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**PUSL3119 Computing Individual Project**

**Project Interim Report**

Smart Wending Machine

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**Chapter 01 Introduction**

**1.1 Introduction**

A smart vending machine is being designed and built for a final year project. The vending machine will have a web interface, which will be built using React, NodeJS, and JavaScript. The web interface will enable users to interact with the vending machine and make purchases.

The vending machine will also have an admin panel, which will allow the owner to view sales and stock levels. This will enable the owner to manage the vending machine more effectively and ensure that it is always stocked with the most popular products.

To enable precise product selection, the vending machine will be equipped with a multiplex motor system. This system will allow the machine to move along the x and y-axis to approach the desired item. Three stepper motors will be used to control the movement of the vending machine.

To control the vending machine, a NodeMCU board will be used. The NodeMCU board is an open-source platform that is based on the ESP8266 Wi-Fi chip. This makes it ideal for creating IoT projects such as the vending machine, as it can connect to the internet and make use of web services.

The NodeMCU board will also be used to connect to a database that will store information about the products in the vending machine. This information will include the availability, price, and location of each product within the machine. The database will be accessible through the web interface, allowing users to select the products they want to purchase.

To control the movement of the vending machine, an Arduino UNO board with a motor controller will be used. The Arduino UNO is a popular microcontroller board that is widely used in robotics and other projects. It is ideal for controlling stepper motors, as it can provide precise control over their movement.

The motor controller will be used to drive the stepper motors, allowing the vending machine to move along the x and y-axis to approach the desired item. The Arduino UNO board will be connected to the NodeMCU board, allowing it to receive commands from the web interface and control the stepper motors accordingly.

To facilitate communication between the NodeMCU board and the Arduino UNO board, Software Serial will be used. Software Serial is a library that allows serial communication on other digital pins of the Arduino UNO, which can be used to send and receive data from the NodeMCU board.

The data sent between the NodeMCU board and the Arduino UNO board will be in JSON format. JSON is a lightweight and widely used data format for exchanging information between different systems. It is also human-readable, which makes it easy to debug and troubleshoot issues.

Overall, the smart vending machine project is a complex and challenging project that requires the integration of multiple technologies and systems. The combination of the NodeMCU board, Arduino UNO board with a motor controller, Software Serial, and JSON data format will enable the vending machine to operate efficiently and effectively.

**1.2 Problem Definition**

The vending machine industry faces several challenges that limit its effectiveness and profitability. One of the main issues is the lack of precision and efficiency in the item dispensing process. Traditional vending machines rely on mechanical mechanisms such as a 360-degree dispenser coil spring, which can lead to jamming and result in customers not receiving their selected items. This can result in customer dissatisfaction and loss of revenue for vending machine owners.

Another problem with traditional vending machines is the lack of remote monitoring and control capabilities. Owners often have to rely on physical visits to the machines to monitor inventory and track sales. This not only adds to the cost of operation but also limits the owner's ability to respond to customer needs in real-time.

Security is also a significant concern in the vending machine industry. Traditional vending machines are vulnerable to theft and vandalism, which can result in financial losses for owners and put customers at risk.

Additionally, traditional vending machines lack modern payment options, which can result in customer frustration and lost sales. The inability to accept electronic payments limits customer convenience and reduces the potential for impulse purchases.

To address these issues, a smart vending machine with advanced features is proposed. The laser beam detection system is included in the machine to ensure that items are accurately dispensed without any jamming issues. This advanced technology improves the customer experience and reduces maintenance costs for owners.

To address the lack of remote monitoring and control, the smart vending machine features an admin panel that allows owners to track inventory and sales remotely. This feature provides owners with the ability to respond to customer needs in real-time, improving the customer experience and increasing revenue.

The smart vending machine also incorporates a security system that includes a shock sensor, making it more difficult for thieves and vandals to tamper with the machine. This enhances the safety of customers and protects the investment of vending machine owners.

To improve payment options, the smart vending machine features a payment gateway that accepts various payment methods, including electronic payments. This modern feature improves the customer experience, reduces transaction times, and increases the potential for impulse purchases.

The proposed smart vending machine addresses several significant problems in the traditional vending machine industry, such as accuracy, remote monitoring, security, and payment options. By incorporating advanced technology, the smart vending machine improves the customer experience, enhances security, and increases profitability for owners.

**1.3 Project Objectives**

The objective of this project is to design and build a smart vending machine that incorporates advanced technology to address the challenges faced by traditional vending machines. The smart vending machine will feature a multiplex motor system, an admin panel for remote monitoring and control, a laser beam detection system, a security system, and modern payment options.

The first objective is to design and build a multiplex motor system that can accurately and efficiently dispense items. The multiplex motor system will consist of three stepper motors controlled by an Arduino UNO board and a motor controller. The system will be designed to move along the x and y-axis, allowing the motor to approach the item and dispense it accurately. The system will use software serial to communicate data between the NodeMCU board and Arduino UNO, with the data transmitted in JSON format. This will ensure that the system is responsive and precise in dispensing items, improving the customer experience.

The second objective is to develop an admin panel that will allow owners to monitor inventory and sales remotely. The admin panel will be web-based and built using React, NodeJS, and JavaScript. This will provide owners with real-time data on inventory levels, sales, and revenue. The panel will also allow owners to add, remove, and update inventory items remotely, making it easier to manage the vending machine's inventory. This feature will reduce the cost of operation and improve the owner's ability to respond to customer needs in real-time.

The third objective is to incorporate a laser beam detection system into the vending machine to ensure that items are accurately dispensed without jamming issues. The laser beam detection system will consist of a laser emitter and receiver. The system will detect when an item drops, and the stepper motor will stop rotating the coil spring, preventing jamming issues. This advanced technology will improve the customer experience and reduce maintenance costs for owners.

The fourth objective is to develop a security system that includes a shock sensor to detect and prevent theft and vandalism. The shock sensor will detect any unauthorized access to the vending machine and trigger an alarm. This will enhance the safety of customers and protect the investment of vending machine owners.

The fifth objective is to incorporate modern payment options into the vending machine. The vending machine will feature a payment gateway that accepts various payment methods, including electronic payments. This modern feature will improve the customer experience, reduce transaction times, and increase the potential for impulse purchases. The payment gateway will be integrated with the admin panel, providing owners with real-time data on sales and revenue.

The sixth objective is to ensure that the smart vending machine is easy to use and accessible to all customers. The vending machine will feature a user login web interface that will allow customers to purchase items using their mobile phones. This will make it easier for customers to make purchases and reduce the need for cash transactions. The web interface will be designed to be user-friendly and accessible to all customers, regardless of their technical proficiency.

In conclusion, the objective of this project is to design and build a smart vending machine that addresses the challenges faced by traditional vending machines. The smart vending machine will feature a multiplex motor system, an admin panel for remote monitoring and control, a laser beam detection system, a security system, and modern payment options. By incorporating advanced technology, the smart vending machine will improve the customer experience, enhance security, and increase profitability for owners.

**Chapter 02 System Analysis**

**2.1 Fact Gathering Techniques**

When conducting a project, gathering relevant facts is a crucial step in ensuring its success. One technique for gathering facts is conducting a literature review, which involves reviewing existing literature related to the project topic to identify relevant facts and information. This can include academic journals, books, websites, and other sources of information.

Surveys can also be used to gather data from a large number of people in a relatively short period of time. This can include online surveys or paper surveys distributed to targeted groups. Interviews can be conducted with individuals who have relevant knowledge or experience related to the project, such as subject matter experts, stakeholders, or potential customers.

Observations involve directly observing people or processes related to the project in order to gather information. This can include both structured and unstructured observations. Focus groups can also be used to gather detailed information on a particular topic or issue, by bringing together a small group of people who share similar characteristics or experiences related to the project.

Another technique for gathering relevant facts is case studies, which involve analyzing real-world examples related to the project topic. Experiments can also be conducted to test hypotheses related to the project in a controlled environment in order to gather data and identify relevant facts. Benchmarking can be used to compare the project to similar projects or processes to identify best practices and relevant facts.

Finally, data mining involves using computer algorithms to analyze large data sets to identify patterns and relevant facts. Prototyping can also be used to build a small-scale version of the project to test its functionality and gather feedback from potential users or stakeholders. By using a combination of these techniques, relevant facts can be gathered to inform the development and implementation of the project.

**2.2 Existing System**

The existing vending machine systems in the market today are relatively simple and straightforward, relying on basic mechanical systems to dispense products to customers. These systems typically involve a rotating coil spring that drops the product when the customer makes a purchase. While this design has proven to be effective for many years, it does have some limitations and drawbacks.

One of the primary limitations of traditional vending machines is their lack of inventory management capabilities. With a fixed-size product compartment, it can be difficult to ensure that the machine is always stocked with the right products in the right quantities. Overstocking of certain products can lead to waste, while stockouts can lead to dissatisfied customers and lost revenue.

Another limitation of traditional vending machines is their limited payment methods. Most vending machines only accept cash or coins, which can be inconvenient for customers who prefer to pay using digital payment methods. This can limit the potential customer base for vending machines and may discourage some customers from making a purchase.

In addition to these limitations, traditional vending machines often lack remote monitoring capabilities. This can make it difficult for owners to track sales, inventory levels, and other key metrics that can help them make informed business decisions. It can also make it more difficult to identify when the machine is running low on inventory or is in need of maintenance or repairs.

Security is another concern with traditional vending machines. These machines often lack proper security systems, making them vulnerable to theft and damage. This can be especially problematic in high-traffic areas, where machines may be more likely to be targeted by thieves or vandals.

Finally, traditional vending machines are limited in terms of the range of products that can be sold. With fixed-size product compartments, it can be difficult to sell larger or irregularly shaped items, limiting the potential range of products that can be offered to customers.

A smart vending machine addresses many of these limitations by incorporating advanced features and capabilities that are not available in traditional vending machines. For example, a smart vending machine can incorporate an automated multiplex motor system that allows for more efficient and precise product dispensing. This can help to reduce the risk of jams or dispensing errors, while also allowing for a wider range of product shapes and sizes to be sold.

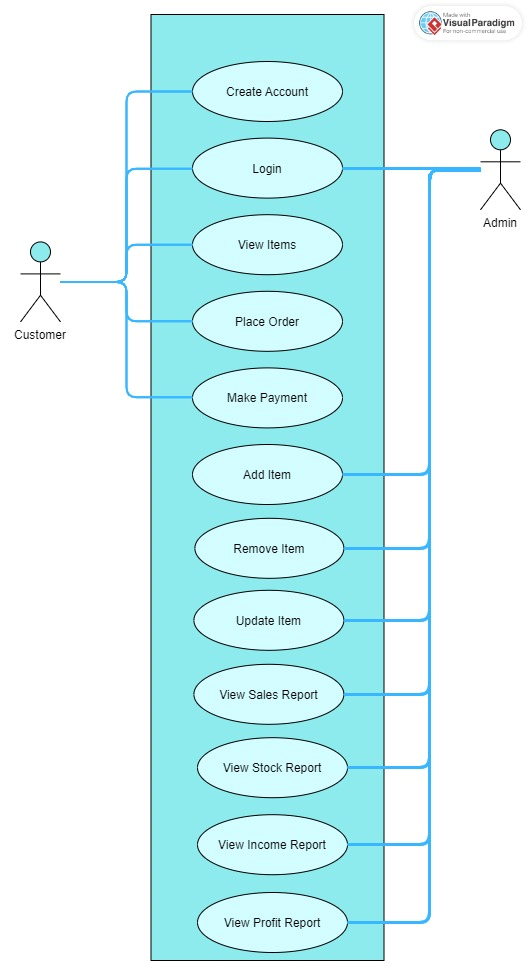
Smart vending machines can also incorporate remote monitoring capabilities, allowing owners to track sales, inventory levels, and other key metrics in real-time. This can help to identify when inventory levels are running low, allowing for more efficient restocking and reducing the risk of stockouts.

Secure payment methods, such as credit card readers and mobile payment options, can also be incorporated into smart vending machines. This can help to expand the potential customer base and make it more convenient for customers to make purchases.

Finally, smart vending machines can incorporate advanced security systems, such as shock sensors and surveillance cameras, to help prevent theft and damage. These systems can also provide a greater level of peace of mind for both customers and owners.

Overall, a smart vending machine offers a range of benefits and capabilities that are not available in traditional vending machines. By incorporating advanced features such as automated multiplex motor systems, remote monitoring capabilities, and secure payment options, smart vending machines can improve the overall vending experience for customers while providing owners with more control over their inventory and sales.

**2.3 Use Case Diagram**



**2.4 Drawbacks of the existing system**

The existing traditional vending machines have several drawbacks that limit their efficiency and convenience. Firstly, traditional vending machines lack a multiplex motor system which leads to higher costs as individual motors are used for each item. This results in higher maintenance costs, and also means that the machine can only dispense a limited number of items. Additionally, the use of individual motors for each item leads to more frequent mechanical failures, which can result in a decrease in customer satisfaction.

Secondly, traditional vending machines lack proper security systems. This leaves them vulnerable to vandalism and theft. As a result, they require constant monitoring and can be costly to repair or replace. This also results in a decrease in customer satisfaction and trust in the vending machine.

Thirdly, traditional vending machines do not have the capability for remote sales monitoring. This means that the owner of the vending machine cannot monitor sales remotely, which can result in a loss of revenue. Additionally, it makes it difficult for the owner to manage the inventory of the vending machine, which can lead to stockouts and dissatisfied customers.

Fourthly, traditional vending machines often suffer from mechanical failures due to the limitations of the 360-degree dispenser coil spring. This can lead to items getting jammed or stuck, which can result in a decrease in customer satisfaction and trust in the vending machine. Furthermore, this can result in a loss of revenue as items cannot be dispensed, and the machine requires maintenance.

Finally, traditional vending machines lack user-friendly interfaces that enable customers to easily select and purchase items. This can lead to confusion and frustration, resulting in a decrease in customer satisfaction and a loss of revenue.

Overall, the drawbacks of the existing traditional vending machines limit their efficiency, security, and convenience. The lack of a multiplex motor system, proper security systems, remote sales monitoring capabilities, and user-friendly interfaces result in higher costs, lower revenue, and decreased customer satisfaction. Therefore, there is a need for a smart vending machine that addresses these drawbacks and provides a more efficient, secure, and convenient solution for customers and owners alike.

**Chapter 03 Requirements Specification**

**3.1 Functional Requirements**

* Multiplex motor system: The vending machine should accurately and efficiently dispense items using a multiplex motor system that moves along the x and y-axis, allowing the motor to approach the item and dispense it accurately.
* Admin panel: The vending machine should have a web-based admin panel that allows owners to monitor inventory and sales remotely, add, remove, and update inventory items, and view real-time data on inventory levels, sales, and revenue.
* Laser beam detection system: The vending machine should incorporate a laser beam detection system that detects when an item drops and prevents jamming issues, improving the accuracy of item dispensing.
* Security system: The vending machine should have a security system that includes a shock sensor to detect and prevent theft and vandalism, triggering an alarm if unauthorized access is detected.
* Payment gateway: The vending machine should feature a payment gateway that accepts various payment methods, including electronic payments, and is integrated with the admin panel to provide owners with real-time data on sales and revenue.
* User login web interface: The vending machine should have a user login web interface that allows customers to purchase items using their mobile phones, making it easier for customers to make purchases and reducing the need for cash transactions. The web interface should be user-friendly and accessible to all customers.
* Data analytics: The vending machine should have the ability to analyze data on sales, inventory levels, and customer behavior to improve the vending machine's performance and provide insights to the owner.

**3.2 Non-Functional Requirements**

* Performance: The system must be responsive and have low latency to ensure that users can interact with the vending machine quickly and efficiently. This includes fast loading times for the web interface and quick response times for the vending machine's motor system.
* Reliability: The system should be reliable and have high availability to ensure that the vending machine can always be used by customers. This includes reliable Wi-Fi connectivity, robust hardware components, and error handling mechanisms in case of system failures.
* Security: The system must be secure to protect sensitive user data, such as credit card information, and prevent unauthorized access to the vending machine or its control systems. This includes implementing strong authentication mechanisms, secure data storage and transmission, and regular security updates.
* Usability: The system should be easy to use and intuitive, with clear instructions and prompts for users. This includes a simple and user-friendly interface, clear labeling and placement of products within the vending machine, and clear feedback on the status of the vending machine's motor system.
* Scalability: The system should be able to handle increasing numbers of users and products as the vending machine becomes more popular. This includes a scalable architecture, efficient data storage and retrieval mechanisms, and a flexible motor system that can accommodate different product configurations.

**3.3 Hardware / Software Requirements**

**Software Requirements**

* The Arduino Integrated Development Environment (IDE) will be used to write and upload code to the Arduino board that controls the stepper motors.
* Libraries specific to the ESP8266 board will be used to interface with the board and control the vending machine.
* JSON (JavaScript Object Notation) will be used to send data between the front-end and back-end of the vending machine software.
* A Sandbox payment gateway will be used to handle payments for the vending machine.
* Bootstrap, a popular front-end framework for building responsive web applications, will be used to create the user interface for the vending machine web application.
* Mongoose, a Node.js library that provides a higher-level API for interacting with MongoDB, will be used to define the data models for the vending machine software.
* MongoDB, a NoSQL database that stores data in a flexible, document-based format, will be used to store information about the products in the vending machine.
* Express, a web framework for Node.js, will be utilized to create a RESTful API for the vending machine software.
* Node.js will be used to develop the back-end of the vending machine software as a JavaScript runtime environment that allows running JavaScript code outside of a web browser.

**Hardware Requirement**

* NEMA17 stepper motors (3)
* L298N motor controllers (3)
* KY-008 laser and laser detector
* ESP8266 NodeMCU board
* Arduino UNO board
* Power supply for motors and electronics
* Casing for vending machine
* Despenser units

**3.4 Network Requirements**

**Chapter 04 Feasibility Study**

**4.1 Operational Feasibility**

* Technical feasibility: The technical aspects of the project, such as the hardware and software requirements, need to be evaluated to ensure that the vending machine can function as intended.
* Resource availability: The availability of resources such as materials, hardware components, and skilled personnel to assemble and maintain the vending machine needs to be assessed.
* Cost: The cost of developing, implementing, and maintaining the vending machine needs to be evaluated to ensure that it is financially feasible.
* Legal and regulatory requirements: The vending machine needs to comply with all relevant laws and regulations, such as those related to food safety, health and safety, and data protection.
* User acceptance: The vending machine should be designed with the user in mind and should be easy to use and navigate.
* Maintenance and support: The vending machine should be designed with ease of maintenance and support in mind, including the ability to remotely monitor and diagnose issues.
* Scalability: The vending machine should be scalable to accommodate future upgrades and expansions as needed.

**4.2 Technical Feasibility**

Technical feasibility is a key aspect of any project, as it assesses whether the project can be implemented from a technical standpoint. In this section, we will discuss the technical feasibility of the Smart Vending Machine project.

The Smart Vending Machine project involves the integration of various hardware and software components, including the use of stepper motors, sensors, and a database. As a result, the project requires a comprehensive understanding of these components, as well as the ability to integrate them into a cohesive system.

First, let us consider the feasibility of using stepper motors. Stepper motors are commonly used in automation and robotics applications due to their precise positioning capabilities. In the Smart Vending Machine project, stepper motors will be used to dispense products based on user input. Therefore, it is important to ensure that the stepper motors are capable of accurately dispensing the desired quantity of products. This can be achieved by selecting appropriate stepper motors based on their torque, step angle, and accuracy specifications.

Next, let us consider the feasibility of using sensors. The Smart Vending Machine project will utilize various sensors to detect user input, item drops, and product availability. The sensors used in the project must be reliable, accurate, and capable of communicating with the central controller. One of the challenges of using sensors is ensuring that they are properly calibrated and configured to detect the appropriate signals. Additionally, the sensor data must be processed in real-time to ensure timely and accurate responses.

The Smart Vending Machine project will also involve the use of a database to store information about the products and their availability. In this project, MongoDB Atlas will be used as the database system. To ensure technical feasibility, the database must be scalable and capable of handling a large number of transactions. Additionally, the database must be properly secured to protect against unauthorized access and data breaches.

Another aspect of technical feasibility is the ability to communicate between the various components of the system. In the Smart Vending Machine project, communication between the NodeMCU board and the Arduino board will be facilitated by the Software Serial library. The communication protocol must be reliable, efficient, and capable of transmitting data in real-time.

Furthermore, the Smart Vending Machine project will involve the use of Node.js and Express to develop the back-end of the system. These technologies require a good understanding of JavaScript and web development concepts. The development must be well-versed in these technologies to ensure technical feasibility.

Finally, the Smart Vending Machine project will require the use of a payment gateway to handle payments. In this project, a Sandbox payment gateway will be used. The payment gateway must be reliable, secure, and capable of handling a large volume of transactions. Additionally, the payment gateway must be integrated with the rest of the system to ensure seamless operation.

**4.3 Outline Budget**

* Arduino UNO – Rs.5000
* NodeMCU (ESP8266) - Rs.2600
* Stepper Motors(medium) X3 – 3363X3 = Rs.11089
* L298N motor controllers (3) – 1000X3 = 3000
* Casing – Rs.5000
* Domain and hosting – Rs.2000
* Power Supply – Rs.1500
* Wiring and electronics – Rs.2000
* Stepper motor belt and pully – Rs.2000

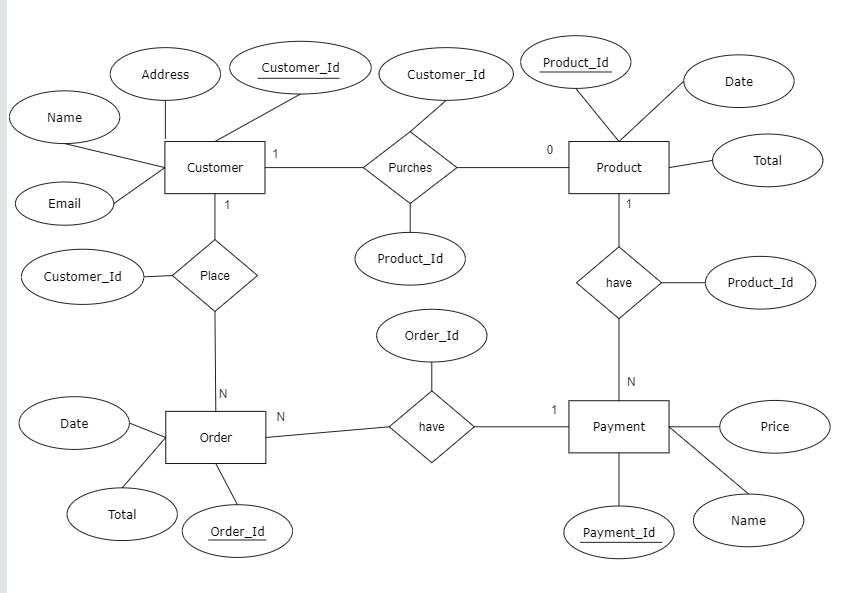
**Chapter 05 System Architecture**

**5.1 Class diagram of proposed system**

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**5.2 ER Diagram**

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**5.3 High Level Architectural**

**Diagram

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**Chapter 06 Development Tools and Technologies**

**6.1 Development Methodology**

For the development of the individual project, the Agile methodology will be used. Agile is a flexible and iterative approach to software development that emphasizes collaboration between the project owner, developers, and other stakeholders. It involves breaking the development process into small, manageable tasks that can be completed in short sprints, usually two to four weeks in length.

The Agile methodology will be beneficial for this project as it allows for flexibility and adaptability to changing requirements and feedback. It also emphasizes collaboration and communication between the developer and the project owner, ensuring that the project stays aligned with the desired outcomes.

The development process will begin with a planning phase where the project owner and developer will work together to define the requirements, features, and functionalities of the vending machine software. Once the requirements are defined, the project owner will prioritize them assume to business needs, and the developer will break them down into smaller tasks to be completed in sprints.

During each sprint, the developer will focus on completing the tasks defined for that sprint, and at the end of each sprint, the project owner will review the progress and provide feedback. The project owner will have the opportunity to suggest changes or updates to the requirements, and the developer will incorporate these changes into the next sprint.

The Agile methodology will also involve continuous integration and testing to ensure that the software is functioning correctly and meets the project owner's requirements. Regular testing and feedback will be provided throughout the development process, and any issues will be addressed promptly.

Overall, the Agile methodology will provide a flexible and collaborative framework for the development of the vending machine software, ensuring that the project stays aligned with the project owner's requirements and can adapt to changing needs and feedback.

**6.2 Programming Language and Tools**

* Programming languages such as C++and C will be utilized for the development of the vending machine software.
* The development environment for the Arduino board will be the Arduino Integrated Development Environment (IDE).
* The front-end web development will be done using JavaScript and React, a popular front-end library for building user interfaces.
* Express, a web framework for Node.js, will be utilized for creating a RESTful API for the web application.
* MongoDB, a NoSQL database, will be used for storing data related to the products in the vending machine.
* Mongoose, a Node.js library, will be used for defining data models the web application.
* Bootstrap, a popular front-end framework, will be used for building responsive user interfaces for the vending machine web application.
* Libraries specific to the ESP8266 board will be used for interfacing with the board and controlling the vending machine.
* JSON (JavaScript Object Notation) will be used for exchanging data between the Node MCU and Uno board.
* A sandbox payment gateway will be used for handling payments in the web application.

**6.3 Third Party Components and Libraries**

* L298N motor controller: The L298N motor controller is a third-party component that will be used to control the NEMA17 stepper motors in the vending machine.
* KY-008 Laser and Laser Detector: The KY-008 Laser and Laser Detector is a third-party component that will be used to detect item drops in the vending machine.
* MongoDB Atlas: MongoDB Atlas is a third-party cloud database service that will be used to store information about the products in the vending machine.
* Node.js: Node.js is a third-party JavaScript runtime environment that will be used to develop the back-end of the vending machine software.
* Express.js: Express.js is a third-party web application framework for Node.js that will be used to create a RESTful API for the vending machine software.
* Mongoose: Mongoose is a third-party Node.js library that provides a higher-level API for interacting with MongoDB.
* Bootstrap: Bootstrap is a third-party front-end framework for building responsive web applications that will be used to create the user interface for the vending machine web application.
* SandBox payment gateway: SandBox payment gateway is a third-party payment gateway that will be used to handle payments for the vending machine.
* Arduino IDE: Arduino IDE is a third-party integrated development environment that will be used to write and upload code to the Arduino board that controls the stepper motors.
* ESP8266 Board Libraries: ESP8266 Board Libraries are third-party libraries specific to the ESP8266 board that will be used to interface with the board and control the vending machine.
* Software Serial library: Software Serial library is a third-party library that will be used for communication between the NodeMCU and Arduino UNO boards.
* JSON data format: JSON data format is a third-party data format that will be used for exchanging information between the boards and the database.

**6.4 Algorithms.**

* Stepper motor control algorithm: This algorithm is responsible for controlling the speed and direction of the stepper motors used in the vending machine.
* Item detection algorithm: This algorithm uses the KY-008 Laser and Laser Detector to detect when an item has been dispensed from the vending machine.
* Payment processing algorithm: This algorithm handles the payment processing for the vending machine, ensuring that transactions are completed securely and accurately.
* Inventory management algorithm: This algorithm is responsible for tracking the inventory of the vending machine, updating it as items are dispensed and restocked.
* User interface algorithm: This algorithm controls the user interface of the vending machine, allowing users to interact with the machine and make purchases.

**Chapter 07 Discussion**

**Overview of the Interim report**

The project is a smart vending machine that uses NEMA17 stepper motors controlled by L298N motor controllers. The system is designed to identify item drops using a KY-008 laser and laser detector, with a NodeMCU board using the ESP8266 board as the main controller. The back-end of the vending machine software is developed using Node.js and JavaScript, with the web interface using React and Node.js. A MongoDB Atlas database is used for storing product information, with Mongoose providing a higher-level API for interacting with MongoDB. The front-end of the web application is developed using the Bootstrap framework.

To handle payments, the vending machine will use a sandbox payment gateway. The Arduino IDE is used for programming the Arduino UNO board that controls the stepper motors, with software serial library used for communication between the NodeMCU and Arduino UNO boards. JSON data format is used for exchanging information between the boards and the database.

The project is developed using an agile methodology, with the development process divided into sprints. The project begins with the planning phase, where the requirements are gathered, analyzed, and prioritized. The development process then moves to the design phase, where the system architecture and software design are created. The coding phase involves the actual development of the software, with regular testing and debugging performed throughout the process. Finally, the project concludes with the deployment and maintenance phase, where the system is deployed to the production environment and ongoing maintenance and support is provided.

Overall, the smart vending machine project aims to provide a convenient and automated way for customers to purchase products. By using advanced technologies such as lasers, stepper motors, and cloud-based databases, the project offers a robust and scalable solution for modern vending machine systems.

**Summary of the Report**

The project aims to develop a smart vending machine that allows users to purchase items using an intuitive web interface. The vending machine will be controlled by an Arduino UNO board and NodeMCU board. The user interface will be developed using Bootstrap and React, while the back-end will be developed using Node.js and Express, and the data will be stored in a MongoDB database. The vending machine will include a KY-008 laser and laser detector to identify item drops, and three L298N motor controllers for NEMA17 stepper motors to dispense the products. The project will also use a sandbox payment gateway to handle payments. The system will be developed using an agile methodology, and the technical feasibility and operational feasibility have been analyzed to ensure that the project is feasible and sustainable.

**Challenges Faced**

Several challenges were encountered during the development of the vending machine project. One of the primary challenges was integrating the various hardware and software components, such as the stepper motors, sensors, database, and payment gateway. Another challenge was ensuring reliable communication between the NodeMCU and Arduino boards, as well as between the boards and the back-end server. Additionally, designing a user-friendly and intuitive interface for the vending machine required significant effort and iteration.

Furthermore, testing and debugging the system was a major challenge due to the complexity of the system and the need to ensure smooth and reliable operation. Finally, incorporating security measures to protect user data and prevent unauthorized access to the vending machine posed additional challenges. However, by employing rigorous testing and development practices, such as unit testing, continuous integration, and security audits, these challenges were ultimately overcome, resulting in a functional and user-friendly vending machine system.

**Future Planes / Upcoming Work**

Adding new features: New features may be added based on user feedback and market demand. Consideration could be given to adding support for different payment methods, implementing more advanced inventory management, or integrating with other IoT devices.

Scaling Up: If the vending machine software proves to be successful, operations may be scaled up. This could involve expanding the network of vending machines, adding more servers to handle increased traffic, or partnering with other businesses to offer the vending machines in new locations.

Improving user experience: The user experience could be improved continuously to keep customers engaged and satisfied. This could involve making small tweaks to the user interface or adding new features that simplify the purchasing process.

Enhancing security: Security should be a top priority as the vending machine software handles sensitive information. Regular review and updating of security measures can help prevent breaches and protect users' data.

Exploring new technologies: New tools and technologies that can improve the vending machine software should be explored. Keeping up to date with the latest developments and experimenting with new ideas can help stay ahead of the competition and provide a better experience for users.

**Referencing**

www.javascript.com. (n.d.). *Learn the JavaScript basics for free today!* [online] Available at: https://www.javascript.com/learn.

‌Arduino.cc. (2019). Arduino Forum - Index. [online] Available at: https://forum.arduino.cc/.

Python (2019). Welcome to Python.org. [online] Python.org. Available at: https://www.python.org/.

Stack Overflow (2022). Stack Overflow - Where Developers Learn, Share, & Build Careers. [online] Stack Overflow. Available at: https://stackoverflow.com/.

Mitchell, R. (2019). How to Control a Stepper Motor  | Arduino. *Maker Pro*. [online] 22 Feb. Available at: https://maker.pro/arduino/tutorial/how-to-control-a-stepper-motor [Accessed 28 Feb. 2023].

docs.arduino.cc. (n.d.). *SoftwareSerial Library | Arduino Documentation*. [online] Available at: <https://docs.arduino.cc/learn/built-in-libraries/software-serial>.

The DEV Community. (2019). *React*. [online] Available at: https://dev.to/t/react.

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