Example 1

Project Title: A blockchain-based application to verify higher education certificates

Project Aim

• The aim of the project is to build a blockchain based application that allows for potential employers, academic institutions, and any other interested parties to verify the legitimacy of academic certificates. Universities should be able to publish certificates to the blockchain. Potential employers should be able to verify certificates using a front-end web application that accesses the blockchain. Students should also be able to access and download their certificates.

• As reported in 2018, only around 20% of UK employers run proper checks on applicants' qualifications (Clifton et al.). In 2015 Axact, a company which operates a network of hundreds of fake online universities, sold more than 215,000 fake qualifications (Clifton et al.). As such, fake certificates are a big problem for employers. For this reason, a tamper proof, blockchain based solution would negate this risk. A blockchain based solution would also remove the need for a middleman that verifies degree legitimacy.

Related Work

• Jirgensons and Kapenieks, 2018, explore two implementations of blockchain educational technology; Blockcerts by the MIT Media Lab and Open Digital badges by the Open University. Blockcerts is a full-scale blockchain education credentialing system built on Bitcoin and Open Digital badges is built using Ethereum smart contracts. The paper found that both implementations provided a very high level of security due to the nature of distributed ledgers, however detailed potential issues with the scalability of both speed and storage.

• Rama Reddy et al., 2021, proposes a prototype blockchain based system where certificates are stored on the blockchain and can be accessed through a front-end web app. The proposed application successfully stores certificates on the blockchain in a tamper-proof manner, however the proposed implementation raises concerns with storage scalability since storing many thousands of student's certificates would become very costly.

• San, Chotikakamthorn and Sathitwiriyawong, 2019 propose a Merkle tree-based solution for storing hashes of degree certificates on the blockchain in a way that maximises memory efficiency and allows for differing types of certificates to be stored.

• Gupta and Nath, 2020 propose an incentive based blockchain system for delivering courses, as well as storing student credentials. This application is more complicated than the previous proposals. It contains a system for conducting examinations, marking, storing grades and storing certificates. It also implements an ERC20 token that is used within the application to incentivise markers to mark exam papers to a high level.

Project Objectives/Deliverables

• We will develop a back-end that employs smart contract(s) to allow data to be stored on and accessed from the blockchain.

• We will develop a front-end to the application that allows different types of users to access the smart contracts to upload certificate signatures, as well as verify existing certificates.

• Include a way for students to view and download their certificates using either a centralised or decentralised database.

• Create different permissions for different users. For example, only universities should be able to upload certificates.

• The usage of the application must be tamper-proof. This means that it must not be possible for any user to compromise the system in such a way that it allows for fake certificates to present as legitimate, and visa-versa.

Methodology

• Research will be conducted on related work to determine the best way to implement the storage of certificates on the blockchain.

• The front end will be developed using the NodeJS React framework. In order for users to upload new certificates and verify existing certificates, a user interface (UI) will be developed that includes the option to browse local files to upload/verify, or a space to drag and drop local files to upload/verify.

• The application will be developed to include certificate storage for students. This is to be achieved either using a centralised database that is verified using merkle tree, or to use a web3 based storage solution such as IPFS (InterPlanetary File System).

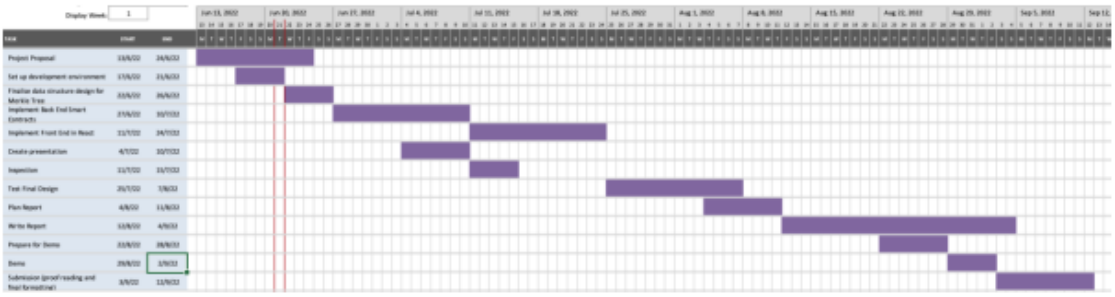
• We will develop smart contract(s) to store data in the blockchain. In particular, the data stored on the blockchain should be in a form of a merkle tree that contains hashes of each piece of data. Doing so will allow for different types of data to be stored within the same data structure (different types of certifications), as well as allowing for only the Merkle root to be stored on-chain. This would reduce blockchain storage costs if the application were to be deployed on to a main network. Successful delivery of this aim will be in the form of working smart contracts deployed to a local test network, that can be utilised by the application. The backend of the application will be developed using the truffle framework. This allows smart contracts written in Solidity to be deployed to the blockchain.

• To ensure that only legitimate certificate signatures are stored on the blockchain, the application will include different permissions for different users. This will be achieved by either assigning upload rights to specific Ethereum accounts or including a traditional centralised account management system.

• Ganache will be used to create a local Ethereum test network that will allow the back end of the application to be developed and tested with no cost. Mock data will be used to evaluate the feasibility of the system running on the local test network.

Project Plan

• Previous experience with web development, specifically with Node and React. Therefore, the only new skills to learn are truffle, solidity, and smart contracts.



Risks and contingency plan:

• Self-learning the blockchain based parts of the project may prove to be challenging. This includes: learning the Solidity language, learning the Truffle framework, and learning how to develop and deploy smart contracts.

• The complexity of this side of the project has been kept to a minimum. Additionally, a large portion of time has been devoted to this part of the project (as per the project plan).

• If the project is completed ahead of schedule, then there will be scope to add more functionality to the application such as file storage.

Hardware/Software Resources

• There are no specialised HW/SW resources required to complete this project. A personal laptop will be used for the coding portion of the project.

Data

• There are no datasets required to complete the project as mock data will be created.

References

Helen Clifton, Matthew Chapman, and Simon Cox. 2018. Staggering trade in fake degrees revealed. https://www.bbc.com/news/uk-42579634. Accessed June 21, 2022.

Jirgensons, M. and Kapenieks, J. (2018). Blockchain and the Future of Digital Learning Credential Assessment and Management. Journal of Teacher Education for Sustainability, 20(1), pp.145–156. doi:10.2478/jtes-2018-0009.

Rama Reddy, T., Prasad Reddy, P.V.G.D., Srinivas, R., Raghavendran, Ch.V., Lalitha, R.V.S. and Annapurna, B. (2021). Proposing a reliable method of securing and verifying the credentials of graduates through blockchain. EURASIP Journal on Information Security, 2021(1). doi:10.1186/s13635-021-00122-5.

San, A.M., Chotikakamthorn, N. and Sathitwiriyawong, C. (2019). Blockchain-based Learning Credential Verification System with Recipient Privacy Control. 2019 IEEE International Conference on Engineering, Technology and Education (TALE). doi:10.1109/tale48000.2019.9225878.

Gupta, J. and Nath, S., 2020, May. Skillcheck: An incentive-based certification system using blockchains. In 2020 IEEE International Conference on Blockchain and Cryptocurrency (ICBC) (pp. 1-3). IEEE.

Example 2

Project Title: Android based On-Street and Off-Street Parking Availability Prediction & Space Reservation model.

Project Aim:

To develop a real-time smart parking android application intended to effectively assist drivers in locating parking spaces by using IoT data. This application not only makes it simple to find a parking space but also saves time, lessens pollution and traffic, increases safety, improves the driving experience of its users, and lowers management and operating expenses. The system consists of an IoT-based prototype to demonstrate the feasibility of the proposed app.

Related work:

There are several parking systems which have been developed in the past. According to the study [1], a system for locating open parking places would rely on a network of sensors. Additionally, cameras are used to capture images of the parking spaces and these images are transmitted to a centralised system for analysis. This system showed encouraging results, however, it produces a huge amount of image data that must be sent across a network to a centralised system, which raises the cost of data transmission and more energy consumption. The research paper [2], is a study on multiple parking systems. It demonstrates how each smart parking system works to lessen traffic, especially in locations where there are traffic jams and a shortage of parking spaces. Studying various sensor technologies, one of the most crucial elements of the smart parking system, allows for a comparison of the benefits and drawbacks of each sensor technology. This study also comes to the conclusion that there are certain downsides to adopting a visualbased technique to identify vehicles.

In the study [3], the parking availability for both on and off-street parking places at the projected arrival time of the driver is predicted using the autoregressive model. It is employed to suggest the parking space with the greatest likelihood. The findings show that the suggested approach provides very reliable parking site recommendations to drivers. The algorithm was shown to propose a parking spot to a vehicle with an accuracy of roughly 95% during a 20-minute forecast horizon. Using this study, the proposed project can be implemented to achieve higher accuracy. Additionally, the survey's results in [4] indicate that people have a strong demand for more precise, and personalised parking information both before and during the journey. The proposed system will employ a micro-controller device to represent the information to the user on the map with the aid of the Google API. This will conserve energy and minimise the quantity of communicated data.

Most of these systems are either completely sensor-based [1] [2] or information and guidance based [3] [4]. The former model focuses on finding the status of parking spaces while the latter provides information using message signs and parking space availability for a specific place. These systems might solve the problem of finding a parking space but don’t solve the difficulties in finding the nearest parking spot from the user’s location, an alternative parking spot, and booking these parking spaces in advance. They also do not provide a subscription-based model, automatic payment system, and on-street parking services which can save the user time and make their life more effortless. There are a few systems that might solve a few of these problems but they do not provide an accurate personalized parking solution which is the main aim of the proposed android application.

Project Objectives/Deliverables:

• To use google maps API and sensor-tagged location data to provide basic functions like booking, finding and navigating the customer to the empty/booked parking slot.

• To develop a subscription-based parking system which allows users to book a space in advance for the required dates using the IR sensor data received from the required parking space/area.
• To design a solution to find the nearest parking space around the customer's required location, which would display the location of the parking spaces with per hour parking prices on the user's map.

• To create an automatic payment system which reduces human interaction.

• To assist in finding a personalised parking spot for the user from the available data sets using machine learning algorithms.

• To provide a dependable and dynamic on-street parking support which can be achieved using the data received from the IR sensors installed at the parking spaces.

To achieve the above-mentioned objectives the proposed system will focus and comprise of:

• Data from the IoT components like IR sensors and QR scanners installed in parking spaces can be collected and formulated into meaningful information. • Use of machine learning algorithms on the data sets used and provide a personalized parking experience to users. These objectives when implemented successfully would ensure to achieve the accurate dynamic model as proposed.

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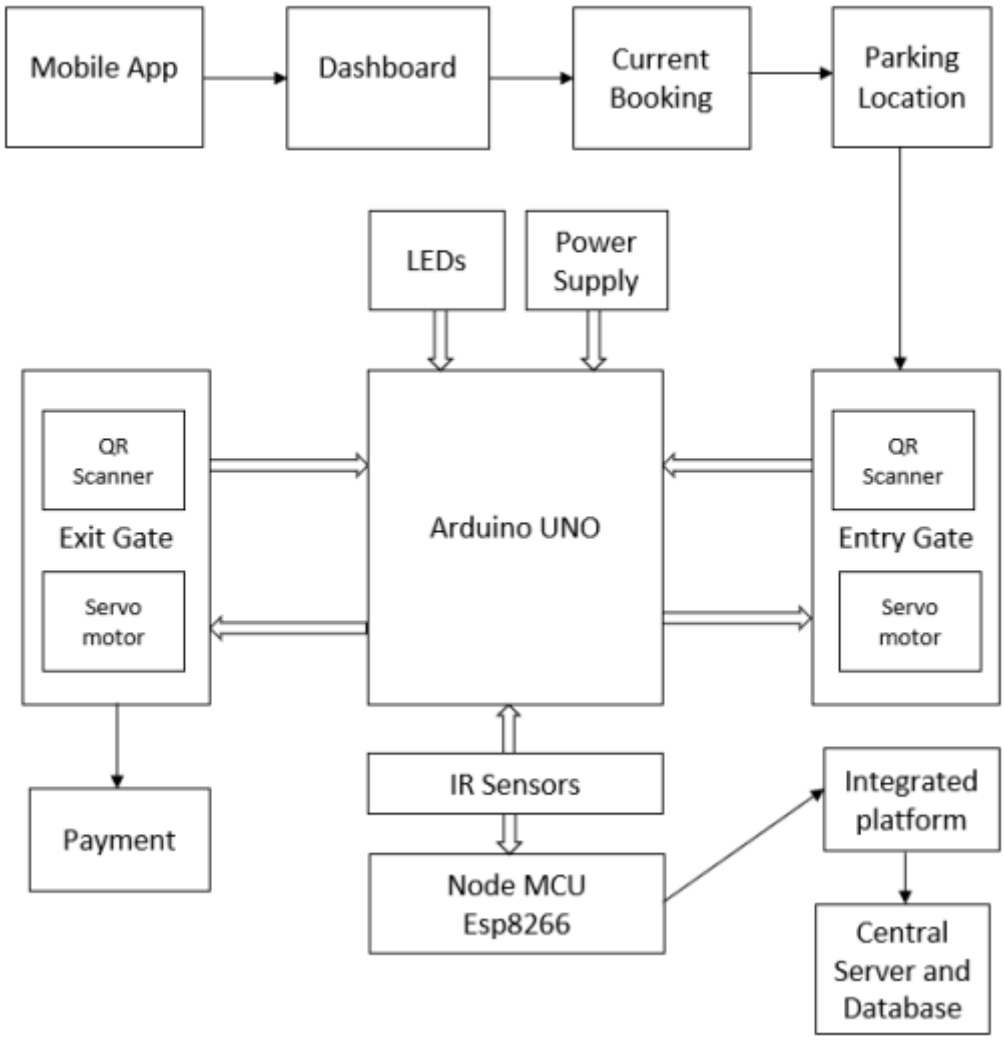
Methodology:

The whole process can be divided into various blocks. One process can be the wireless connection and another wired connection. The user first books the slot using the data derived from IR sensors which provide slot number, floor, navigation details, QR code, and QR scanner. These are used in the wireless process. In the wired connection, Arduino, IR sensor, Wi-Fi module, LEDs can be used. From the QR code, information will be sent to the QR scanner then Arduino will get that information. For valid information, the gate will be opened. The parking amount and parking time are calculated automatically using the data from IR sensors and the time QR was scanned from the exit gate. Then the payment is automatically made for that time. Similarly, for on-street parking the slot there would not be any QR code but the slot booking, and cost details are calculated using the data from IR sensors.



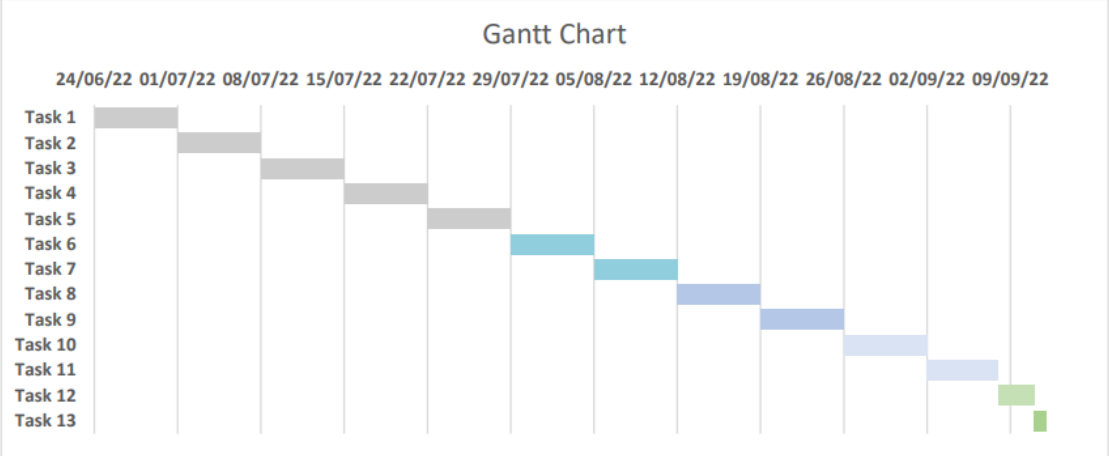
Block Diagram

The application will be equipped with a lot of features and is easy to use which suits the customer's needs. At its most basic, the user can search for the parking places around their required location or pre-book the slot in the preferred location. When the user searches for a parking space, a map is displayed with the spaces available. This also shows their tariffs and the distance from the user's location. The user can also filter parking sites with support for disabled parking and electric vehicle chargers. A special feature is enabling users to book the parking spaces in the form of a subscription model where the user can book a parking space for multiple days at once. The payment for this feature can be completed at once or after each day. The payment feature in the app will support the customers to make their purchases using the smartphone rather than to carrying cash or credit cards around to vending machines. An optional feature is provided to the user where the payments will be made automatically in the application once the user leaves the parking spot. This can be achieved with the help of sensor data. Drivers can also view/manage the current parking bookings, past parking sessions and invoices.

Project plan:

• Feasibility: Explain why your skills/expertise and the available resources are sufficient to complete the project in time. I have previously worked on an IoT project where I have experience on how to set communication between the IoT components. During my degree at the University of Birmingham, I have studied the modules Mobile Ubiquitous and Computing and Human-Computer Interaction where we

Gantt chart with tasks and milestones, reflecting the project objectives/deliverables.



Task Number	Task Name	Description
Task 1	Design and Implementation (1)	Basic design implementation.
Task 2	Design and Implementation (2)	Develop basic functions like booking/cancelling a slot, navigation and starting IoT implementation.
Task 3	PPT for project inspection and Design and Implementation (3)	PPT for project inspection and completion of IoT system implementation.
Task 4	Design and Implementation (4)	Implementation of payment model, subscription model.
Task 5	Design and Implementation (5)	Implementation of machine learning algorithms for personalization
Task 6	Design and Implementation (6), Testing and Evaluation (1)	Complete the entire application flow and start testing with basic test cases.
Task 7	Testing and Evaluation (2) and Project Improvements (1)	Application improvements based on test case results and further testing with more test cases.
Task 8	Project Improvements (2), Evaluation and Writing (1)	Begin evaluation of the project and report writing with further application developments.
Task 9	Project Improvements (3), Evaluation and Writing (2)	Complete further evaluations and improvements in application and update report with findings, goals achieved and limitations.
Task 10	Project Improvements (4) and Project Demo	PPT preparation and project completion for demonstration.
Task 11	Project Improvements (5) and Evaluation and Writing (3)	Complete the project based on feedback and add report with the conclusion, future work, references and appendices.
Task 12	Project and Report Completion	Complete the report and project with all improvements.
Task 13	Submit Project	Submit Project.

Risks and contingency plan:

• What might happen that would prevent you from reaching the project objectives?

The IoT components which are being used might stop working or can malfunction at any point during the development which can hinder the process of development. Some of the software side objectives might face implementation problems due to the difficulties that might arise while solving the objective.

• What are the particularly difficult aspects of the project which you are worried about completing?

Machine learning algorithms will be used in this project to provide customized parking for the user. From the available data sets, I will try to implement the machine learning model, but I am worried that the results might not be very accurate as this is the first time I would be implementing a machine learning model and also I am not sure how much data is enough data for implementing this.

• What is your contingency plan if there are problems? Re-purchase IoT components or buying extra components to counter the failure of any components can be done. If any of the software objectives face any issues due to implementation problems, a maximum functioning of that objective will be tried to implement. For the machine learning model as well, the maximum possible will be implemented in case of any problems.

Hardware/Software Resources

• What HW/SW resources will be required to complete the project? Hardware resources: Arduino board, IR sensors, LED's, Wi-Fi module/GSM module, QR scanner which will be implemented using a Mobile phone, and Servo motor. Software resources: Flutter, Eclipse, Git, Postgres SQL.

• Does the student/supervisor have access to these resources? Yes Data

• What datasets (if any) are required to complete the project?

Parking information for the demo places like the University of Birmingham and Selly Oak or any other related spaces.

• Does the student/supervisor have access to this data? Yes

References:

[1] Baroffio, Luca & Bondi, Luca & Cesana, Matteo & Redondi, Alessandro & Tagliasacchi, Marco. (2015). 'A visual sensor network for parking lot occupancy detection in Smart Cities.' 745-750. 10.1109/WFIoT.2015.7389147.

[2] Idris, Mohd & Y.Y, Leng & E.M, Tamil & N.M, Noor & Razak, Zaidi. (2009). 'Car Park System: A Review of Smart Parking System and its Technology'. Information Technology Journal. 8. 10.3923/itj.2009.101.113.

[3] Rajabioun, Tooraj & Ioannou, Petros. (2015). 'On-Street and Off-Street Parking Availability Prediction Using Multivariate Spatiotemporal Models.' IEEE Transactions on Intelligent Transportation Systems. 16. 1-13. 10.1109/TITS.2015.2428705. [4] Ji, Yanjie & Guo, Amy & Blythe, Philip & Tang, Dounan & Wang, Wei. (2013). 'Understanding drivers perspective on parking guidance information.' IET Intelligent Transport Systems. 7. 10.1049/ietits.2012.0167.