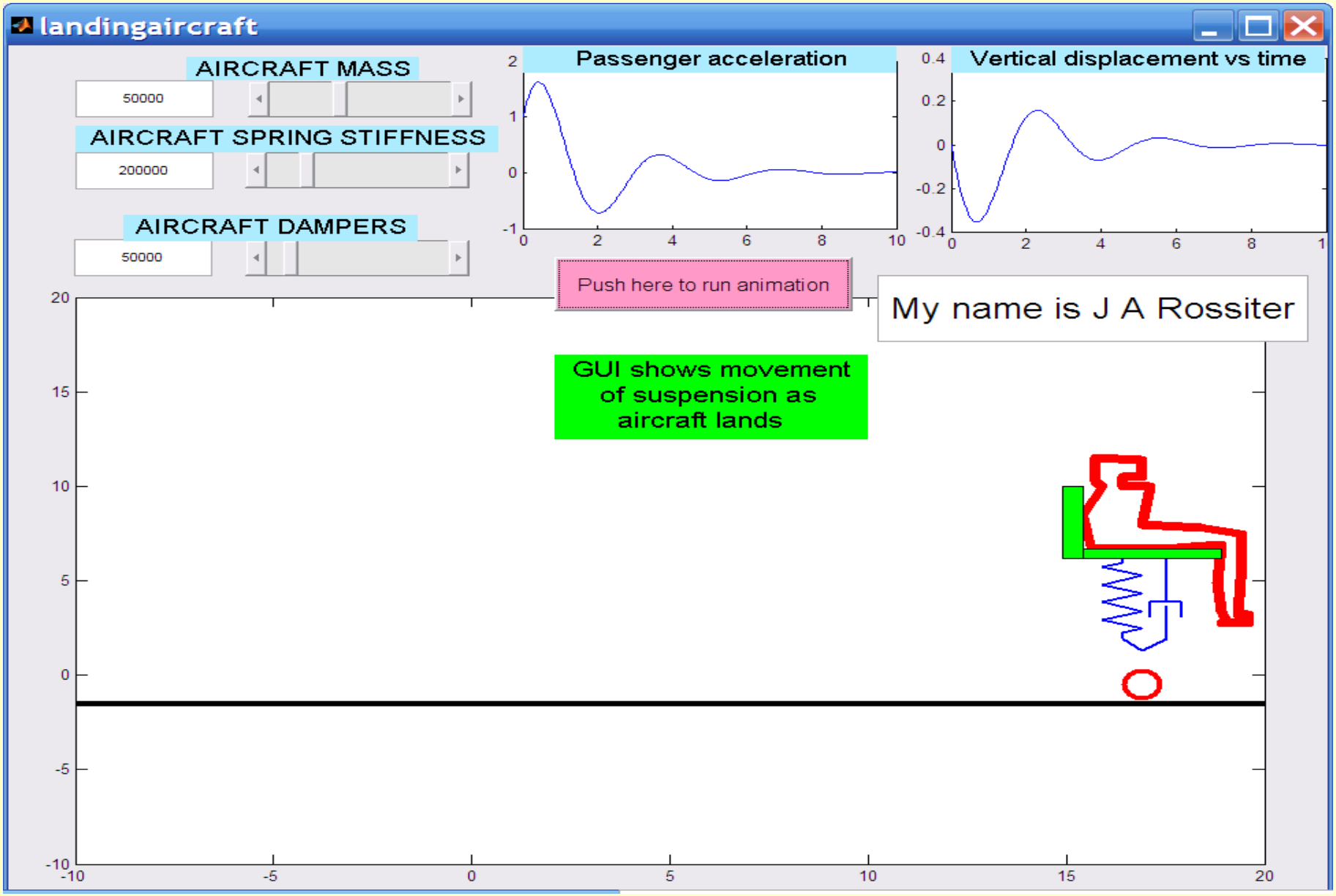
Cruise control and uncertainty



Temperature control



Suspension systems



Building MATLAB GUIs

- Environment is intuitive.
- Add an icon (e.g. a slider) and MATLAB creates a subfunction which operates whenever this icon is selected.
- Decide on learning outcomes and therefore student choices.
- Decide on figures required.
- Add animations to give a pseudo real effect.

If environment at conference venue allows, an example will be given next.

Conclusions

Students learn by doing by access to ‘doing’ activities in the laboratory is severely limited in practice.

Modern technology enables ordinary unskilled academics to create meaningful doing activities which therefore aid student understanding and help them relate their learning to real problems.

Not a substitute for real laboratories; we recommend using with the Tri-lab concept or similar.

Thank you and questions