Web3 Campus Marketplace: Practical Implementation and Future Expansion Paths

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Executive Summary

The proposed project focuses on designing and implementing a Web3 Campus Marketplace to address the clear need for a secure, transparent, and easy-to-use platform for buying and selling second-hand goods within a university community. Traditional online systems often feel very basic and lack the engaging design and smart features found in high-quality consumer apps. This design is primarily driven by the goal of creating a platform that looks and feels like a good product, offering a superior user experience (UI/UX), demonstrating our skills effectively, and having plenty of room to add more complex functions later on.

Our group's design scope will cover all the essential parts of a digital marketplace, significantly upgraded using modern Web3 technology. At its core, the system will allow users to post items for sale, browse, search, and chat directly with buyers or sellers. To make sure the platform is reliable and safe, we will add features for connecting a crypto wallet and a system for verifying a user's campus identity using the secure, decentralized nature of Web3. This ensures that only verified students can participate. Beyond just transactions, we are designing a dedicated community forum to allow students to discuss products, share tips, and build a more interactive environment. The project is well-structured for teamwork, offering many distinct Use Cases. This foundation also makes it easy to add advanced features later, such as smart recommendation systems or automatic recognition of book covers (OCR), ensuring the final deliverable is a comprehensive and visually strong demo video.

Statement of Problem

In university communities like those in Singapore, the exchange of second-hand goods is a prevalent and necessary activity. Students seek to save money, find affordable textbooks, or declutter their dormitories, creating a vibrant internal market. Currently, students primarily rely on general-purpose online marketplaces such as Carousell, which is highly popular in Singapore, or use decentralized channels like social media groups and instant messaging apps for these transactions. While functional, these existing methods are not tailored to the unique ecosystem of a university and present significant challenges.

The primary problem is the inefficiency and information overload inherent in these generic platforms. On a large marketplace like Carousell, listings from students are easily lost among a vast sea of commercial and non-student listings. Conversely, in social media groups, transactional information is quickly buried by irrelevant conversations, making it difficult for buyers to find specific items and for sellers to gain adequate exposure for their products. This lack of a dedicated, streamlined channel leads to high transaction friction. A study on student online marketplaces confirms that the “main problem faced by students either as the buyer or the seller is there is no business platform to promote their products or services” within the university community, forcing them to rely on fragmented communication channels like WhatsApp, which are not designed for commerce .

Furthermore, trust and security concerns are paramount. Peer-to-peer (P2P) marketplaces inherently carry risks, as they often connect strangers for financial transactions. The absence of a trusted, university-centric verification system means that students must rely on the platform’s generic reputation scores, which may not accurately reflect behavior within the campus community. This can lead to anxiety and hesitation. A 2010 empirical study on online social networks highlights that “privacy risks” and the inability to “construct their identity in the desired way” can cause users to “restrict or even terminate their platform activities” . In a transactional context, this translates to users being wary of scams, misrepresentation of goods, and the potential for disputes with no clear, locally-relevant resolution process.

Finally, data privacy and the lack of user control present a growing issue. Centralized platforms act as intermediaries that control user data, transaction histories, and reputation scores. Users have little to no ownership over their digital footprint within the marketplace. This model concentrates power in the hands of the platform operator and exposes users to risks associated with data breaches or misuse of their personal information. The increasing public awareness of these issues creates a demand for a system where users have greater sovereignty over their data and interactions.

In conclusion, the current landscape for student second-hand trading in a place like Singapore is characterized by inefficiency, a deficit of trust, and a lack of user-centric data control. These problems create a clear and pressing need for a specialized solution. Therefore, this project aims to design and implement a campus-focused second-hand trading platform that integrates Web3 wallet functionality. This platform will address the identified shortcomings by providing a dedicated, efficient, and transparent environment, leveraging decentralized technology to build trust, enhance security, and restore data ownership to the users within the university ecosystem.

Objectives

This project proposes the design and implementation of a Web3-enhanced campus marketplace that enables students to list items, conduct transactions, and communicate within a secure, authenticated, and user-friendly environment. The project focuses on integrating essential marketplace features with simulated decentralized wallet authentication and transaction-signing mechanisms to build a modern and trustworthy trading ecosystem restricted to university users. The design objectives are as follows:

(1) Develop a secure authentication and campus-verification mechanism based on simulated Web3 wallet login to ensure that only verified students can access the platform.

(2) Implement a fully functional marketplace that supports item listing, browsing, searching, and real-time communication between buyers and sellers.

(3) Design and integrate a simulated decentralized transaction-signing workflow to demonstrate secure and transparent trading behavior.

(4) Deliver an intuitive, high-quality user experience supported by an extensible system architecture that accommodates future feature enhancements.

Objective (1): Secure Web3-Based Authentication and Campus Verification

This objective focuses on building an identity system that uses a simulated Web3 wallet as the login method, with the wallet address serving as a unique decentralized identifier. To maintain a campus-exclusive environment, the backend will link this identifier to a verified university email. The goal is to demonstrate the principles of decentralized identity (DID) in a controlled environment without relying on live blockchain networks.

Objective (2): Fully Functional Campus Marketplace

This objective covers the development of essential marketplace capabilities that support everyday campus trading needs, including CRUD operations for item listings, image uploads, search and filtering, and a real-time chat system for buyer-seller communication. The system architecture will also reserve space for future enhancements

such as intelligent recommendation features or OCR-based book recognition, which can be added in subsequent development phases to further enrich the platform experience.

Objective (3): Simulated Decentralized Transaction-Signing Workflow

This objective aims to construct a simulated Web3 transaction flow that demonstrates data integrity and decentralized verification principles without connecting to an actual blockchain. When users initiate purchases, the system will generate a transaction payload that must be “signed” using a simulated private key. The backend will verify this signature before authorizing the transaction. This design also establishes a groundwork for optional future integration with real blockchain-based payment or escrow mechanisms.

Objective (4): High-Quality User Experience and Extensible Architecture

This objective emphasizes delivering a clean, modern, and responsive user interface that aligns with the standard of consumer-grade applications. The underlying system architecture—built using a modular three-tier structure with a dedicated Web3 simulation service—is intentionally designed for maintainability and scalability, enabling smooth adoption of real blockchain networks or additional smart features in the future.

Technical Approach

This section outlines the strategic methodology for achieving the project's objectives. Our approach is structured around a modern, iterative development lifecycle, ensuring that we first understand user needs, translate them into precise specifications, select appropriate technologies, and architect a robust and scalable system. The core of our strategy involves simulating key Web3 behaviors—specifically wallet-based authentication and transaction signing—within a controlled, educational environment, allowing us to demonstrate the principles of decentralized identity and secure transactions without the complexities of a live blockchain network.

Customer Needs

To accurately identify the needs of our target users—university students—we will employ a multi-faceted approach. Initially, we will conduct informal surveys and interviews within the campus community to gather direct feedback on the pain points of existing marketplace platforms. Key needs we anticipate and will validate include: a desire for a more secure and trustworthy trading environment, reduced friction in the user onboarding process, and a platform that feels modern and engaging. The need for verification to ensure all participants are part of the university community is paramount. Furthermore, users will require an intuitive system for listing items, searching with filters, and communicating securely with other users. By grounding our development in these user-centric needs, we ensure the final product is both functional and desirable.

Target Specifications

Based on the identified customer needs, we have derived the following target specifications to guide the design and development process

1. User Authentication & Verification: The system shall implement a simulated Web3 wallet login, where a user's wallet address serves as a unique identifier. A

backend verification process will link this address to a valid university email to ensure community membership.

2. Transaction Process: For payment, the system shall simulate a transaction signing flow. When a purchase is initiated, the backend will generate a unique transaction payload, which the frontend will prompt the user to "sign" with their simulated private key. A successful signature will be validated by the backend to authorize the transaction.
3. Core Marketplace Functionality: The platform must support creating, reading, updating, and deleting (CRUD) listings with images, titles, descriptions, and prices. It must include a search and filter function. A real-time messaging system between buyers and sellers is essential for negotiation and communication.
4. User Experience (UI/UX): The interface must be intuitive, responsive, and visually appealing, providing a user experience comparable to high-quality consumer applications.
5. Data Integrity & Security: All user data, including wallet addresses and item listings, will be stored securely in a relational database. The simulated signing process must use cryptographic principles to ensure the integrity of transaction data.

Technology Consideration

After evaluating several technology stacks, we have selected the following for their robustness, developer ecosystem, and alignment with our project goals. The technologies are categorized below for clarity.

Category	Technology	Justification
Frontend	React.js with TypeScript	Provides a component-based architecture for building a dynamic and maintainable user interface. TypeScript ensures type safety, reducing runtime errors.
Backend	Node.js with Express.js	Offers a unified JavaScript/TypeScript development stack (full-stack JS), simplifying development. It is lightweight, fast, and has a vast library ecosystem.
Database	PostgreSQL	A powerful, open-source relational database ideal for structuring complex relationships between users, listings, and messages.
Authentication	Simulated Web3 Auth (Public/Private Key Cryptography)	We will use libraries like ethers.js or web3.js in a simulated mode to generate key pairs and create/verify digital signatures, mimicking MetaMask's behavior without connecting to a live network.
Real-time	Socket.IO	Enables seamless, real-time bidirectional

Communication		communication for the chat feature between buyers and sellers.
Deployment & DevTools	Docker, Git	Docker ensures environment consistency from development to deployment. Git is essential for version control and collaborative teamwork.

System Architecture/Platform

The system will follow a classic three-tier architecture, enhanced with a dedicated service layer for handling Web3 simulations. This separation of concerns promotes scalability, maintainability, and clear data flow.

1. Presentation Layer (Frontend): A single-page application (SPA) built with React.js will serve as the user interface. It will handle all user interactions, including rendering pages, initiating login requests, and constructing transaction data for signing.
2. Application Layer (Backend): An Express.js server will act as the central hub, managing business logic and API endpoints. It will interface with the database and include a critical Auth/Web3 Simulation Service. This service is responsible for generating nonces for login challenges, verifying digital signatures to authenticate users, and validating transaction signatures to authorize payments.
3. Data Layer: A PostgreSQL database will persistently store all application data, including user profiles (linked to their wallet address), product listings, chat messages, and transaction records.

The platform will be developed cross-platform and deployed using Docker containers to ensure consistency across development and production environments. The architecture is designed to be modular, allowing for future expansion, such as integrating with a real blockchain network or adding a smart recommendation engine.

Project Management

The overall management strategy for this project encompasses task phase delineation, team member responsibilities, time planning, key milestones, and communication protocols with the sponsor/supervisor. To ensure the project's successful completion, we have established clearly defined development phases, a manageable work pace, and a monitorable progress management process. This project will adopt iterative development, a methodology characterised by defined phases and milestones. This approach represents a widely accepted best practice in engineering projects [Fox and McDonald, 1978], ensuring features are progressively deployed according to priority and deliverables are consolidated after each iteration.

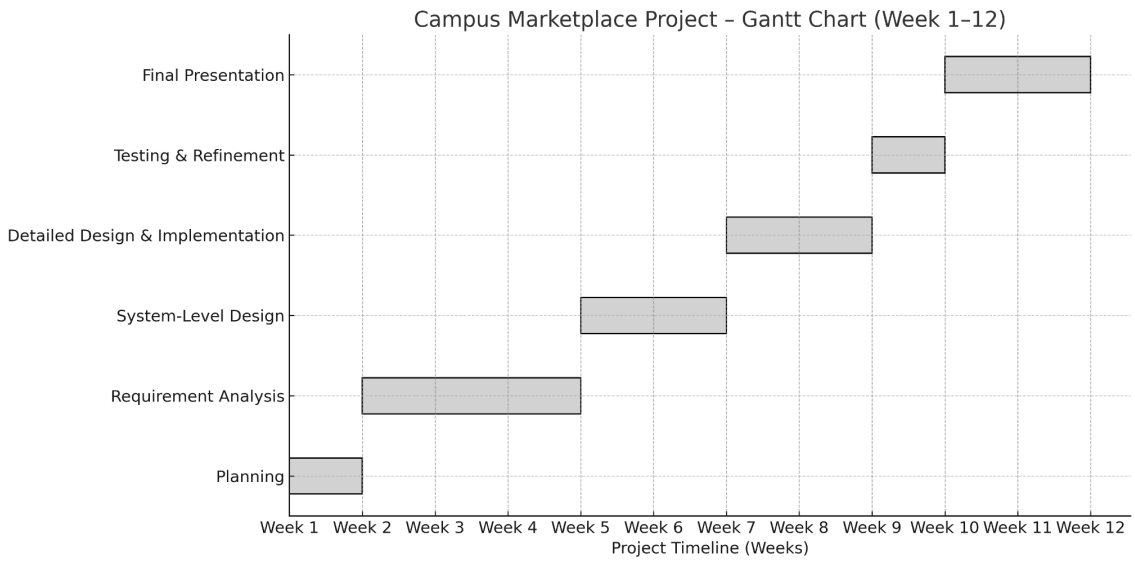

Figure 1: Gantt chart illustrating the planned 12-week project schedule, showing the sequential workflow from Planning to Final Presentation.

Deliverables

All project deliverables shall adhere to course requirements and be supplemented with blockchain-specific technical documentation to fulfil the auditable and transparent requirements of Web3 development [Varian Corporation, 2002].

Project Proposal（Week 2）

This document shall comprehensively outline the system's scope, functional objectives, user scenarios, and contextual challenges, whilst presenting a high-level architecture for the Web2 and Web3 composite framework. This includes the holistic relationship between the front-end presentation layer, back-end microservices layer, on-chain smart contract module, and wallet interaction layer..

SRS（Week 5）

This document shall comprehensively outline the system's functional requirements, non-functional requirements, use case models, data dictionary, and UI prototypes. In the section concerning Web3 expansion, we shall incorporate specifications for decentralised identity (DID) login procedures, ensuring users can authorise transactions password-free via their wallets. Concurrently, we shall define the on-chain metadata structure for goods, encompassing the hashed evidence format for goods, ownership representation methods, and status fields. To support more secure transaction methods, the SRS will incorporate smart contract requirements for escrow/guaranteed transactions, clarifying the on-chain state machine, fund flows, timeout mechanisms, role permissions, and exception handling. Furthermore, it will supplement an optional NFT-based ownership signing mechanism for goods, enabling

each item to be uniquely identified via a smart contract-issued token when necessary, thereby enhancing product credibility.

System-Level Design（Week 5–7）

During the system-level design phase (Weeks 5–7), the team will complete the comprehensive technical design for Web3 components, including: defining the smart contract interface (ABI) to specify on-chain invocation methods; developing a Web2–Web3 hybrid architecture diagram illustrating data flows between frontend, backend, and blockchain nodes; creating sequence diagrams for contract and backend service interactions to ensure consistency between on-chain and off-chain operational logic; and designing transaction signature and on-chain state machine workflows to standardise the complete lifecycle of user wallet authorisation, transaction validation, and state transitions.

Detailed Design & Implementation（Week 7–9）

During the detailed design and implementation phase (Weeks 7–9), the team will complete smart contract development (Solidity/Rust) and conduct unit testing using Foundry to validate core logic and security. Concurrently, a backend Web3 Service will be established to handle on-chain interactions, transaction transmission, and event monitoring. The frontend will integrate a wallet interface based on EIP-1193, implementing the user interaction workflow for wallet connection, authorisation, and on-chain operations. This will culminate in a fully functional Web2 + Web3 system framework.

Testing & Refinement（Week 9–10）

During the testing and optimisation phase (Weeks 9–10), the team will conduct security testing on the smart contracts, including validation against risks such as re-entrancy attacks, integer overflow, and access control. Concurrently, end-to-end full-chain testing will be executed, ensuring system logic consistency, transaction executability, and a seamless user experience through the complete call flow from wallets, front-end, back-end to contracts. This prepares the system for stability and reliability ahead of the final demonstration.

Final Presentation（Week 11–12）

During the final demonstration phase (Weeks 11–12), teams will integrate all technical deliverables into a fully functional prototype system. The objective of the demonstration is to illustrate, in the most intuitive manner, how Web3 technology enhances transaction credibility and process transparency.

Budget

The budget planning for this project is based on the hardware and software resources, development tools, testing environments, and additional blockchain-related costs required for the initial system design and implementation. As the project involves

dual-stack development encompassing both Web2 and Web3, we have incorporated cost estimates for smart contract development tools, testnet node services, and on-chain debugging environments beyond those of a traditional project. The budget design adheres to the principles of being 'reasonable, necessary, and auditable' to ensure the project can proceed smoothly within the allocated resources. The project budget breakdown is detailed in the table below, referencing equipment, tools, and service configurations commonly employed in engineering projects.

Table 1: Requested items and funds for initial design.

Item	Supplier	Quantity	Unit Price	Total
Project manager		1	$3,000.00	**$3,000.00**
Project team members		6	$3,000.00	**$18,000.00**
Computers	Dell	7	$1,000.00	**$7,000.00**
Printer	HP	1	$3,000.00	**$3,000.00**
Technology license（Cloud, Web3 Node）	Amazon.com	1	$2,000.00	**$2,000.00**
Development SDK（Web2 + Web3）	Oracle	1	$5,000.00	**$5,000.00**
Database	Oracle	1	$1,000.00	**$1,000.00**
Office rental	NTU	1	$6,000.00	**$6,000.00**
Transportation	Taxi	1	$1,000.00	**$1,000.00**
			TOTAL	**$46,000.00**

Communication and Coordination with Sponsor

The communication strategy for this project aims to ensure consistent direction, clear requirements, and trackable progress between the team and the supervising tutor/sponsor. Communication methods will follow the 'structured communication plan' recommended in the template, incorporating practical software engineering collaboration and Web3 project characteristics (such as the additional design reviews required for smart contracts).

The team shall submit weekly written progress reports to the mentor, covering completed tasks, ongoing work, technical challenges, and plans for subsequent phases. Additionally, fortnightly meetings with the mentor will focus on critical technical decisions, including system architecture, blockchain functionality implementation, and smart contract security. All meeting content will be documented in Meeting Minutes stored within the project repository to ensure audit transparency.

For day-to-day communication, the team will utilise WhatsApp/Telegram for instant messaging to swiftly confirm requirement changes, interface issues, or anomalies encountered during smart contract testing. Should any decision involve on-chain logic modifications, wallet interaction workflows, or system architecture alterations, a formal Change Proposal will be submitted. This ensures all members and the mentor are promptly informed of the scope of impact and can provide feedback.

Team Qualifications

Yangyanqi

Possesses experience with Kaia, and PICC; In addition, demonstrates strong capability in Python-based data analytics, statistical modelling, and automation workflows, and is also experienced in Java for systems development and backend logic implementation.

Zhangsong

Has experience in full-stack development for the Moledao Web3 community, mainly familiar with Go backend development.

Hushengquan

Possesses experience with DCS, Kaia, and Seth projects; proficient in Solidity/Rust smart contracts and Golang backend development; specialises in building Web3 applications within the Solana and Kaia ecosystems.

Huangqiyuan

Obtained a bachelor degree in Computer Science.

Qiuyixuan

Has experience in data analytics, software testing, and backend development, with a solid foundation in blockchain and computer science.

Fanqianyi

Experienced developer from Zhipu AI, a top LLM company in China, with a strong background in project development and DApp creation.

Conclusion

This proposal comprehensively outlines the design and implementation plan for the Web3 Campus Marketplace, a project initiated to address long-standing pain points in university second-hand trading and establish a more secure, interactive, and user-friendly campus trading ecosystem. By systematically organizing the project background, core issues, development objectives, technical routes, and management plans, this document fully demonstrates the necessity, feasibility, and innovation of the project, laying a solid foundation for subsequent development work.

The core value of this project lies in its precise response to user needs and innovative integration of Web3 technology. Traditional campus trading platforms are generally plagued by issues such as inadequate trust mechanisms, simplistic functions, and poor

user experience. In contrast, this project effectively resolves the problem of identity authenticity through a combination of simulated Web3 wallet authentication and campus identity verification, constructing a closed and trustworthy trading environment exclusively for students. Meanwhile, the platform integrates core functionalities including complete Create, Read, Update, Delete (CRUD) operations for product information, real-time messaging, and a community forum—fulfilling both essential trading needs and the social demands of the campus community. In terms of technology selection, the combination of React.js, Node.js, and PostgreSQL ensures system stability and maintainability; the simulated Web3 transaction process achieves a balance between technical demonstration and practicality, embodying the core advantages of decentralized security while avoiding the complexity and barriers associated with live blockchain networks.

At the project implementation level, the clear three-tier architectural design, detailed phased tasks, and rational division of team responsibilities provide strong guarantees for the smooth progression of the project. From the delivery of the project proposal and Software Requirements Specification (SRS) to the final system demonstration, each milestone has clear requirements and evaluation criteria, enabling effective control of project progress and ensuring delivery quality. Budget planning adheres to the principle of "reasonableness and necessity," covering expenditures on software, hardware, human resources, and other aspects to provide financial support for project implementation. Additionally, the structured communication mechanism with supervisors ensures that potential issues during development are identified and resolved promptly, maintaining consistency in the project direction.

Beyond immediate functional realization, this project also possesses significant long-term development potential and far-reaching impact. The modular system architecture reserves sufficient space for future upgrades—such as integrating official blockchain networks, adding intelligent recommendation systems, and implementing OCR book cover recognition—enabling continuous enhancement of platform competitiveness and user stickiness. For the campus community, the platform not only facilitates the efficient circulation of second-hand resources to achieve energy conservation and environmental protection but also cultivates students' understanding of Web3 technology through

practical application scenarios, laying the groundwork for their adaptation to the digital economy era. For the project team, the development process will comprehensively enhance capabilities in full-stack development, system design, and project management, fulfilling the practical objectives of undergraduate senior design.

In summary, the Web3 Campus Marketplace project features clear objectives, a scientific implementation plan, and significant practical value coupled with development potential. It not only effectively addresses current pain points in campus second-hand trading but also provides a new exploration path for the application of Web3 technology in campus scenarios. With the collaborative efforts of the project team and the professional guidance of supervisors, it is expected that all preset objectives will be successfully achieved, delivering a high-quality, user-recognized platform product that contributes to the digital transformation of campuses and the improvement of students' daily life convenience.

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Appendix A:
Résumés of Team Members

The following pages present one-page résumés of the team members for this project.

Yanqi YANG

Email:yanqi001@e.ntu.edu.sg

EDUCATION

Nanyang Technological University — **Singapore**
Master of Science in Blockchain Technology — *08.2025-present*

Temple University — **Tokyo, Japan**
Bachelor of Arts in Economics, Minor in Computer Science — *05. 2022-05.2025*

- GPA: 3.16/4.0
- Core Course: Database Management System, Math Concepts in Computing I, Micro Economics, Macro Economics, Statistical Business Analysis, Intro to Econometrics, Computer Programming in C, Program Design & Abstraction, etc.

National Taiwan University — **Taipei, China**
Academic Exchange Program — *09. 2023-12. 2023*

- Core Course: International Trade, Money and Banking, Perception Psychology, etc.

PROFESSIONAL EXPERIENCE

Ningbo Metals Processing Import and Export CO., LTD — **Ningbo, China**
Supply Chain Operations Assistant — *07. 2024-08. 2024*

- Undertook operation analytics to streamline supply chain operations
- Discussed with the senior management team to identify key constraints in the entire operation process
- Examined main clients' ordering cycles and suppliers' delivery cycles and set corresponding optimal stock range for products;
- Designed a new risk alert scheme for product shortage and overstocking and worked with the external IT team to adjust data flow in the information systems
- Sorted out data and carried out comparative analysis on potential warehouse locations in the Yangtze River Delta; Processed logistics costs, warehouse rental fees, and variable costs for the purpose of new warehouse selection

PICC P&C — **Ningbo, China**
Data Analyst Intern — *12. 2023-01. 2024*

- Researched databases like Wind and Choice to conduct analysis of macroeconomic and financial market data; traced the return rate of annuity products and identify potential risks
- Presented, visualized and interpreted data to output reports about global economic turbulence
- Participated in discussions about global economic risks and help agents and internal trainers gain a better understanding of issues including system risks and forex risks
- Compared functions of our insurance APP with APPs of other competitors, analyzed APP functions and user-friendliness from the perspective of clients, and proposed optimization ideas

RESEARCH EXPERIENCE

Course Project

- Directed 4 members to build and develop an attendance management system
- Proactively performed independent research on the PyQt GUI framework and SQL queries
- Offered guidance to members and properly distributed responsibilities based on their workload
- Adopted Git for version control and reviewed the overall output of the project
- Performed debugging and arranged discussions for further improving the customization for target users

ADDITIONAL

Languages: Mandarin (native), English (fluent), Japanese (Intermediate)
Technical skills: Proficient in SQL, Python, Java and Git(GitHub) version control; familiar with Rust and C
Certificates: IELTS 7.0

ZHANG Song

Email: zhangsong20021002@163.com / Mobile: (+86) 15385333815，(+65) 85979723

EDUCATIONAL BACKGROUND

Anhui University (AHU) **Hefei, Anhui**

Bachelor of Engineering 09/2021-06/2025

Programme: Intelligent Science and Technology

Related Courses: *Algorithm Analysis and Design , Curriculum Design of Machine Learning , High-level Language Programming , Pattern Recognition and Machine Learning , Experiments in Operating System, Digital Logic, Experiments of Database Principle, Principles of Database Systems , Computer Vision , Intelligent Human Interaction , Embedded Systems , Operating Systems*

Nanyang Technological University (NTU) **Singapore**

Master of Blockchain 09/2025-Present

Related Courses: *Web programming*，*Intro to the Blockchain*，*Token economics*，*Crytography*，*Distributed system....*

INTERNSHIP

Anhui Telecom Planning&Designing Co., Ltd. **Hefei, Anhui**

Mobile Communication Design and Planning Engineer 10/07/2024-10/08/2024

PUBLICATIONS

- Wrote, as the fourth author, Shenchun Qian; Hugen Yao; Tao Cheng; **Song Zhang**; Yufeng Wang; Yan Zhang (2024, July), *Point Marking Rebar Detection Algorithm Based on Regression-Classification Branch Attention,* published in **Institute of Electrical and Electronics Engineers (IEEE)**

ADDITIONAL

Technical Skills: C, C++, Python, CPP, html5, Js, Css, Mysql, MongoDB PS, PR

Languages: Chinese (Native), English (Fluent)