Annual Report on May 2026

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This annual report summarizes my research progress and life in Cambridge/UK during the 1st year from May 2025 to the present (up to April 2026), achieved with the generous support by Post-Doctoral Research Track of Shida Scholarship Program.

1. Research

After successfully obtaining a UK visa, I left Japan in May 2025 and arrived in Cambridge. Since then, I have been based at the Department of Engineering at the University of Cambridge (Photo 1) as a Visiting Research Fellow. I have been working closely with Professor Dongfang Liang at the University of Cambridge, and over the past year I have achieved the following research results.

Photo 1: Exterior view of the Department of Engineering building. Judging from, it seems to have been built in 1952, indicating the building itself is not particularly historic...

1.1 Publications

The following four papers have been published in SCI journals. In addition, one further paper has been submitted to an SCI journal and is currently undergoing peer review.

1. **Takafumi Gotoh**, Naoki Tsuruta, Shun Yamanaka, Abbas Khayyer, Hitoshi Gotoh. “Wave overtopping analysis by an enhanced SPH method considering the porosity structure of wave-dissipating blocks”. Coastal Engineering Journal, Oct 2025. https://doi.org/10.1080/21664250.2025.2531704.

This is one of the outcomes of collaborative research carried out during my doctoral course in a research team at Kyoto University. In wave simulations over wave-dissipating blocks, the so-called porous models have been widely used for modelling the blocks. However, as semi-empirical experimental constants are employed, leading to poor reproducibility. Therefore, a novel permeable boundary model is proposed, which explicitly represents the target structure as a group of blocks. Consequently, the reproducibility of wave overtopping flow rates has been enhanced, and it has also been made possible to reproduce the local flow distribution within the voids between wave-dissipating blocks, which was previously difficult to capture.

2. **Takafumi Gotoh**, Abbas Khayyer, Dongfang Liang, Hitoshi Gotoh. “A smoothed particle hydrodynamics solver for hydroelastic interactions between fluid and structure”. AIP Advances, 16(1), Jan 2026. https://doi.org/10.1063/5.0311048.

This paper summarizes the achievements of Fluid-Structure Interaction (FSI) simulations, obtained by the code I developed during my PhD research and further refined after moving to the UK. It is my first journal paper co-authored with Professor Dongfang Liang.

3. Naoki Tsuruta, **Takafumi Gotoh**, Moeto Watanabe, Abbas Khayyer, Hitoshi Gotoh. “Development of Interphase Particle for multiphase flow simulation by ISPH”. Computational Particle Mechanics, 15 96-111, Jun 2026. https://doi.org/10.1016/j.cpms.2026.04.002.

After moving to the UK, through collaborative research with the research team at Kyoto University to which

I belonged to during my PhD, we developed the Interphase Particle (IP) method, which enables the stable analysis of interfaces between two phases with significant density differences. Its effectiveness has been demonstrated under some simple conditions. This has provided a significant step forward for the analysis of gas-liquid two-phase flow, which is essential for modelling the interaction between wind and waves around offshore wind turbines.

4. **Takafumi Gotoh**, Naoki Tsuruta, Abbas Khayyer, Dongfang Liang, Hitoshi Gotoh. "Wall Boundary Potential model for incompressible smoothed particle hydrodynamics with arbitrary kernel functions". Engineering Analysis with Boundary Elements, 188 106749-106749, Jul 2026. https://doi.org/10.1016/j.enganabound.2026.106749.

After moving to the UK, I developed the Wall Boundary Potential (WBP) method, a wall boundary scheme capable of significantly reducing unphysical disturbances compared to conventional methods, and demonstrated its effectiveness for some simple flow fields. By applying this method, it is expected that the fluid-structure interface in FSI simulations can be further stabilized. This is my 2nd co-authored journal paper with Prof. Liang.

1.2 Conference presentations (oral presentations) and lectures (in the UK)

Since moving to the UK, the reduced distance to Europe has enabled me to attend several academic conferences. I also had two opportunities to present at conferences and give lectures in the UK; I hereby report on these two opportunities in the UK below.

1. **Takafumi Gotoh**, Abbas Khayyer, Dongfang Liang, Hitoshi Gotoh. "A Particle-Based FSI Solver with Riemann-Based Interfacial Coupling Acceleration". UK Association of Computational Mechanics (UKACM) 2026 Conference, Apr 9, 2026.

This was my first time attending a conference in the UK. I made an oral presentation on the fluid-structure interaction research I had been conducting since arriving in the UK. Although this was a UK conference on Computational Mechanics, there were many participants from overseas, such as Germany and India, and the event continues to grow in scale year by year. The conference took place over three days from 8 April 2026 to 10 April 2026 at Liverpool. It was a highly rewarding experience, as it provided an opportunity to closely explore the research of scholars in the field of Computational Mechanics in the UK and to meet many researchers.

Photo 2: UKACM

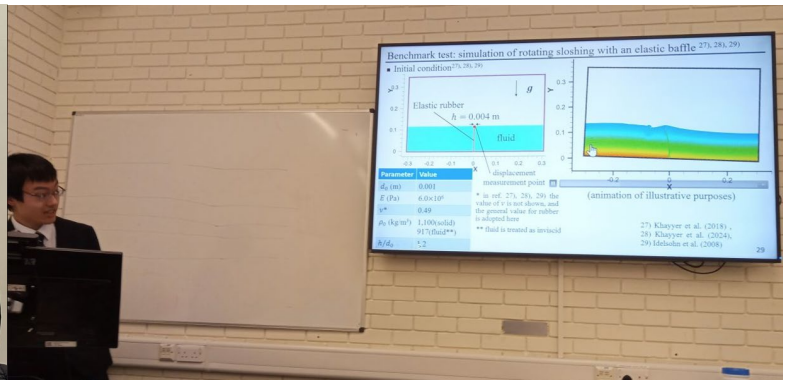

Photo 3: Loughborough University

2. **Takafumi Gotoh**. “Recent development of a fully SPH-based hydroelastic FSI solver”. presentation in the School of Architecture, Building and Civil Engineering at Loughborough University, Apr 16, 2026.

I was invited to deliver a lecture by Professor Chris Keylock at Loughborough University, and visited Loughborough University (located approximately two and a half hours by train from Cambridge) to conduct the lecture on the above topic. The lecture lasted approximately 50 minutes. As many members of the audience were not familiar with the particle method I am researching, the questions I received after the lecture were a great source of insight for me. Following the lecture, I held a research discussion with Prof. Keylock. As Prof. Keylock specializes in turbulence, a joint research project is currently being explored with the aim of acquiring verification data for accurate calculations of wall turbulence with the particle method, as a novel advancement.

1.3 Other academic contributions

1. Session Chair (Session 10: Boundary Conditions) in 19th SPHERIC World Conference. Jun 18, 2025.

SPHERIC is an annual European conference focusing on SPH (one of the main methods in the particle method). This was my second time attending SPHERIC and I made an oral presentation; and likely due to the increased number of papers I have published and the resulting greater recognition of my name, I was also invited to chair a session. Although I was concerned about whether I would be able to manage chairing a session as it was my first time, I managed to wrap up the session on time and successfully, which gave me more confidence.

2. Panelist in Panel Discussion in SPH Online VII. Oct 3, 2025.

SPH Online is an online workshop on SPH. The focus topic for this occasion was Fluid-Structure Interactions, and as it seems my research on fluid-structure interaction during my PhD was known, I was selected as a panelist for the panel discussion. I had to present my views in front of a large audience, which made me a bit nervous, but I think I was eventually able to express my opinions on each topic with confidence. Details of the panel discussion are also included in the latest SPHERIC newsletter (Issue 40, April 2026. URL: www.spheric-sph.org/newsletters).

3. Proposal of SPHERIC Benchmark Case 24. Two-dimensional Manufactured Torsional Deformation. Nov 19, 2025.

While I was a PhD student, I developed a scheme for accurate and stable nonlinear finite-strain elastic structure simulations by the TLSPH method. In its development, I derived analytical solutions for various physical quantities related to elastic body motion under nonlinear finite-strain conditions—for which obtaining analytical solutions had previously been difficult—employing the manufactured solution method, thereby demonstrating a quantitative and comprehensive validation of the proposed scheme. Following several rounds of discussions with the board members of the SPHERIC, the analytical solutions I derived were selected as the first solid mechanics test case for the SPHERIC benchmark problems (No. 24).

4. Certificate of Excellence in Reviewing, Computer Physics Communications. Apr 2026.

As the number of papers I have published has increased, I have been invited to review papers for SCI journals more frequently, and I was awarded a Certificate of Excellence in Reviewing by Computer Physics Communications (WoS, Q1 journal).

1.4 Ongoing work and future prospects

I am currently focusing primarily on the further development of SPH-based fluid-structure interaction schemes, with the aim of enhancing the accuracy and stability of calculations at the fluid-structure interface,

as well as on the extension of the WBP method. I plan to broaden the scope of application for the methods I have developed during the past year, including turbulence calculations. I also look forward to tackling the analysis of fluid-soil interaction, which is Prof. Liang's area of expertise. I am determined to devote myself energetically to my research over the coming year.

2. Life in Cambridge/UK

Cambridge is a university city located about an hour's train ride from London, UK. Although it is a compact city, it continues to expand to this day. Many people ride bicycles, and there are bike racks everywhere in the city (though bikes are stolen if left unlocked). I myself am a cyclist and spend about 20 minutes cycling from home to university. The River Cam flows through the town (indeed, the name "Cambridge" originates from the "bridge" over the Cam River), and there is plenty of green space along its riverbanks (Photos 4–6).

Photo 4: At the River Cam near the university. Cows are removing the weeds.

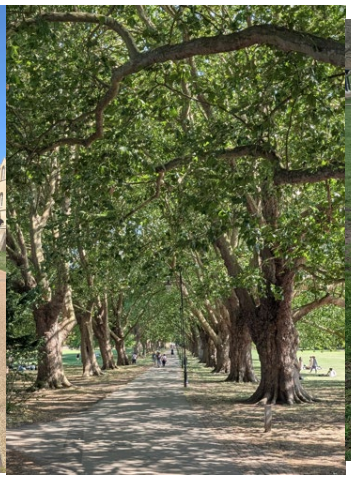

Photo 5: A tree-lined avenue: strikingly beautiful!

Photo 6: Swans by the park. Photographed near the tree-lined avenue mentioned in Photo 5. Occasionally, we can find swans on the land.

Throughout the town, particularly in the center, there are many churches and pubs (social gathering places serving beer and food). The oldest surviving pub is the Pickerel, founded in 1608, but the most famous pub is the Eagle, founded in 1667 (the second oldest), which is said to be the place where the double helix structure of DNA was discovered (Photo 7).

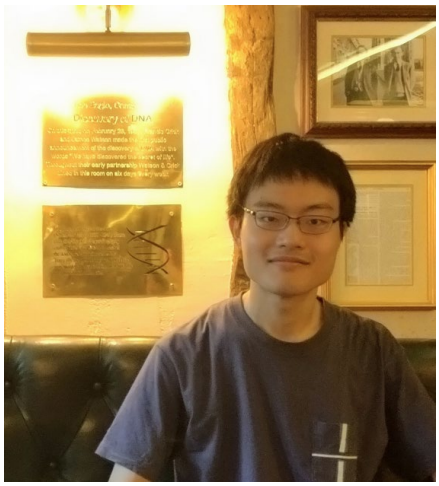

Photo 7: A plaque inside the pub marking it as the site where the double helix structure of DNA was discovered.

The University of Cambridge is a historic university founded in 1209. It is said to have been established by a group of scholars that separated from the University of Oxford. A distinctive feature of the University of Cambridge is the existence of "Colleges" alongside the Faculties/Departments; all full-time academician and students belong to one of these Colleges. Each College is home to staff and students from various academic disciplines, serving as a forum for interdisciplinary exchange among researchers. It seems that apart from the University of Cambridge, only the University of Oxford and Durham University adopt this collegiate system in UK (I don't know about regions outside England). There are 31 Colleges in total at the University of Cambridge, the oldest of which is Peterhouse College, founded in 1284. Admission to a College requires passing a selection process; Trinity College (founded in 1546) is known as

the most prestigious College and is highly competitive. King's College (founded in 1441) (Photo 8) is also highly competitive and is frequently visited by tourists. As I am a Visiting Research Fellow, I am not currently affiliated with any college, but I am frequently invited to events at Churchill College (founded after the Second World War by Sir Winston Churchill, the British Prime Minister during the war), where my host, Professor Dongfang Liang, belongs (Photo 9).

Photo 8: King's College, from the Backs. (Centre tall building: the college chapel, left building: the neighboring Clare College's one.

Photo 9: At a formal dinner at Churchill College. Professor Dongfang Liang is on my left in the photo.

I aim to continue making the most of this blessed environment in Cambridge, expanding my academic network while developing the foundations for my future research career.

Acknowledgment

I appreciate the Shida Scholarship Program of the Kyodai Collaborative for financial support and continuous kind attention from the Kyodai Collaborative board members and staff, particularly Ms. Rika Okayama. I also appreciate Prof. Dongfang Liang and my other collaborators for their kind support and encouragement during this one year.