Personal Statement

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Ever since my first Pentium 4 PC, I've been tinkering with computers and checking out all the intriguing software applications. This hobby inspired me to be a lifelong computer science enthusiast. However, it wasn't until I was studying medical information in school that I discovered the true promise of Computer Science. I learned that smart healthcare not only has the potential to significantly reduce the staff needed for patient surveillance but, more importantly, it allows early detection and intervention through artificial intelligence, drastically improving patient outcomes. By continuously leveraging AI to analyze real-time data, healthcare providers can make decisions more wisely, reduce human errors, and ultimately provide faster and more accurate diagnoses that transform the overall quality of care. However, I can't help but notice that my resources were very limited at the time, given that my university is a pure Medical University. Driven by this realization and my passion for applying computer science to healthcare, I became the first to pursue a double major program between two top-tier schools, Kaohsiung Medical University and National Sun Yat-sen University.

During my junior year, I was a research assistant in Professor Wen-Hsien He's AI Lab at Kaohsiung Medical University, where I designed a clinical medical module. This project involved embedding an Arduino-based temperature and humidity sensing module and a triaxial accelerometer into a medical mattress to probe its potential future application in medical chips for clinical use. The research aims to predict the risk of pressure ulcers remotely, with plans to eventually integrate this design concept into medical chips for use in clinical smart healthcare devices. We estimated the patient's surface temperature distribution using embedded thermostats and calculated heat flux and temperature distribution through the heat diffusion equation with finite difference methods and dual iteration of the unscented Kalman filter. Additionally, we combined temperature and humidity signals with wound images, utilizing CNN and LSTM for multimodal learning. This approach overcame the difficulty of data cleaning and model optimization, improving the model's accuracy by over 12%. Through this experience, I understand that the development of smart healthcare is an ambitious goal. In particular, it requires not only mastery of software and hardware skills but also in-depth knowledge of biology and biomaterials.

As I continued accumulating experience in software and medical IoT, I gradually noticed that thinking and developing solely from a medical application's perspective may be too one-sided. Therefore, I became interested in smart manufacturing in the industry. Smart manufacturing's real-time monitoring and machine predictive maintenance are applicable to the development of smart healthcare. I led two key projects in the smart manufacturing department of AU Optronics (AUO). One project focused on converging panel machine data from the factory sensor to facilitate the factory director's decision-making during emergencies, while another focused on the panel machine's predictive maintenance. We used a CNN model to detect surface wear and cracks in the panel machine's bearing. Then, we trained the Autoencoder model to identify anomalies, enabling the maintenance team to intervene as soon as possible. These projects improved my understanding of hardware real-time fault detection and preventive maintenance, adding depth to fulfill my long-term target of popularizing precision medicine and turning it into reality.

Gradually, as my knowledge about smart manufacturing grew, I recognized the value of domain knowledge in processing skills of different types of data. Hence, I joined Flow Inc., which focuses on automated industrial and geospatial data processing. I was responsible for building a data preprocessing pipeline in Python and integrating different data preprocessing modules into the AI platform of Flow, Inc. I reduced system time by 23% and improved data processing efficiency. Besides process optimization, I am also responsible for building AWS EC2 machines to move some mature data processing services into it to scale our capacity. This experience reinforced my understanding of data workflow and cloud computing integration. Reflecting on my experiences in domain knowledge in medical, industrial, and geospatial data, I learned that data quality and feature selection are the key factors of machine learning. These recognitions also influence my research during my master's thesis in biomedical engineering at NYCU. I developed a machine-learning-based pre-diagnostic system for periprosthetic joint infection for my master's thesis. When I worked with healthcare professionals, I encountered a recurring problem: healthcare workers spend considerable time recording data manually, which often leads to errors and delays that impede the training of machine learning models. This challenge revealed the urgency of automation by improving hardware in the smart healthcare field and thus inspired me to develop hardware-integrated products to raise the standard of data quality and provide real-time monitoring and diagnosis. These skills would also be the core foundation for creating smart healthcare solutions.

To sufficiently cope with these challenges, we must develop a wearable or implantable data-collecting device compatible with the artificial joint prosthesis. For example, medical chips would allow the real-time monitoring of patients' physiological information. This solution would reduce errors and guarantee that the data required for the model training is of high quality and timeliness, thereby improving diagnostic accuracy. By integrating my experience in data processing and machine learning along with the optimization of clinical signals and chip designs, I am convinced that I can drastically improve the development of intelligent healthcare and bring a variety of remarkable progress to the medical field.

One of my ultimate goals in my career is to research and develop a high-efficiency, low-power implantable medical chip based on GaN materials integrated with biocompatible materials such as titanium and parylene for encapsulation, which can stably work in the human body for a long time without triggering immunity or other adverse reactions. I will target the single most essential biomarker, alpha-defensin, to keep technical complexity as low as possible and create a more stable system. The biomarker, a molecule strongly linked to periprosthetic joint infection, helps alert medical personnel when an issue arises so they can intervene. As the project progresses, I plan to gradually expand the system to detect other important biomarkers, such as leukocyte esterase (LE) and synovial C-reactive protein (CRP), further enhancing the diagnostic capabilities of the system. With that said, however, the most important function of the chip is to monitor specific physiological indicators of patients in real-time, especially critical biomarkers in the synovial fluids, which are essential for assessing inflammation and infections. These biomarkers can effectively identify and target early complications in periprosthetic joint infection (PJI), such as infection, loosening, or wearing. By continuously monitoring the data, the medical chip can integrate and process it to achieve real-time awareness of the patient's joint condition, triggering alerts when anomalies occur. This approach allows medical staff to intervene early and prevent serious complications.

To reach this goal, I need to learn more about the characteristics of organisms and biomaterials, so I joined a professional team to develop highly sensitive biosensors and to explore the use of nanomaterials, such as graphene, to improve the sensitivity and selectivity of the sensors. Moreover, I am also committed to further research on how to apply microfluidic technology to mitigate environmental interference, which will guarantee the long-term stability and accuracy of the sensors in the body. Recently, I joined the R&D team of Anivance AI, one of the world's leading startups in organ-on-a-chip technology. I'm looking forward to this opportunity because it will help me understand the architecture of biochips, as well as the advantages and limitations of biomaterials and microfluidic technologies. Moreover, this opportunity can give me the privilege to be exposed to the processing of multi-omics data, such as genomics, proteomics, and metabolomics, and to understand the interactions between drugs at different biological levels. This research experience in the company will effectively bridge the gap between medical chips and biological fields. Additionally, one possible complication is the stability and timeliness of the data transmission. Therefore, I plan to lead into variants of low-power wireless technologies to transmit data to clinical edge computing systems. I believe the plans above will further the development of smart healthcare, thereby illuminating significant breakthroughs in diagnosing and treating PJI and the patient's quality of life.

My past work has equipped me with the skills to process medical data and develop early-stage medical IoT products. I am also conducting in-depth research in biochips to ensure my capabilities can perfectly meet the needs of smart healthcare fields. However, it also revealed some gaps in my computer science background, especially in signal processing, IoT, and IC design. Although I excelled in software skills in IoT-based machine learning programs, I still need more hardware knowledge to create a complete solution in the medical field. This motivates me to apply for the University of Glasgow's Computer System Engineering (CSE) program, which can help me acquire the necessary hardware expertise to close the gap between software and hardware, promoting intelligent healthcare technologies.

Graduate studies at U of G's Computer System Engineering (CSE) program will thus be a strategic step toward my long-term goals, where courses in computer architecture, VLSI/CAD, and Digital Signal Processing will help me narrow the divide between software and hardware. Classes like VLSI Design (ENG5092) will help me learn the skills I need to make medical chips, including integration enhancement of chips, low-power design, and wireless communication module integration. Meanwhile, Digital Signal Processing (ENG5027) would supplement my signal processing skills and equip me with the knowledge of processing biological signals from medical sensors. Digital Communication (ENG5336) can help me design efficient and reliable medical chip communication modules to ensure that physiological data can be transmitted to clinical systems with low latency and power consumption smoothly. These classes fit perfectly with my goal of using wearable and implantable medical devices for remote patient monitoring and conducting real-time data capture and analysis. Regarding Integrating my software skills, Realtime Embedding Programming(ENG5220) will provide hands-on experience in the embedding system, as well as the ability to manage real-time operating systems (RTOS) and communication protocols. The course is important for parallel processing of multiple data sensor signals to achieve on-the-fly analysis and connecting medical chips between external sensors. Moreover, Human-centered security (COMPSCI5060) will empower me to fully consider system security, privacy protection, and ease-of-use when designing medical chips, to create safe and user-friendly products. Integrating the knowledge gained from these courses allows me to seamlessly combine AI with hardware, driving significant innovation in smart healthcare solutions.

As a candidate in the Computer System Engineering program at Glasgow, I will combine my experience in Biomedical Engineering and AI with a special focus on smart healthcare technology. Including medical chips in every device enables real-time patient monitoring along with AI-powered diagnostic and prompt precognitive abilities. My objective is to develop an AI-enabled Diagnostic Framework incorporating medical chips to amplify the accuracy and efficiency of diagnosis in health care. Graduate studies at Glasgow will thus be a strategic step towards my long-term goals. Glasgow is renowned for its strengths in AI and Engineering, and I will seek to enhance my expertise in IC design and deep dive into Machine Learning while there. In particular, the Master's degree offers a robust theoretical foundation with hands-on experiences. I am deeply attracted by the University of Glasgow's "World Changer" philosophy and I look forward to joining #TeamUofG, contributing to impactful global change in smart healthcare.