RESEARCH DOCUMENT

Group 4

OnlyDevs;

Contents

1. Main question

How to create a reliable, maintainable, user-friendly software system which helps in the business process of a visitor arranging a meeting with an employee from SIOUX by making possible for the secretary to manage the meetings, keeps track of parking spots available in the parking lot for visitors, notifies the visitors where they can park and notifies the employees when the visitor arrives?

2. Sub questions and Planning

1. How are the meetings going to be managed?

1.1 Methods

Field:

Explore User Requirements

It is very important to know in detail what does the client expects in terms of functionalities.

Library:

Available product analysis

Researching what other products are already being developed for the particular problem will help in the choice of type of software system and tech stack.

2. How is the system going to notify the visitor and the employee?

2.1 Methods

Library:

Available product analysis

By researching how other solutions approach this problem we can figure out how to implement it in our solution.

Best good and bad practices

There might be multiple solutions for this problem so we have to pick up the solution that is the most appropriate for our case.

3. How is the system going to keep track of parking spaces?

3.1 Methods

Lab:

Hardware validation

We are going to try different hardware solutions in different circumstances so we know which one is the best solution for the actual application context and in real environment.

Field:

Problem analysis

Prioritizing what is needed and what is not needed helps to pick up the right solution.

4. How is the visitor identified when arriving?

4.1 Methods

Lab:

Computer simulation

By mocking the situation in small scale necessary hardware will be tested.

Library:

Available product analysis

By checking what is available we can take examples from some solution, adjust it and use it in our system to save resources.

Showroom:

Ethical check

Identifying a person and storing personal data is a sensitive topic nowadays so we must check for any constraints.

5. How do we make sure to have reliable, maintainable and user-friendly software system?

5.1 Methods

Lab:

Component test

By testing whole subsystems, we make sure that they are working and can be used together.

Library:

Design pattern research

By checking the design patterns, we make sure that we are applying the right principles in our software. Which will increase the quality.

- Separate front-end and back-end
- Testing – unit tests, user acceptance tests
- Documentation
- Using CSS framework for consistency of the UI
- Following SOLID principles

2. Results

1. How are the meetings going to be managed?

Explore User Requirements

Due to the fact that it is quite challenging to gather all functional requirements in one meeting, our group decided to take the iterative approach to gathering the requirements. Our group had multiple brainstorming sessions where the requirements were analyzed. We created a User Requirements document with use cases – how the system behaves in the different cases, user stories with acceptance criteria – what a user should be able to do. After analyzing the requirements we found out that we should create a multiple page web application where the secretary can log in, create meetings, edit meetings, deleted meetings and see an overview of the meetings.

Available product analysis

We researched similar software products that offer the same service. We found out that most of them are web applications that support a great variety of functionalities. Most of them are scheduling apps with a Calander or planners - functionalities that are not needed for solving the problem. Most of them are paid – monthly subscription or cannot be customized for the purposes of the project so the conclusion is that a custom web application with only what is required should be created from scratch. Most of these apps use a variation of a calendar for a layout, but after analyzing the user requirements, a table for the meetings overview will look cleaner and simpler.

2. How is the system going to notify the visitor and the employee?

2.1 Methods

Library:

Available product analysis

There are three most popular notification practices. Notifying by email, SMS and in-app notification. Since our solution is webapp, and visitor has no access to it, we will be using SMS and emails.

Best good and bad practices

Notification	Pros	Cons
SMS	- There is no need for internet connection. - Based on statista research, there are 6.648 billion owners of cell phones, which means that the probability of receiving SMS is very high. - Most people take their mobile phones everywhere - People tend to read virtually every text they get - unlike junk mail, spam or adverts which can be ignored.	- Messages should be short, the longer the message gets, less the receiver wants to read it - People are wary of responding to SMS messages due to an increase in fraudulent messages.
Email	- E-mails provides faster and easy mean of communication. - E-mail is not just only for textual message. - E-mail can be send at any hour of day - It is secure and reliable method to deliver our message - There is also facility of auto-responders in e-mail i.e. to send automated e-mails with certain text	- It can be source of various spams - To use facility of e-mail, user must have an access to internet

3. How is the system going to keep track of parking spaces?

3.1 Methods

Lab:

Hardware validation

Most widely used: in-ground sensors, overhead indicator sensors, camera sensors
Technologies: electromagnetic, ultrasonic, ultrasound, infrared, visual, magnetic

Field:

Problem analysis

Sensors	**Technologies**	Pros	Cons	**Mocking**
In-ground sensors(Infrared)	- Infrared	- Low power consumption - Detect motion in daytime and nighttime reliably - Physically smaller in size and are more affordable - It supports shorter range and hence it performance degrades with longer distances	- Infrared frequencies are affected by smoke, dust, fog, sunlight etc.	- Easy to mock, affordable
In-ground sensors(Ultrasonic)	- Ultrasonic	- It has sensing capability to sense all the material types. - This sensor is not affected due to atmospheric dust, rain, snow etc. - It has higher sensing distance (in centimeters and inches) compare to	- It is very sensitive to variation in the temperature - It has more difficulties in reading reflections from soft, curved,	- Harder to mock, less affordable, bit more expensive

		inductive/capacitive proximity sensor types	thin and small objects	
Overhead indicator sensors	- Ultrasonic	- Not affected by color or transparency of objects - Can be used in dark environments - Not highly affected by dust, dirt, or high-moisture environments	- Have to be mounted overhead - Used mostly indoors	- Therefore harder to mock - Overall more expensive
Camera sensors	- Visual with AI	- Wide view range - Can detect multiple objects/spots at once	- Bad performance in lower light conditions - Risk of data leaks - Highly affected by rain, snow and fog	- Harder to mock, synchronize with real environment (mounted in right angle)

4. How is the visitor identified when arriving?

4.1 Methods

Lab:

Computer simulation

Identifying a user when he arrives is part of the requirements for the project so this can be easily done by scanning his license plate on the entrance of the parking lot. Since we do not have access to the real parking and don't have the resources to test it with a real camera, we decided to simulate it in a controlled, modeled environment. We found out that we can use any camera without interfering with the functionalities of the software system. For our prototype we decided to use a web camera because it was easy available and its only purpose is to send a picture or a life stream. In order for the visitor to be recognized when arrives, he should specify his license plate when creating an appointment otherwise, he cannot be identified as a visitor.

Library:

Available product analysis

Scanning a license plate is used in many different cases in parking lots, checkpoints, crime-detecting technologies and many more. Since it's a quite complex software system to develop from scratch we started looking for public projects that might solve our problem.

Showroom:

Ethical check

Since a license plate is considered personal sensitive data, there are some regulations about it. We read the following licenses: GPLv2, GPLv3, LGPL, Apache, BSD, AGPL.

In the lab research we concluded that the visitor should specify his license plate when creating an appointment. Due to legal regulations and security concerns, we are not going to store the license plate as plain text, but it will be hashed, and the hashed value will be stored in the database. After the license plate is scanned and the visitor identified, the data is deleted from the database.

5. How do we make sure to have reliable, maintainable and user-friendly software system?

5.1 Methods

Lab:

Component test

So far with the research above, we have concluded that we will end up with 3 systems – web application, a system that keeps track of the parking spots and a system that scans the license plates. In order for our solution to be completed and fully operational the all 3 systems should work without errors. We are going to test each system individually, separated from the others

Library:

Design pattern research

Being consistent in our code and following the best practices for creating software, we researched the design patterns that we can use to make sure we provide a high quality and maintainable software system. The first design principle we are going to follow is separating of concerns – separate the front-end and the back-end application. Secondly, we are going to create a test plan for how we are going to test our system – unit tests and user acceptance tests. Another thing that we found out is for better user experience and design of a web application, it is better to use a CSS framework that will speed up the process and make the user interface looks smooth and consistent. The SOLID principles are also very important design pattern for creating high-quality, extensible and maintainable software.

3. Conclusion

Based on collecting user requirements our group has decided to create User Requirements Document. After analyzing the requirements we found out that the best way is to create a multiple page web application where the secretary can log in, create meetings, edit meetings, deleted meetings and see an overview of the meetings.

From our notification research we suggest to use SMS and emails for notifying the visitor and employee when arriving. SMS to notify visitor, since it is most reliable and internet-free and email to notify employee since it is free, fast and additional attachments can be attached.

We will keep track of the parking spots using sensors, where each parking spot will have its own inground sensor. In case of sensors, we would recommend to use infrared sensor, because it is not highly affected by weather in comparison to other solutions, it is also easy to mock and very reliable.

From fourth question research, the results are to model a controlled environment in a small scale and for reading license plates use web camera.

4. Sensors implementation strategy

Steps in developing the parking system

PAHSE 1: Define the scope of the prototype

PHASE 2: Research

PHASE 3: Design circuit

PHASE 4: Acquire materials needed

PHASE 5: Prototype hardware

PHASE 6: Test hardware with software

PHASE 7: Integrate the system into our application

PHASE 1: Define the scope of the prototype

The system will consist in 2 IR sensors which will simulate the possible scenarios of the parking spots availability. The system will be capable of tracking the status of the parking spots; if there are available or not. Their status will be sent to our application in order for it to react in the according way.

PHASE 2: Research

In order to develop the application we needed to be familiar with the environments in which we'll work:

- the Arduino IDE along with the hardware
- the Java integration

First, we looked into the best alternative for input in our prototype. After investigating this matter, we concluded that infrared sensors are the best option.

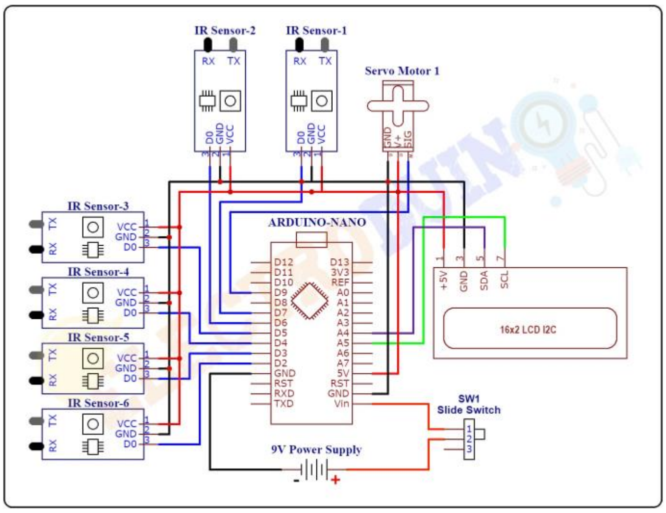
PROS	CONS
- easy to integrate - simulates a real-life system - the sensor detects motion in the daytime and nighttime reliably - the sensor does not require any contact with the object to be sensed - Infrared devices can measure the distance to soft objects which may not be easily detected by ultrasound - no corrosion or oxidation can affect the accuracy of infrared sensor	- objects (such as walls, doors) can alter infrared frequencies, as well as smoke, dust, fog, sunlight, etc. Therefore, it cannot pass through walls or doors - it supports a shorter range and hence its performance degrades with longer distances

Second, we understood how the whole hardware system would look like: the sensors will be connected to the Arduino UNO using a breadboard and connection wires.

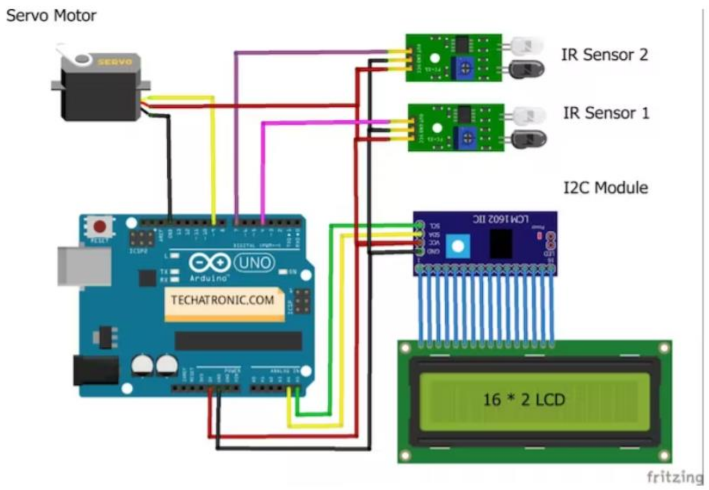
Then, we needed to find a way in which the Arduino could communicate with our Java code. We will be able to do this using a Serial Communication Library especially built for Java.

PHASE 3: Design circuit

In creating our design, first we investigated the plans for similar parking systems. Because we'll integrate the system directly with our laptop in order to receive the signals, we won't need an extra power supply.



Also, adding an LCD Display might not be necessary but we could implement it for demonstration purposes.



PHASE 4: Acquire materials needed

- 2 IR sensors
- Arduino UNO
- Jumper Wires
- Breadboard
- LCD Display (maybe)

PHASE 5: Prototype hardware

- we are going to make connect the sensors and register their status
- we'll build an efficient way of transmitting the signals (only when their status change) and maybe add the LCD Display in order to observe these changes

PHASE 6: Test hardware with software

- does the state chance for our parking spots?
- is the state updated in real time?
- how does our application handle the changes of state?

PHASE 7: Integrate the system into our application

The role of the sensors in our application is to notify the visitors if there is an available parking spot for them.

This means that the status of the parking lot will be sent to our application in order for it to take the actions that need to be taken depending on the situation: either send a confirmation that a spot is free or send the directions to the next parking lot available.

For testing this we will also need to integrate the API responsible for sending text messages.

5. License plate reader implementation strategy

Setup

1. Cloning baseline code
2. Creating a virtual environment
3. Installing dependencies
4. Installing Tensorflow Object Detection
5. Cloning pre-trained models

Data

1. Cloning images from Kaggle
2. Creating a training and testing partition

Training

1. Updating the LabelMap
2. Creating TF records
3. Updating transfer learning config
4. Training the model

Detecting plates

1. Detecting plates from an image
2. Detecting plates from video

Applying OCR

1. Splitting GPU
2. Setup EasyOCR
3. Applying detection thresholding
4. Extract image width and height
5. Loop through detections and apply OCR
6. Filtering algorithm
7. Final OCR function
8. Applying ANPR in real time

Saving results

1. Importing dependencies
2. Building a save function
3. Saving plates from video

6. References

Question 1

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