Singapore Polytechnic

School of Electrical & Electronic Engineering

Mini Project (LAB3)

Mini-Project Themes

1. Smart Drink Vending Machine

Customer Requirements

- The drinks vending machine shall allow customers to purchase drinks physically at the vending machine or remotely via their smartphones or an external website
- At the vending machine the customers can select their drink/s using the numeric keypad and the LCD screen
- Payment of the drink/s can be done via the RFID card reader, QR code or Barcode using a camera connected to the vending machine or any other means
- Collection of drink/s purchased via their mobile phones or website is via a QR code or Barcode that is generated by the website or mobile App and scanned by a camera connected to the vending machine
- To avoid any theft of the drinks, the vending machine shall implement a burglar detection system to detect if the door of the vending machine has been forcefully pried open
- If the vending machine detects that there has been an attempt to forcefully open it then the buzzer shall be activated
- For service technicians and drinks suppliers, they need to enter a valid user code on the keypad in order to open the vending machine door without triggering the buzzer alarm

2. Library Book Reservation and Collection System

Customer Requirements

- To encourage and increase the number of people reading and loaning books from the public libraries, an automated book loan and return system is proposed.
- The system allows users to select the books that they would like to borrow online via a website or mobile App and make a reservation
- Users can also select which library branch they would like to collect the book from
- Reservations for any books that are not collected by the user within 5 days are automatically cancelled
- Each book has a loan period of 18 days and can be renewed only once for an additional 7 days
- Individual users are allowed to borrow a maximum of 10 books at any time
- There will be a fine of $0.15 per book for each day after the return date
- Users must pay any outstanding fines at the machine using the RFID card reader before being allowed to collect their book reservations
- To collect their books from the automated system, users will first need to scan the barcode on their NRIC or SP Student Card
- After a valid user has been authenticated, the system will then dispense the books to the customer.

3. Vehicle Security and Telematics System

Customer Requirements

- A new vehicle is being developed with additional functionalities that allow the user to remotely interact with their car as well as a security system that allows the driver to share their digital car keys as well as protect the car against theft

- From a smartphone or website, the driver has remote access to their vehicle to control and monitor the following,

    - Start the car engine
    - Control the air conditioning and heating
    - Monitor the car battery level, fuel, engine temperature, etc

- User authentication should be implemented based on a login and password and if possible also with 2FA. (2 Factor Authentication)

- The driver also can lock and unlock their car using the smart phone via BLE (Bluetooth Low Energy) or via an internet connection

- The door locks on the car can be activated using a DC motor or Servo motor

- When all the doors of the car are locked, any door that is forcefully opened will trigger the car alarm to sound and the user will be notified via their smartphone of a possible car theft attempt

- The vehicle can also be shared with at least 2 different drivers via the use of separate RFID cards

- Each vehicle allows a maximum of 3 RFID cards to be registered at anytime

- The RFID card must be placed on the vehicle RFID card reader located at the car dashboard to be able to start the car engine whilst in the vehicle

4. Supermarket Self-Checkout System

Customer Requirements

- To reduce the time required for customers at a supermarket to pay for their purchases, SPmart Supermarket has decided to award a contract to develop an automated system for customers to self-checkout their purchases

- **Online Purchases**

    - In addition to purchasing the items in the store, customers also have the option to purchase the items online via a Smartphone App or website.

    - For items purchased online, the customer then has the option to pick up the items from the supermarket themselves or deliver directly to their homes with a delivery fee of $4.00

    - Online customers that opt to collect their items from the supermarket will receive a QR code after online payment that they will need to show to the supermarket staff to collect their items

- **In-Store Purchases**

    - The system is based on a camera that is used to read the bar codes on the products

    - Each product has a barcode which contains a 10 digit unique identifier

    - In a central database, the product IDs are mapped to the price of the product as well as several other attributes related to the product

    - Each time a product's barcode is scanned, the LCD screen shall display the product name as well as the price and the current cumulative total on the last line of the LCD

- The system supports the following payment modes

    - ATM via pin code on the numeric keypad
    - "PayWave" via the RFID card reader

5. Automated Gardening System

Customer Requirements

- In line with the Singapore government's "30 by 30" goal to produce 30% of food locally in Singapore by 2030, a tender has been issued to develop an "Automated Gardening System"

- Due to the limited land area allocated for agriculture, the automated system shall support the monitoring and control of a hydroponics system

- For optimal plant growth in a hydroponics system, the following key parameters must be monitored continuously,

    - pH level of the solution
    - Ambient temperature
    - Relative humidity
    - Ambient lighting intensity
    - EC (Electrical Conductivity) level

- The automated hydroponics system shall be a closed loop system where the EC level needs to be constantly adjusted to maintain the pre-set optimal level

    - If the EC level is too low, then additional nutrient solution needs to be dispensed into the hydroponics solution by activating a pump based on a DC motor or servo

- To visualize the data from the different sensors a dash board should be implemented via web page or mobile application

- The light intensity should also be controlled based on the measured ambient lighting intensity to ensure that plants have optimal lighting at all times

    - If the light intensity level is too low, then a UV light shall be activated

    - It's not required to control the intensity or brightness of the UV light and a basic on/off activation is sufficient

- Ambient temperature is also critical variables in a hydroponics system which needs to be maintained at a constant level as much as possible

    - If the ambient temperature gets too high then a fan needs to be activated to reduce the ambient temperature

6. Smart Fire Alert System

Customer Requirements

- In the last few years, there have been several instances of the outbreak of fires at the home of elderly residences in rental apartments in several areas in Singapore

- To detect these fire outbreaks as early as possible, SCDF is planning to develop an IoT driven system which continuously monitors the homes of elderly residents for early signs of fire

- The system shall deploy at least 2 of the following types of sensors,
  - Temperature sensors
  - Visual sensors
  - Light sensors
  - Smoke detectors

- Each of these sensors can detect the possible presence of an uncontrolled fire based on different parameters measuring the room temperature, camera detection of possible flames, increase lighting intensity in the house.

- If at least 1 of these sensors detects a possible fire outbreak,
  - The resident/s need to be alerted via an audible alarm as they may be in a another room in the house

  - The SCDF also needs to be informed of the fire via notification system via email, SMS, Telegram or another other delivery method

- In addition to the automatic fire detection system, the system should also support a manual alert system where the resident/s can activate a manual switch or button to immediately alert the SCDF or urgent help required

- As a first line of fire defence, the sprinkler system shall be activated in the room where the fire is detected by any of the sensors

- The water sprinklers are connected to a control valve, which can be electrically activated via a servo motor, DC motor or via a digital output connected to a relay, etc.

1. Project Management

- Each team must be organized as a Scrum team with 3 to 4 members
- Every team needs to appoint 1 Product Owner and 1 Scrum Master and the roles should be rotated each Sprint (every 2 weeks)
- During each lab session, each Scrum team has to perform the following Scrum ceremonies,
    - Daily Stand-Up
    - Sprint Planning
    - Sprint Demo
- The duration of each sprint shall be fixed for 2 weeks
- All User Stories planned for each Sprint must be planned in JIRA

2. System Requirements Specification (SRS)

- Based on the customer requirements, each team must derive System Requirements on which the implementation and Test Cases will be based on
- All customer requirements must be implemented and the SRS should define the detailed system requirements as an input for the implementation
- The System Requirements must be formally documented based on the provided SRS template
    - Use Case Diagram
    - System Architecture Diagram
        - All sensors and actuators used on the Raspberry Pi evaluation board must be clearly shown with the mapping to the customer requirements
        - For example, if the LED on the Raspberry Pi development board is used to represent a room light in a home automation project, then this should be clearly shown in the System Architecture diagram.
    - System Requirements
        - Textual Description with Requirement IDs
        - UML diagrams
            - Flowcharts
            - State Machines
            - Sequence Diagrams
- Software Architecture layer diagram showing all the Application Python Software Units that will be developed to realize all the defined System Requirements

3. Test Cases

- All System Test cases must be documented using the provided Test Case Report Excel sheet template

- Software Unit Test cases must be created and executed using PyTest

4. Configuration Management

- All Software code must be under Git source control and pushed to a Github repository

- The Github repository will be created for you using Github class room and the URL will be provided for each team

- Each Scrum team must create a Github major release at the end of every Sprint every 2 weeks with each release containing the following,

    - Python code
    - Software Unit Test cases
    - SRS document
    - System Test Case Excel Sheet

5. DevOps

- **Containerization**
    - Create Docker container for complete Python Application and all dependencies

    - Push Docker container to Docker Hub

- **Deployment**
    - New versions of the software needs to first be released in Github using a specified Git tag

    - Released Software in Github needs to pass all automated PyTest Unit Tests and System Tests before deployed to the Raspberry Pi

    - New versions of the software needs to be deployed to the Raspberry using Docker and K3S

Suggested Project Schedule and Sprint Planning

The Sprint Planning and Project schedule below is only a suggestion, please discuss and plan within your own Scrum Teams during your Sprint Planning meetings at the start of every sprint.

Week	Sprint	Sprint Goal	Deliverables	Github Release
1	**-**	Form Scrum teams of up to 4 persons		-
2	**1**			Rel_1.0
3	**1**			
4	**2**			Rel_2.0
5	**2**			
6	**3**	Complete SRS Document		Rel_3.0
7	**3**			
8		**MST**		
9 to 11				
12	**4**			Rel_4.0
13	**4**			
14	**5**			Rel_5.0
15	**5**			
16	**6**			Rel_6.0
17	**6**			
18		Final Demo		Rel_7.0