Motivation: With my strong foundation and extensive research experience in AI and healthcare [1], I am committed to improving healthcare using AI. Specifically, I am keenly interested in developing deep learning and computer vision-based solutions for medical image analysis to improve diagnostics, treatment and survival rates. The PhD program at School of Computing Science, XX University, is the next pivotal step in my journey. It will provide me with the opportunity to further advance my AI, deep learning and computer vision skills and to conduct impactful research at the intersection of AI and healthcare.

My fascination with improving healthcare using technology stems from a very personal place. Growing up in Lahore, Pakistan's second-largest city, I watched countless families travel from smaller towns to seek care their local hospitals couldn't provide, due to a lack of affordable medical equipment. Using my bachelor's training in electrical engineering, I have worked to address these disparities by developing affordable health monitoring and breathing support devices [2][3]. However, after completing various research projects in AI in healthcare during my master's in electrical and computer engineering, I realized that my true passion lies in analyzing medical data through AI to improve patient health outcomes. This realization motivated me to pursue AI in healthcare research through a PhD in computing science.

My interest in deep learning and computer vision was first ignited during my graduate coursework at the XXX. In my machine learning and data mining course, I implemented and benchmarked vanilla CNNs and transfer-learning algorithms including VGG-19, ResNet-50, and DenseNet-121, on MNIST, Fashion-MNIST, and CIFAR-10 data sets for class assignments. Earning an A in the course, I gained a strong foundation and interest in deep learning and computer vision that motivated me to pursue this field through a Ph.D. in computing science.

As a Lecturer at the XXX, the top-ranked computer science institution in Pakistan, I supervised senior-year research projects in medical image analysis. In one project, we built an AI-based clinical decision-support system for improving diagnostic accuracy and reducing diagnostic times for diseases such as brain tumor and pneumonia. Our MRI based brain tumor-detection pipeline achieved **95.3%** accuracy with **YOLOv8**; segmentation pipeline reached a best **mean IoU of 79%** with **U-Net**; and chest X-ray classifier for pneumonia detection achieved **91.99%** accuracy using vanilla CNN. Guiding students through image analysis and preprocessing, model development, and evaluation gave me end-to-end experience in medical image analysis (focusing on machine and deep learning) for health applications, ignited my interest in pursuing it through a PhD in computing science.

In another flagship project, we focused on fetal-anomaly detection in ultrasound. We first localized fetal anatomical structures with **Faster R-CNN (ResNet backbones)**, achieving **85% detection accuracy** on phantom data. We then classified fetal brain anomalies achieving 95.6 percent accuracy using a **Vision Transformer (**chosen for its superior ability to capture spatial patterns compared to traditional CNNs), reaching **up to 98% accuracy**. Finally, we **fine-tuned BLIP** for multimodal analysis such as caption generation for our dataset, exploring **vision-language models** to enhance downstream recognition. Guiding students in exploring relevant vision language model and fine-tuning it for caption generation, provided me extensive experience in multimodal medical image analysis. These senior year projects received **perfect grades** in both internal and external evaluations, were ranked in top 1 percent of 450+ senior year projects and cemented my interest in pursuing multimodal medical image analysis through a PhD in computing science.

International hackathons: To deepen my hands-on experience in multimodal image analysis, I competed in various international hackathons. In Google's Gemma 3N Impact Challenge, I built an AI navigation assistant for people with visual impairment that combined YOLOv12 for object detection, MiDaS for monocular depth estimation, and gemma-3-4b-it for real-time scene understanding and natural-language guidance. Additionally, I used gTTS for audio output. I then extended this system in the Co-creating with GPT-5 hackathon (AI/ML API and lablab.ai, USA), replacing Gemma with GPT-5 to leverage stronger reasoning and adding a fall-detection module by extracting video frames and applying Roboflow's fall-detection models. This work led to my selection as a mentor for lablab.ai's, USA global AI hackathons (from 300+ applicants) and further reinforced my commitment to pursue multimodal image analysis through a PhD in computing science.

I have worked extensively both in industry and academia to strengthen my machine learning and deep learning skillset. As a part-time, remote AI Research Assistant at Integrated Medical Sensors (IMS) Inc., California, USA I utilized RNN/LSTM models for glucose trend forecasting and built a multi-agent-based diabetes-management application. My forecasting results were a key component of the IMS winning proposal for the 2024 DCB Open Innovation Challenge. Previously, at the University of Oklahoma, I built classical machine learning pipelines to predict students' mental-health outcomes and used LIME and SHAP to enhance transparency, resulting in a first-author ASEE 2025 publication. These projects gave me technical expertise in machine learning, deep learning and explainable AI techniques for healthcare, deepening my commitment to pursuing AI in healthcare research through a PhD in computing science.

Beyond deepening my own expertise, I have taught and mentored 3,000+ learners in AI, deep learning, and computer vision. As a senior mentor at AI Club at XXI, I conducted 10+ hands-on workshops in computer vision for freshman and sophomore year students of engineering and computer science. At FAST University, I taught senior-year AI courses to 600+ senior students. As a volunteer instructor with Aspire Pakistan, USA, I led computer vision module of three six-week AI bootcamps, teaching 500+ students and mentored 30+ hackathon teams across five intensive generative AI courses. I also organized three workshops on vision-language models attended by 200+ participants, covering architecture, strengths, and limitations of foundation models. These sessions included hands-on exercises: zero-shot image classification with CLIP, image captioning and spatial reasoning with QwenVL, and biomedical image classification with BiomedCLIP. Collectively, these experiences reinforced my focus on AI, deep learning, computer vision and multimodal image analysis and inspired me to pursue this field through a PhD in computing science.

In my future research, I aim to work on multi-modal medical image analysis (focusing on machine and deep learning) to improve diagnosis and treatment for fatal diseases such as cancer and brain tumor. Additionally, I want to explore efficient approaches to produce labeled datasets to reduce resources needed to train radiology AI models. I am also interested in developing explainable AI methods to support physicians' decision-making in image-based diagnosis. I am passionate about optimizing AI model architectures to reduce their size and computational requirements, enabling deployment of edge devices with limited memory and processing capabilities.

Match: I am drawn to School of Computing Science of XX University for its strong research background in computer vision and graphics, advanced research facilities, and faculty expertise in medical imaging and deep learning. Particularly, I am deeply interested in the work of medical image analysis lab. I was especially inspired by lab's recent review paper on active learning, an approach used to produce labeled

datasets by identifying the most informative or uncertain data for human annotation, to maximize AI model performance and reducing radiologists' labeling burden. I am interested in extending current research in active learning by assessing its performance on tasks such as segmentation, classification, and generation and investigating if it can contribute to the development of foundation model by improving the scalability of the labeling process. Additionally, I found lab's work on evaluation on the clinical utility of AI and its explanation for brain MRIs from patients with gliomas, very fascinating. I am interested in extending this work by developing more powerful explainable AI methods.

My background and experience paired with my specific interests in AI, deep learning, computer vision and healthcare research, make me an ideal candidate for this path. In the long term, I aspire to pursue an academic career, continuing to advance AI for healthcare while mentoring future generations of computer scientists and AI researchers.

[1] E. T. R. Babar and M. Mujeeb U. Rahman. A smart, low-cost, wearable technology for remote patient monitoring. IEEE Sensors Journal. 21, 19 (Oct. 2021), 21947–21955. DOI:https://doi.org/10.1109/jsen.2021.3101146