Muhammad Ali Hassan

25100003@lums.edu.pk • +92-333-6018187 • LinkedIn • GitHub • Personal Website

Education

LUMS, School of Science & Engineering | B.S. Computer Science **Sep 2021 – May 2025**

- **Coursework**: *Distributed Systems*, *Blockchain*, *Topics in Internet of Things*, Operating Systems, *Network Security*, *Topics in LLMs*, Network Centric Computing, *Machine Learning* (Graduate courses mentioned in *italics)*
- **Exchange Semesters:** University of Baltistan (Summer 2023)

Bloomfield Hall School |Cambridge Assessment International Education A Level **Aug 2018 - May 2020**

- **Grades:** Math(A*), Physics(A*), Chemistry(A*)

Research Experience

Research Assistant - Cloud Computing Research Lab (CCRL), LUMS **Jun 2024 - Present**

Blockchain-Based AI Model Governance and Auditable Policy Compliance System

Advisors: Dr. Basit Shafiq (Associate Professor, LUMS), Dr. Jaideep Vaidya (Distinguished Professor, Rutgers)

Developing a blockchain system using BPMN workflows and LLMs for secure, decentralized policy-compliant access to AI models and healthcare datasets, addressing critical privacy concerns in highly regulated fields like healthcare.

- Co-authoring a research paper on the system's infrastructure and its applications in policy-compliant medical research, with plans for submission to conferences like IEEE HealthCom.
- Developed an LLM-based workflow architecture to generate accurate BPMN diagrams and recommend datasets/models based on natural language queries, significantly improving workflow usability.
- Engineered interactive workflow visualization using survival analysis models (Cox model/Kaplan-Meier curves) on SEER and German Cancer registry datasets to enable LLM-guided survival analysis for 400,000+ patients.
- Established a pipeline for reliable communication between smart contracts, servers, and clients using Web3 and INFURA APIs, enabling seamless deployment and interaction over the Sepolia Testnet.
- Created a platform using React, with optimized UI/UX and integrated BPMN Modeler and RESTful APIs, enhancing navigation and improving healthcare professionals' workflow efficiency.

Research Apprentice — IoT Lab, LUMS **Sep 2024 – Present**

Dynamic IoT Surveillance for Fire-Prone Regions

Advisor: Dr. Murtaza Taj (Associate Professor, LUMS)

Developing an IoT-based forest fire detection system using Hikvision IP cameras for real-time monitoring in Pakistan's fire-prone regions.

- Optimized pan, tilt, and dynamic zoom with automated overlap calculations and hyperparameters for recursive image capture, enabling precise and flexible inspection and addressing challenges for localizing fire hotspots.
- Identified deployment issues where tilt angles exceeded the limit threshold; adjusted tilt values and added alerts to notify users, ensuring rapid detection of monitoring anomalies and clear knowledge of monitoring bounds.
- Streamlined fire detection by integrating into existing LLMs and YOLO architecture, improving early warnings, precise localization, and timely alerts to authorities.
- Developed GIF workflows with Python's OpenCV to automate the visualization of capture sequences, improving monitoring efficiency, enabling quick analysis, and enhancing early warnings to authorities.

Research Intern — Centre for Water Informatics & Technology, LUMS **Jun 2024 – Aug 2024**

*Cost-Effective AIoT Flood Monitoring System- **Internship Paper***

Advisor: Dr. Talha Manzoor (Assistant Professor, LUMS)

Developed a cost-effective Edge AIoT system using ESP-32 Cam for real-time flood and wildlife monitoring in northern Pakistan, enhancing disaster preparedness and environmental protection.

- Integrated YOLOv5 with Edge Impulse and LLM on ESP-32 Cam for real-time image analysis, achieving disaster monitoring at 1/10th the cost of traditional systems.
- Engineered GSM-based data transmission pipeline using sleep modes and watchdog timers for real-time drive uploads to ensure reliable operation in internet-limited regions with optimized power usage.
- Explored and proposed advanced hardware alternatives, such as the XIAO ESP32S3 Sense, to enhance processing power and scalability, addressing ESP-32 limitations.
- Formulated key deployment strategies that are being utilized at the Centre for Water Informatics to deploy the AIoT camera in resource-constrained regions, driving scalable and cost-effective disaster monitoring.

Researcher – Topics in Large Language Models **Sep 2024 – Present**

*Identifying Bottlenecks in Deploying LLMs on Resource-Constrained Devices – **Research Paper***

Advisors: Dr. Ihsan Ayyub Qazi (Associate Professor, LUMS), Dr. Zafar Ayyub Qazi (Assistant Professor, LUMS)

Exploring the deployment of Llama 3.2 (1 billion parameters, 2-bit quantized) on low-cost Android devices to optimize LLM usability for underserved users in resource-constrained environments.

- Conducted a user study highlighting the prevalence of older Android devices in Pakistan, emphasizing the need to adapt LLMs for equitable AI access akin to advanced tools like Apple Intelligence.
- Developed a memory monitoring pipeline using Ollama to host the LLM locally and the Android Debug Bridge to track metrics such as active/inactive memory, cache usage, and response latency during specific LLM prompts.
- Analyzed performance by testing different prompts across multiple iterations, identifying memory and runtime bottlenecks, and visualizing the data with box-and-whisker plots for comparison.
- Future work focuses on benchmarking LLM performance on diverse Android devices, exploring KV cache optimization techniques, and enhancing scalability for improved AI access in underserved regions.

Researcher – Topics in IOT **Jan 2024 – May 2024**

Security Vulnerabilities in Battery-less IoT Devices

Advisor: Dr. Naveed Anwar Bhatti (Assistant Professor, LUMS)

Investigated critical vulnerabilities in battery-less IoT devices, highlighting the need for improved security measures in resource-constrained IoT systems to mitigate risks and prevent exploitation.

- Developed a voltage monitoring pipeline using Mementos to preserve intermittent states and capacitors to do non-invasive charge monitoring to track the charge/discharge cycles of the IoT device.
- Analyzed discharge patterns and device algorithms in battery-less IoT devices to uncover security flaws, revealing unique charge/discharge cycles for different apps and highlighting the need for tailored safeguards.

Teaching Experience

Teaching Assistant — School of Science & Engineering, LUMS **Aug 2022 – May 2024**

CS 3812, EE 3812 – Blockchain: Technology and Applications (Spring 2023)

- Led weekly office hours and tutorials on concepts such as using Solidity and JavaScript-based contract deployment, guiding 40 graduate/undergrad students through complex concepts in blockchain.
- Enhanced course content by developing assignments, quizzes, and exam questions to ensure a challenging curriculum with 20 hours/week dedicated support.

CS 100: Computational Problem Solving (Fall 2022 & Summer 2022)

- Led teaching team as Head TA, managing 4 other TAs, lab logistics, and coordinating tutorials to establish an effective support system for 200+ students.
- Mentored C++ programming labs through control flow, functions, and data structure instructions to guide 20+ students across 6 project groups to implementation mastery.

CS 210: Discrete Mathematics (Fall 2023)

- Guided students on set theory, logic, combinatorics, graph theory, and proofs, providing assignment support and office hours to ensure understanding and strong academic performance for 200+ students.

Projects

Distributed, Fault-Tolerant Key-Value Store |*Golang* **Sep 2023 – Dec 2023**

- Implemented a distributed key-value store using Raft consensus for leader election and log replication, ensuring data persistence, high availability, and fault tolerance across nodes during failures

Distributed Hash Table| *Python, Socket programming* **Feb 2023 – May 2023**

- Developed a distributed hash table with a peer-to-peer model and failure tolerance, improving data retrieval reliability in decentralized networks.

RAG-Based Researcher Chatbot | *Python, LangChain, Pinecone, FAISS* **Sep 2024 – Nov 2024**

- Built a research assistant chatbot using LangChain that leverages Retrieval-Augmented Generation to answer questions by retrieving relevant information from a collection of research papers and Wikipedia.

Oracle Cloud Electricity Billing System | FastAPI, Nginx, SQL, Virtual Machines **Oct 2024 – Dec 2024**

- Designed and deployed a billing system web application on Oracle Cloud, enabling efficient bill retrieval, payments, and adjustments with robust error handling and a scalable three-tier architecture.

Recruitment and Onboarding | *JavaScript, MERN, Firebase, Web Sockets* **Jan 2024 – May 2024**

- Built a MERN-based recruitment platform with video uploads, interactive chat, and an intuitive interface, streamlining the hiring process and improving applicant and HR engagement.

Trading App | *JavaScript, MERN, Web Sockets* **Mar 2024 – May 2024**

- Engineered a real-time trading platform using the MERN stack and Socket.io, enabling instant offer updates and inventory synchronization to enhance user experience and market responsiveness.

Command-line Shell |*C* **Sep 2023 – Nov 2023**

- Developed a command-line shell in C replicating UNIX shell functionality, including pipelining and command chaining, to enable efficient process management and task automation.

Awards & Honors

- Dean's Honor List (2021-2022)
- Merit Scholarship in LUMS (2021-2022)
- Winner of Startup Incubator - Ideation Academy (2023)
- 100% Merit Scholarship in A' Levels

Skills & Toolkit

Programming Languages: Python, Golang, Solidity, JavaScript, TypeScript, C, C++, Haskell, SQL, HTML/CSS
Frameworks and Libraries: MERN, Lang Chain, YOLO, Pinecone, OpenCV
Tools and Platforms: Smart Contracts, Arduino IDE, MetaMask, XACML, BPMN, Oracle Cloud, Hikvision API, Open AI, Git, Linux (Putty, WinSCP), MongoDB
Certifications: Fundamentals of Accelerated Data Science (NVIDIA)

Leadership & Community

Co-Founder & General Secretary – *E-Gaming at LUMS* **May 2023 – June 2024**

- Founded and led the LUMS E-Gaming Society, hosting high-profile esports events (1000+ attendees, 200K PKR sponsorships), managing a 50+ member team, and catalyzing a thriving gaming community.

Peer Ambassador for Social Support – *LUMS* **Sept 2023 – June 2024**

- Acting as a mentor and resource for freshmen, offering advice on academic, social, and personal matters to enhance their overall university experience and assisting them in navigating the university's structure.

Committee Director – *LUMS Model United Nations* **May 2023 – May 2024**

- Led international conference organization by directing a 50-member team in scheduling 20+ academic sessions and managing multi-venue operations to foster leadership and academic dialogue among participants.

Director Media – *SPADES & DANCELUMS* **May 2021 – May 2023**

- Led university-wide media coverage by managing media teams 10+ for PSIFI and premier events to reach a 50,000+ audience through creative content and targeted campaigns.