# Information on Postgraduate Research Scholarship - Ref: Eng-PhD-23-25

| **Faculty:** | Engineering and Science | **Department:** | School of Engineering |
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| **Lead Supervisor:** | Dr Zarak Khan | | |
| **Project Title:** | AI-Driven Digital Twin for Real-Time Vibration Modelling and Stability Control in Machine Tools | | |

| **Project Description:** (maximum 500 words) | Modern manufacturing industries increasingly rely on high-precision machine tools to produce components with tight dimensional tolerances and high-quality surface finishes. However, unwanted vibrations during machining remain a major challenge, often leading to poor surface quality, reduced tool life, dimensional inaccuracies, and increased material waste. These issues significantly affect productivity, cost, and sustainability in advanced manufacturing environments. |
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| | This PhD project aims to develop an AI-enabled digital twin framework that can monitor, predict, and control vibration behaviour in machine tools in real time. A digital twin is a virtual representation of a physical system that continuously synchronises with real-world data. In this research, the digital twin will replicate the dynamic behaviour of a machine tool during machining and link vibration behaviour directly to surface quality outcomes, particularly surface roughness. |
| | The project will combine numerical simulation, experimental data, and artificial intelligence to create a predictive system capable of identifying vibration-induced instability before it degrades part quality. Sensor data collected from machining experiments, such as vibration, displacement, and strain, will be used to continuously update the digital twin. Machine learning techniques will then be applied to recognise vibration patterns associated with surface deterioration and process instability. |
| | A key objective of the research is to establish a clear and quantitative relationship between machine vibrations and surface finish, enabling proactive decision-making during machining. Rather than reacting to defects after they occur, the proposed framework will support adaptive process control, allowing machining parameters to be adjusted in real time to maintain surface integrity and process stability. |
| | The methodology will involve the development of a virtual model of the machine tool that reflects its dynamic response under different cutting conditions. Experimental machining trials will be carried out to generate high-quality data for training and validating AI models. These models will be integrated into the digital twin environment, enabling real-time visualisation of system behaviour and prediction of surface quality trends. The interaction between the physical machine and its digital counterpart will form the basis for feedback-driven vibration suppression and performance optimisation. |
| | The expected outcomes of this research include improved machining accuracy, enhanced surface finish consistency, reduced tool wear, and |

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| | lower energy and material waste. From an academic perspective, the project will contribute to emerging research areas at the intersection of digital manufacturing, artificial intelligence, and smart machining systems. The developed framework will also serve as a valuable platform for postgraduate training and further research in Industry 4.0 and Industry 5.0 technologies.<br><br>This PhD project is well suited for applicants with backgrounds in mechanical engineering, manufacturing, mechatronics, or related disciplines, and offers strong opportunities for both academic impact and industrial relevance.<br><br>This scholarship is awarded competitively, and all applications are carefully reviewed. While we cannot guarantee an offer, we encourage strong candidates to apply. |
| **Duration:** | 3 years, Full-Time Study or 6 years, Part-Time Study |

**Support available (subject to satisfactory performance):**

A successful Home candidate will receive:
- A Full tuition fee waiver at the university Home-student rate for the specified duration of the scholarship

A successful International candidate will receive:
- A tuition fee waiver for 50% of the International-student rate for the specified duration of the scholarship.

Tuition fees are subject to annual increases.

This scholarship does not include funding for living expenses.

**Person Specification of Essential (E) or Desirable (D) requirements:**

| Criteria: | E or D |
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| *Education and Training:* | |
| • 1st Class or 2nd class, First Division (Upper Second Class) honours degree or a taught master's degree with a minimum average of 60% in all areas of assessment (UK or UK equivalent) in a relevant area to the proposed research project | E |
| • For those whose first language is not English and/or if from a country where English is not the majority spoken language (as recognised by the UKBA), a language proficiency score of at least IELTS 6.5 (in all elements of the test) or an equivalent UK VISA and Immigration secure English Language Test is required, if your programme falls within the faculty of Engineering and Science a language proficiency score of at least IELTS 6.5 overall with a minimum of 6.0 in all elements of the test or an equivalent UK VISA and Immigration secure English Language Test is required. Unless the degree above was taught in English **and** obtained in a majority English speaking country, e.g. UK, USA, Australia, New Zealand, etc, as recognised by the UKBA. | E |
| *Experience & Skills:* | |

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| • Previous experience of undertaking research (e.g. undergraduate or taught master's dissertation) | E |
| • A strong academic background in Mechanical Engineering, Manufacturing, Mechatronics, or a related discipline | D |
| • Experience or interest in numerical modelling, simulation, or dynamic systems. | E |
| • Basic programming and data analysis skills (e.g. Python or MATLAB), with an interest in AI or machine learning. | E |
| • Practical or experimental experience, including laboratory work, sensor data collection, or machining processes. | E |
| *Personal Attributes:* | |
| • Understands the fundamental differences between a taught degree and a research degree in terms of approach and personal discipline/motivation | E |
| • Able to, under guidance, complete independent work successfully | E |
| *Other Requirements:* | |
| • This scholarship may require Academic Technology Approval Scheme approval for the successful candidate if from outside of the EU/EEA | E |
| • The scholarship must commence before 15th July 2026 (offers will be withdrawn if this condition is not met) | E |
| **Closing date for applications:** | *midnight UTC on 20th February 2026* |
| **For further information contact:** | *Zarak.khan@greenwich.ac.uk* |

**Making an application:**
Please read this information before making an application. Information on the application process is available at: https://www.gre.ac.uk/research/study/apply/application-process. Applications need to be made online via this link. **No other form of application will be considered**.

All applications **must include** the following information. **Applications not containing these documents will not be considered.**
- **Scholarship Reference Number (\*insert reference\*)**– included in the personal statement section together with your personal statement as to why you are applying
- **a CV including 2 referees** \*
- **academic qualification certificates/transcripts and IELTs/English Language certificate if you are an international applicant or if English is not your first language or you are from a country where English is not the majority spoken language as defined by the UK Border Agency** \*

\**upload to the qualification section of the application form. Attachments must be a PDF format.*

Before submitting your application, you are encouraged to liaise with the Lead Supervisor on the details above.

September 2021