### MSc Independent Engineering Scholarship (IES) Proposal

**Personal Details**

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| --- | --- | --- |
| 1 | Family Name | Durbridge |
| 2 | Other Names | Simon |
| 3 | Email Address (University) | s.durbridge1@unimail.derby.ac.uk |
| 4 | Award Title | MSc Audio engineering |
| 5 | Proposed Supervisor | Dr. Adam Hill |
| **NOTES:** You can paste material into this form if you wish and expand the sections but the proposal must not exceed 8 pages in length overall, excluding the risk assessment record and the ethics form attached at the end of this proposal. All sections of the risk assessment and ethics form should be completed. | | |

**Dissertation Proposal**

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| --- | --- |
| 6 | **Proposed Title**  The Application of Time Domain Acoustical Modelling Methods for Very Large Problems |

**What is the rationale for the proposed IES?**

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| --- | --- | --- |
| 7 | **Background**  The use of acoustic modelling has expanded from theatre and concert hall design using scale models, through to large format loudspeaker system deployment, environmental noise studies and virtual reality auralization using innovative software. With this expansion in use case, the breadth and depth of available tools for acoustic modelling has also expanded.  Though acoustic modelling may often be applied to identify the characteristics of relatively large spaces such as lecture theatres and churches, many of the methods based on elastic wave physics are inherently more suited to modelling small scale problems in fine detail e.g. modelling the scattering characteristic of plane waves reflecting off an unpainted brick wall, or modelling the dispersion characteristics of loudspeakers at different frequencies.  Modelling methods used to analyse the acoustics of large spaces can produce relatively fast results of reasonable accuracy, and have in some cases been developed to approximate complex and nontrivial behaviour such as scattering effects and frequency dependent absorption. However, these methods are often inherently limited as they rely on simplifications and assumptions based on ray physics.  The application of appropriately suited elastic wave based acoustic modelling methods may | |
| 8 | | **Aims**  To implement time domain acoustic modelling methods to very large problems |
| 9 | | **Objectives**   * To implement a pseudo-spectral time domain method engine for 2D * To implement a locally sparse finite difference time domain method for 2D * To implement a generic second order finite difference time domain method for 2D * To develop a method for indexing large data sets into smaller sets * To benchmark both ‘fast’ methods against the generic method for a simple test problem |
| 10 | | **Plan of work**   * Develop a series of matlab ‘kernel’ functions for fdtd, sfdtd and pstd simulation * Prove that the results from these kernels is accurate when implemented on a large simulation, by comparing with results of other calculations for the same domain * Develop surrounding code to perform simulations using these kernels * Improve the performance of these kernels with the appropriate code profiling and parallelisation tools * Evaluate performance of the algorithms and suggest areas for improvement, relating to performance speed, with a focus on getting closer to real time simulation |

**Constraints that may restrict the success of the work**

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| 11 | **Foreseeable constraints**  None |

**Identifiable risks to the successful completion of the work**

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| --- | --- |
| 12 | **Foreseeable risks**  None |

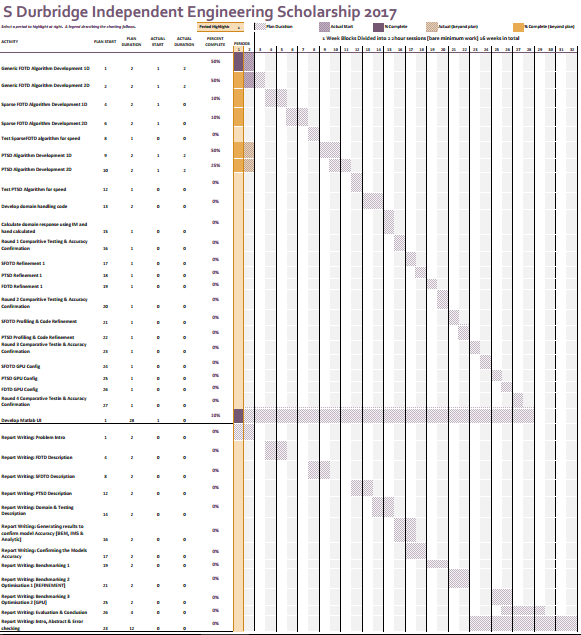
**Resources you envisage utilising to help complete the work**

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| --- | --- |
| 13 | **Textbooks**  S. Bilbao Books  Master Handbook of Acoustics |
| 14 | **Journals**  Journal of the AES  JASA |
| 15 | **Electronic (internet)**  AES Library  ASA Library |
| 16 | **Laboratory equipment and software**  Computer running MATLAB with:  Code Profiler  DSP System Toolbox  Signal Processing Toolbox  Parallel Computing Toolbox  Image Processing Toolbox  Statistics & Machine Learning Toolbox |

**Anticipated cost**

|  |  |  |
| --- | --- | --- |
| 17 | **Please enter all costs. Brief Description or explanation.** (£150 maximum) | Cost (£) |
| NVidia GeForce GTX 1060 graphics card – Nvidia graphics card [with large number of CUDA cores](https://developer.nvidia.com/cuda-gpus). [The Matlab Parallel Computing Toolbox has inherent CUDA support](https://uk.mathworks.com/discovery/matlab-gpu.html), allowing for improvement of data processing speed via GPU parallelism with minimal code adaptation.  Mathworks Matlab & Simulink Student Software Maintainance Resubscription with parallel computing toolbox and Audio Systems Toolbox | 83.00  67.00 |

**Gantt chart**



Please find Gantt chart in supporting documentation. The chart is split into 16 weeks with 2 sessions per week, to represent the absolute minimum work time required per task (single blocks of between 2 and 4 hours).

**Record of Risk Assessment**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Assessment Reference | | | | | SDIES\_01 | | | | | | |
|  | | | | |  | | | | | | |  | | |
| Activity assessed | | | | | | The Application of Time Domain Acoustical Modelling Methods for Very Large Problems | | | | | | | | | | | | | |
| Persons who may be affected by the activity | | | | | | **Software Author** | | | | | | | | | | | | | |
|  | | | | | | | | |  |  |  | | | | | | | | | |
| SECTION A : Initial Assessment Overview | | | | | | | | |
| *Consider the activity or work area and identify if any of the hazards listed below are significant.* | | | | | | | | | | | | | | | | | | | |
| 1 | Fall of person |  | 7 | Machinery | |  | 13 | Electricity | | | | |  | 19 | Substances |  | 25 | Drowning |  |
| 2 | Fall of objects |  | 8 | Tools/Equipment | |  | 14 | Noise or Vibration | | | | |  | 20 | High Pressure |  | 26 | Psychological effects |  |
| 3 | Tripping/Slipping |  | 9 | Mobile work equipment | |  | 15 | Hot / Cold Surfaces | | | | |  | 21 | Fire/ explosion |  | 27 | Human error |  |
| 4 | Manual handling operations |  | 10 | Mechanical lifting equipment | |  | 16 | Workstation –  layout / space | | | | | X | 22 | Lighting |  | 28 | Violence |  |
| 5 | Repetitive work | **X** | 11 | Display screen equipment | | X | 17 | Radiation | | | | |  | 23 | Confined space |  | 29 | Peripatetic / lone working |  |
| 6 | Housekeeping / waste material |  | 12 | Sharp objects | |  | 18 | Temperature / weather | | | | |  | 24 | Buildings & glazing |  | 30 | Other(s) |  |

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|  | | | | | | |  | |  | | |  | | | | |
| SECTION B : Second Stage Assessment | | | | | |  | | | |  | | | [S = Severity](file:///C:\Users\sedur\Documents\GitHub\IndiEngiSchola\Risk%20Evaluation%20matrix.doc) | | | | | |
| *For each hazard identified in Section A complete Section B* [*L = Likelihood*](file:///C:\Users\sedur\Documents\GitHub\IndiEngiSchola\Risk%20Evaluation%20matrix.doc) | | | | | | | | | | | | | | | | |
| Hazard  No. | Hazard  Description | | | | EXISTING CONTROL MEASURES | | | | | | | | | | S | L | | RESIDUAL RISK | |
| **11** | **Prolonged exposure to computer screen** | | | | **Periodic break away from computer** | | | | | | | | | | **1** | **2** | | **Tolerable Risk** | |
| **5** | **RSI Through keyboard and mouse use** | | | | **Periodic break away from computer, with appropriate ancillary/rehab exercises** | | | | | | | | | | **1** | **2** | | **Tolerable Risk** | |
| **16** | **Damage to computer equipment through excess mess and dust** | | | | **Use waste paper/plastic bin, and regularly de-dust computer components** | | | | | | | | | | **1** | **1** | | **Trivial risk** | |
| No. of Section B Continuation sheets used: | | | | | | | | | | | | | | | | | |  | |
| Assessor(s) | | Dr. Adam Hill | | | | | | | | | Signed | | | S Durbridge | | | | | |
| Date of Assessment | | | **6/02/2017** | Revision No. | | | | **1** | | |

**Request for ethical approval for students on taught programmes**

**Please complete this form and return it to your supervisor as advised in your module handbook. Feedback on your application will be via your supervisor or co-ordinator.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Name:** | **Simon Durbride** | | |
| **Student ID:** | **100242305** | | |
| **Unimail address:** | [s.durbridge1@unimail.derby.ac.uk](mailto:s.durbridge1@unimail.derby.ac.uk) | | |
| **Other contact information** |  | | |
| **Programme name and code** | **MSc Audio Engineering (MH6AB)** | | |
| **Module name and code** | **Independent Engineering Scholarship (7EJ998)** | | |
| **Name of supervisor** | **Dr. Adam Hill** | | |
| **Name of co-ordinator** | **Dr. Ahmad Kharaz** | | |
| **Title of proposed research study:** | | | |
| **The Application of Time Domain Acoustical Modelling Methods for Very Large Problems** | | | |
| **Supervisor Comments** | | | |
| Are the ethical implications of the proposed research adequately described in this application? | | | Yes ⌧ No ❑ |
| Does the overall study have low, moderate or high risk in terms of ethical implications? | | | Low ⌧ Moderate ❑ High ❑ |
| Does the study method describe a process of research that is ethically sound? | | | Yes ⌧ No ❑ |
| **Signatures** | | | |
| **The information supplied is, to the best of my knowledge and belief, accurate. I clearly understand my obligations and the rights of the participants. I agree to act at all times in accordance with University of Derby Policy and Code of Practice on Research Ethics:** http://www.derby.ac.uk/research/ethics-and-governance/research-ethics-and-governance | | | |
| **Signature of applicant** | | **Simon Durbridge** | |
| Date of submission by applicant | | 09/06/2017 | |
| **Signature of supervisor** | |  | |
| Date of signature by supervisor | |  | |
| For Committee Use Reference Number (Subject area initials/year/ID number)………………….  Date received……………… Date approved ……………. Signed………………………  Comments | | | |

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| --- |
| 1. **What is the aim of your study? What are the objectives for your study?**  * The aim of this study is to explore the application of time domain based numerical methods for solving the elastic wave equation for acoustics on very large domains, such as arena, stadium, and cathedral sizes problems. * To develop finite difference time domain, pseudo-spectral time domain and sparse finite difference time domain algorithms in Matlab for solving the acoustic wave equation in 2 dimensions. * To benchmark time domain numerical methods for performance when solving very large problems. * To profile and improve time domain numerical algorithms for reduced solving time * To (if time available) implement these algorithms in 3D, and implement GPU processing |
| **2. Explain the rationale for this study (refer to relevant research literature in your response).**  Acoustic simulation has continued to mature and develop, with several methods being used for different applications. Time domain numerical methods for acoustic simulation provide some significant benefits over other methods, when considering problems with many sources and receivers, problems that may involve changing domain, source and receiver properties, problems that may require realistic acoustic performance to be simulated, and when a flexible set of inputs and outputs is desired.  Acoustic simulation is useful for lots of things, but ideally you may in some circumstances want to get direct results  Why time domain numerical methods may be beneficial  The problem with time domain numerical methods  Pstd and sfdtd may be a good compromise for large simulations because  Improved performance for large simulations using time domain methods is the focus of this project |
| **3. Provide an outline of study design and methods.**   * Develop a series of matlab ‘kernel’ functions for fdtd, sfdtd and pstd simulation * Prove that the results from these kernels is accurate when implemented on a large simulation, by comparing with results of other calculations for the same domain * Develop surrounding code to perform simulations using these kernels * Improve the performance of these kernels with the appropriate code profiling and parallelisation tools * Evaluate performance of the algorithms and suggest areas for improvement, relating to performance speed, with a focus on getting closer to real time simulation |
| **4. Research Ethics**  **Does the proposed study entail ethical considerations No (please delete as appropriate) If you are unsure please seek advice before submitting this form.**  **If ‘No’ provide a statement below to support this position.**  **If ‘Yes’ move on to Question 5.**  This study does not involve any human participation, in that there is no research element that directly includes any form of interactive testing component with any living organism performing within the test.  **Please note: PROPOSALS INVOLVING HUMAN PARTICIPANTS MUST ADDRESS QUESTIONS 5 - 11.** |
| **5. Please provide a detailed description of the study sample, covering selection, sample profile,   recruitment and if appropriate, inclusion and exclusion criteria.**  Not Applicable |
| **6. Are payments or rewards/incentives going to be made to the participants? Yes 🞎 No ✓   If so, please give details below.** |
| **7. Please indicate how you intend to address each of the following ethical considerations in your study. If you consider that they do not relate to your study please say so.**  **Guidance to completing this section of the form is provided at the end of the document.**   1. **Consent:** Not Applicable 2. **Deception:** Not Applicable 3. **Debriefing:** Not Applicable 4. **Withdrawal from the investigation:** Not Applicable 5. **Confidentiality:** Not Applicable 6. **Protection of participants:** Not Applicable 7. **Observation research:** Not Applicable 8. **Giving advice:** Not Applicable 9. **Research undertaken in public places:** Not Applicable 10. **Data protection:**  Not Applicable 11. **Animal Rights:**  Not Applicable 12. **Environmental protection:** Not Applicable |
| **8. Are there any further ethical implications arising from your proposed research? Yes 🞎 No ✓**  **If your answer was no, please explain why.** All ethical issues have been addressed in 7 above |
| **9. Have / do you intend to request ethical approval from any other body/organisation? Yes 🞎 No ✓**  **If ‘Yes’ – please give details** |
| **10. What resources will you require? (e.g. psychometric scales, IT equipment, specialised software, access to specialist facilities, such as microbiological containment laboratories).**  Computer System with Mathworks Matlab, appropriate toolboxes and graphics card |
| **11. What study materials will you use? (Please give full details here of validated scales, bespoke questionnaires, interview schedules, focus group schedules etc and attach all materials to the application)** |
| **Which of the following have you appended to this application?**   |  |  | | --- | --- | | ❑ Focus group questions | ❑ Psychometric scales | | ❑ Self-completion questionnaire | ❑ Interview questions | | ❑ Other debriefing material | ❑ Covering letter for participants | | ❑ Information sheet about your research study | ❑ Informed consent forms for participants | | ❑ Other (please describe) |  | |

**PLEASE SUBMIT THIS APPLICATION WITH ALL APPROPRIATE DOCUMENTATION**

**Advice on completing the ethical considerations aspects of a programme of research**

**Consent**

Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission, depending on the school, of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. If conducting research on children you will normally also require Criminal Records Bureau clearance. You will need to check with the school if they require you to obtain one of these. It is usually necessary if working alone with children, however, some schools may request you have CRB clearance for any type of research you want to conduct within the school. Research to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority.

**Covert or Deceptive Research**

Research involving any form of deception can be particularly problematical, and you should provide a full explanation of why a covert or deceptive approach is necessary, why there are no acceptable alternative approaches not involving deception, and the scientific justification for deception.

**Debriefing**

Debriefing is a process of reflection once the research intervention is complete, for example at the end of an interview session. How will participants be debriefed (written or spoken feedback)? If they will not be debriefed, give reasons. Please attach the written debrief or transcript for the oral debrief. This can be particularly important if covert or deceptive research methods are used.

**Withdrawal from investigation**

Participants should be told explicitly that they are free to leave the study at any time without jeopardy. It is important that you clarify exactly how and when this will be explained to participants. Participants also have the right to withdraw their data in retrospect, after you have received it. You will need to clarify how they will do this and at what point they will not be able to withdraw (i.e. after the data has been analysed and disseminated).

**Protection of participants**

Are the participants at risk of physical, psychological or emotional harm greater than encountered ordinary life? If yes, describe the nature of the risk and steps taken to minimise it.

**Observational research**

If observational research is to be conducted without prior consent, please describe the situations in which observations will take place and say how local cultural values and privacy of individuals and/or institutions will be taken into account.

**Giving advice**

Students should not put themselves in a position of authority from which to provide advice and should in all cases refer participants to suitably qualified and appropriate professionals.

**Research in public places**

You should pay particular attention to the implications of research undertaken in public places. The impact on the social environment will be a key issue. You must observe the laws of obscenity and public decency. You should also have due regard to religious and cultural sensitivities.

**Confidentiality/Data Protection**

You must comply with the Data Protection Act and the University's Good Scientific Practice <http://www.derby.ac.uk/research/policy-and-strategy> This means:

* It is very important that the Participant Information Sheet includes information on what the research is for, who will conduct the research, how the personal information will be used, who will have access to the information and how long the information will be kept for. This is known as a 'fair processing statement.'
* You must not do anything with the personal information you collect over and above that for which you have consent.
* You can only make audio or visual recordings of participants with their consent (this should be stated on the Participant Information sheet)
* Identifiable personal information should only be conveyed to others within the framework of the act and with the participant's permission.
* You must store data securely. Consent forms and data should be stored separately and securely.
* You should only collect data that is relevant to the study being undertaken.
* Data may be kept indefinitely providing its sole use is for research purposes and meets the following conditions:
* The data is not being used to take decisions in respect of any living individual.
* The data is not being used in any which is, or is likely to, cause damage and/or distress to any living individual.
* You should always protect a participant's anonymity unless they have given their permission to be identified (if they do so, this should be stated on the Informed Consent Form).
* All data should be returned to participants or destroyed if consent is not given after the fact, or if a participant withdraws.

**Animal rights.**

Research which might involve the study of animals at the University is not likely to involve intrusive or invasive procedures. However, you should avoid animal suffering of any kind and should ensure that proper animal husbandry practices are followed. You should show respect for animals as fellow sentient beings.

**Environmental protection**

The negative impacts of your research on the natural environment and animal welfare, must be minimised and must be compliant to current legislation. Your research should appropriately weigh longer-term research benefit against short-term environmental harm needed to achieve research goals.