



Improving Visual pollution in Riyadh City using Artificial Intelligence

Graduation Project, Part-I (SWE 496)
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ABSTRACT

Riyadh is the capital and largest city of Saudi Arabia, and is known for rapid urbanization and modernization. Potholes are a common problem in cities like Riyadh, and can pose a serious safety hazard to drivers and pedestrians. This project aims to develop infrastructure and improve the environmental landscape, and focuses on dispensing with the citizen to identify and discover road potholes. The project will use data analysis techniques, such as Jetson Nano and You Only Look Once, to identify images of potholes and their size, by linking them to the municipality's car camera to detect and locate potholes on the street, upload photos on the map in our application to process potholes, and coding them with color-coded points according to the severity of the pothole, and sending a notification to the municipality to fix it in a certain period of time. Ultimately, this project has the potential to improve road safety, reduce the cost of repairing vehicles caused by potholes, and reduce reliance on the citizen in determining where to locate potholes.

Table of Contents

1.	INTRODUCTION	1
2.	DOMAIN ANALYSIS.....	1
3.	RISK/CONSTRAINTS	3
4.	PROJECT PLAN	4
5.	QUALITY ASSURANCE PLAN.....	6
6.	REQUIREMENTS	ERROR! BOOKMARK NOT DEFINED.
6.1	FUNCTIONAL REQUIREMENTS	ERROR! BOOKMARK NOT DEFINED.
6.2	NON-FUNCTIONAL REQUIREMENTS	ERROR! BOOKMARK NOT DEFINED.
7.	PROBLEM COMPLEXITY	ERROR! BOOKMARK NOT DEFINED.
8.	SYSTEM USE-CASES	ERROR! BOOKMARK NOT DEFINED.
8.1	USE CASE1	ERROR! BOOKMARK NOT DEFINED.
8.2	USE CASE2.....	ERROR! BOOKMARK NOT DEFINED.
9.	ANALYSIS CLASS.....	ERROR! BOOKMARK NOT DEFINED.
10.	INTERACTION DIAGRAM	ERROR! BOOKMARK NOT DEFINED.
11.	DESIGN CLASS.....	ERROR! BOOKMARK NOT DEFINED.
12.	SYSTEM ARCHITECTURE.....	ERROR! BOOKMARK NOT DEFINED.
13.	USER INTERFACE MOCKUP	ERROR! BOOKMARK NOT DEFINED.
14.	DATABASE SCHEMA.....	ERROR! BOOKMARK NOT DEFINED.
15.	ALGORITHMS.....	ERROR! BOOKMARK NOT DEFINED.
16.	EXPECTED DEPLOYMENT	ERROR! BOOKMARK NOT DEFINED.
17.	TEST SCENARIO.....	ERROR! BOOKMARK NOT DEFINED.
18.	PROJECT STATUS.....	ERROR! BOOKMARK NOT DEFINED.
19.	CONCLUSION	ERROR! BOOKMARK NOT DEFINED.
20.	REFERENCE	14

List of Figures

Figure 1. Smart room use cases	Error! Bookmark not defined.
Figure 2. Successful order placement	Error! Bookmark not defined.
Figure 3. Successful order placement	Error! Bookmark not defined.
Figure 4. Successful face recognition log in	Error! Bookmark not defined.
Figure 5. System deployment diagram	Error! Bookmark not defined.

List of Tables

Table 2. Test Table	Error! Bookmark not defined.
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1. Introduction

Riyadh is the capital and largest city of Saudi Arabia, and is known for rapid urbanization and modernization in recent years. The city has a diverse urban landscape, with a mixture of modern skyscrapers, traditional architecture, and sprawling suburbs, and an important aspect of preserving this urban landscape is the repair of potholes in the road. Potholes are a common problem in cities like Riyadh, and can pose a serious safety hazard to drivers and pedestrians. When left unrepaired, they can damage vehicles and lead to accidents. In addition to safety concerns, potholes can have a negative impact on a city's appearance and overall quality of life. It can make roads look unkempt and unattractive, and can also cause traffic jams and delays.

Therefore, we thought of our project, which aims to develop infrastructure and improve the environmental landscape, and focuses on dispensing with the citizen to identify and discover road potholes, by using a technology-based solution to identify potholes in the streets. The project will use several data analysis techniques, including Jetson Nano and You Only Look Once, to identify images of potholes and their size, by linking them to the municipality's car camera to detect and locate potholes on the street, upload photos on the map in our application to process potholes, and coding them with color-coded points according to the severity of the pothole, and sending a notification. Municipality to fix it in a certain period of time.

Through this project, we hope to provide Riyadh and maintenance crews with more timely and accurate information about the condition of roads, allowing them to prioritize repairs and allocate resources more effectively. Ultimately, we believe this project has the potential to improve road safety, reduce the cost of repairing vehicles caused by potholes, and reduce reliance on the citizen in determining where to locate potholes.

2. Domain Analysis

The main aim of our project is to develop infrastructure and improve the environmental landscape, and focuses on dispensing with the citizen to identify and discover road potholes, by using a technology-based solution to identify potholes in the streets. The project will use several data analysis techniques, including Jetson Nano and You Only Look Once, to identify images of potholes and their size, by linking them to the municipality's car camera to detect and locate potholes on the street, upload photos on the map in our application to process potholes, and coding them with color-coded points according to the severity of the pothole, and sending a notification. Municipality to fix it in a certain period of time.

And there is similar applications to our project and we will give a comparison of the features of these applications with our system and see what will met and what will not met.

2.1 Balady

Description

Balady application provides many services through which you can file reports of visual distortion, you can also submit requests for health certificates, as well as book appointments with secretariats and other services.[1]

2.2 Amana 940

Description

Riyadh Municipality has provided this service to residents of Riyadh city, where Emergency center has developed this application to provide the latest methods of notifications delivery to Riyadh Municipality.[2]

Summary

In this table, we compare the main features of our application with Balady and Amana 940 and see what features will be met and what will not and see what application will meet all the features which we choose in this table and we choose this specific features because it's the main features.

TABLE 1: PROPOSED SYSTEM VS EXISTING APPLICATION

Amana 940	Balady	kashef	Features
✓	✓	✓	Repair potholes in the road
		✓	Automatic detection of potholes
		✓	Low reliance on citizen
✓	✓	✓	Detect potholes using camera
✓	✓	✓	Send complaints to municipal

3. Risk/Constraints

The following table demonstrates the risk that could affect the project during its development lifecycle(SDLC). It shows the risk type, which includes

Schedule: A limitation placed on a project schedule that affects the start or end date of an activity.

Technical: A technology-related condition or event that prevents the project from fully delivering the ideal solution to customers and end-users.

Product: Anything that prevents you from making progress towards your product goal.

Team: Any outside event on the team member's life that affects the progress of the project.

The table also shows the Likelihood, and severity then it includes the suggested strategies to manage them and avoid its effect

Table 2: Risks

Mangment Study	Likelihod	Severity	Type	Risk/Constraint	No
Arranging the requirements according to importance and implementing the most important requirements first	high	high	schedule risk	Inability to achieve the plan due to lack of time	1
Watch tutorial for the method of composition on YouTube or the official site of jetson nano NVIDIA	high	high	Technica l	Limited knowledge of using jetson ano	2
Participate in courses that explain these techniques	high	high	product	Difficulty implementing artificial	3

and self-learning, and also read books and research that may help the team understand the technology				intelligence for example computer vision	
Go back to reviewing the SWE312 architecture course to make sure of choosing the most suitable system architecture design	Medium	High	product	Implementation of inaccurate System Architecture design	4
organize work and avoid delaying	High	Medium	Team	conflict of deliverable deadline and exam date	5

4. Project Plan

1- Methodology

In our project, we chose waterfall methodology to develop our web-based application because it provides a structured approach to software development, making it easier to plan and predict a project's timeline and budget.

It also involves extensive testing at each stage, which helps to ensure that the final product is of high quality and meets the requirements.

The methodology defines each stage of the project and what is expected of the team during each stage, which helps to eliminate confusion and ensures that everyone is on the same stage. The waterfall methodology is a sequential process in which each stage is completed before moving on to the next. The waterfall methodology may be appropriate for our project because the scope is well-defined, and the requirements are unlikely to change.

2- Work plan

Our team consists of:

Dr.Sara AlMoaiqel - Project Supervisor.

Monerah Alsubaie - Project Leader.

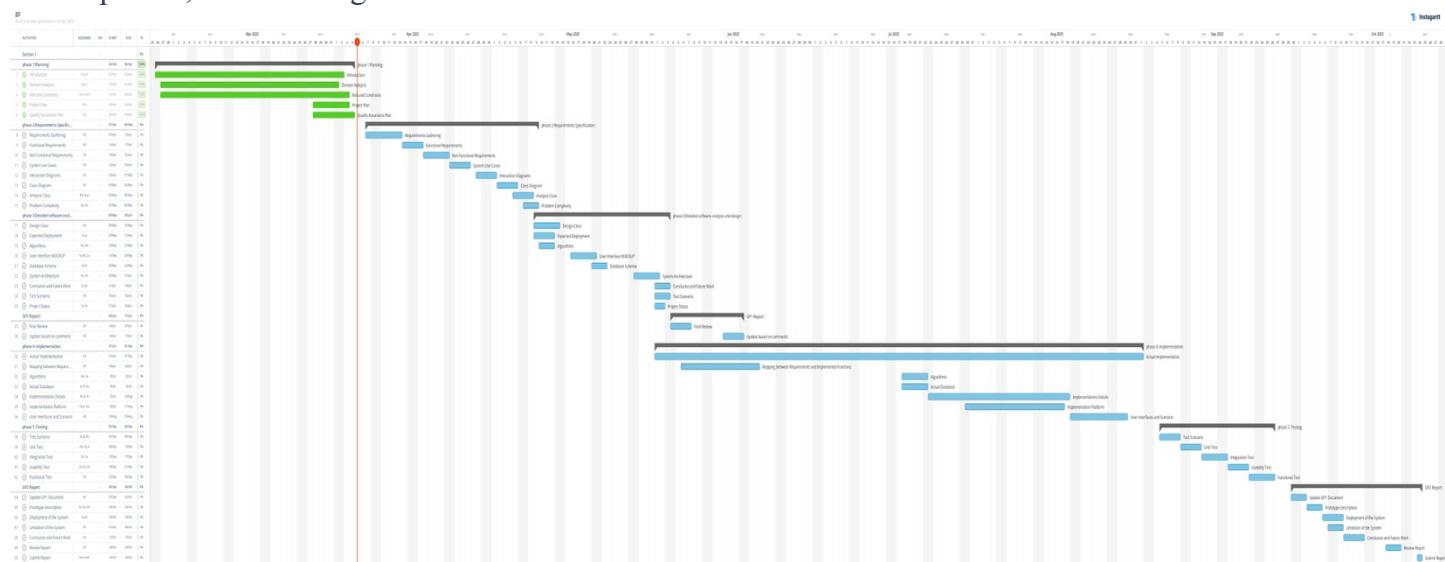
Sara Khalid.

Jouri Alanazi.

Renad Alsubaie.

Fai Alotaibi.

The Gantt chart in the figure below depicts the project schedule, which includes all phases, tasks within phases, and the assignment of each task.



<https://app.instagantt.com/shared/642e048a96a08852acf19a04>

This link for Gantt Chart.

3- Tools used for management:

1- for sharing code and monitor progress and updates:

- GitHub: GitHub is a web-based platform for version control and collaborative software development. It allows us to save, manage, and share code. GitHub provides features such as code review, issue tracking, and project management tools, making it an essential tool for many software development teams.

2-for discussion:

- Meet: Meet is a popular video conferencing application developed by Google. It allows users to hold virtual meetings, webinars, and online events with up to 250 attendees. Meet provides a range of features to enhance the video conferencing experience, including Screen sharing, Recording, Chat.
- WhatsApp: WhatsApp is a powerful and versatile instant messaging application that is

used by billions of people worldwide for personal and business communication. One of most important features is group chat that allow users to create and participate in groups.

3- for document sharing:

- Microsoft Word: Microsoft Word is a word processing application developed by Microsoft. Documents such as reports are created, edited, and formatted using it. Spell check, grammar check, and the ability to insert images and tables into documents are all included in Word. It will assist us in writing our seminar reports.

5. Quality Assurance Plan

Quality assurance (QA) is any systematic process of determining whether a product or service meets specified requirements.[3]

Quality assurance plan is important in any project because it helps a company to create products and services that meet the needs and the expectations of the user about the products.

5.1 Inspection

Inspection are a formal type of review that includes checking and review the documents before meeting and is carried out mostly by the team members.

The team members will divide themselves into different roles. The roles of inspections is reader, moderator, authors and inspector. A meeting is then held to review the code and the design.

To view the performed Inspection until now see Appendix 1.

5.2 Walkthrough

Walkthrough in software testing is used to review documents with peers, managers, and fellow team members who are guided by the author of the document to gather feedback and reach a consensus.[4]

To view the performed walkthrough until now see Appendix 2.

5.3 Templates

This is a standardized document that provides guidelines and instructions to ensure a high-quality

project. Our team used the template provided by the Graduation Project Committee (GPC) to ensure the quality of the report and project and to save time and effort.

To view the templates here <https://bit.ly/2qZuBlr>.

5.4 Checklists

After the team finish the document of the project, they will review it by checklist provided by the Software Engineering Department Graduation Committee (SWE GPC), to ensure the team cover all of deliverables requirements.

To view the Checklists here <https://bit.ly/2DuHhZ0>

5.5 Testing

Software testing is the process of verifying a system with the purpose of identifying any errors, gaps, or missing requirements versus the actual requirement. Software testing is broadly categorized into two types - functional testing and non-functional testing.[5] Our team will do the following testing strategies:

5.5.1 Unit Testing

Our team will test every individual unit/component of the project. to make sure that it performs as expected.

5.5.2 Integration Testing

Integration Testing is defined as a type of testing where software modules are integrated logically and tested as a group. [6]

5.5.3 Functional Testing

Our team will use the black box testing to test all the functionalities of the system.

5.6 Project Management

Project management is the application of processes, methods, skills, knowledge and experience to achieve specific project objectives according to the project acceptance criteria within agreed parameters. Project management has final deliverables that are constrained to a finite timescale and budget.[7]

6- Requirement

requirement gathering phase of our project, Kashef, which aims to detect potholes. As with any project, this phase is crucial in ensuring that we obtain accurate and relevant requirements that will guide the development process. To achieve this, we have used two techniques, including questionnaires, to gather information from different stakeholders. We recognize that the success of our project depends on the effectiveness of our requirement gathering process. Therefore, and We have been reading about the problem thorough research literature to gain a deeper understanding of the issue and identify potential solutions, which involves working closely with people from different backgrounds to ensure that we gather requirements that are comprehensive and meet the needs of all stakeholders. Through this approach, we hope to obtain useful information that will guide the development of a reliable pothole detection system.

Survey

To make good understanding of our project problem we use a survey to gather requirements on a manageable sample size, municipal employees, and user and it was an effective way to understand their needs and preferences. Our survey was designed with clear and concise questions, and an assurance of anonymity and confidentiality. Once the data is collected, it should be analyzed to identify trends and patterns. The findings from the survey should be used to inform decision-making, make improvements, and address any concerns or issues that were raised. Communicating the results and any action taken back to the participants can show that their input was valued and acted upon. Overall, [Appendix 3] present an overview and summary of the survey results.

6.1 - Functional Requirements

6.1.1- User

- 6.1.1.1 The user should be able to log in to the system using their email address and password.
- 6.1.1.2 The user should be able to log out of the system.
- 6.1.1.3 - The user should be able to register for an account by providing their name, email address, phone number, and password.
- 6.1.1.4 - The user should be able to reset their password by entering their email address and following the instructions in the password reset email.
- 6.1.1.5 - The user should be able to view their own profile, which includes their name, email address, phone number, and password.
- 6.1.1.6 - The user should be able to edit their own profile information (name, email address, phone number and password).
- 6.1.1.7 The user shall be able to view all reports history sorted by status.
- 6.1.1.8 The user shall be able to view report details.
- 6.1.1.9 The user shall be able to rate the report service.
- 6.1.1.10 The user shall be able to receive notification about report status.
- 6.1.1.11 The user shall be able to view the comment associated with the rejected report from the municipal employee.
- 6.1.1.12 The user shall be able to view the status of his report (Accepted / Rejected / Pending / In progress / Completed).
- 6.1.1.13 The user shall be able to view the detected potholes.
 - 6.1.1.13.1 the system shall identify pothole using dashcam video.
 - 6.1.1.13.2 the system shall record video.
 - 6.1.1.13.3 the system shall send video with its coordinates(x,y) to server.
 - 6.1.1.13.4 the system shall be able to create report.

6.1.2- municipal Employee

- 6.1.2.1 - The municipal employee should be able to log in to the system using their email address and password.
- 6.1.2.2 - The municipal employee should be able to log out of the system.
- 6.1.2.3 - The municipal employee should be able to reset their password by entering their email address and following the instructions in the password reset email.
- 6.1.2.4 - The municipal employee should be able to view their own profile, which includes their name, email address phone number and password.
- 6.1.2.5 - The municipal employee should be able to edit their own profile information (name, email address, phone number and password).
- 6.1.2.6- The municipal employee should be able to delete report from the list.
- 6.1.2.7- municipal employee shall be able to view statistics of the system.
- 6.1.2.8 The municipal employee shall be able to view report list sorted by regions.
- 6.1.2.9 The municipal employee shall be able to change report status to one of these cases (accepted / rejected / pending / In progress / Completed)
- 6.1.2.10 The municipal employee shall be able to add a comment to a rejected report in order to

provide an explanation for the rejection.

- 6.1.2.11 The municipal employee shall be able to view heat map.
- 6.1.2.12 The municipal employee shall be able to accept reports submitted by users.
- 6.1.2.13 The municipal employee shall be able to reject reports submitted by users.
- 6.1.2.14 The municipal employee shall be able to view report details.

6.1.3 Admin

- 6.1.3.1-The admin should be able to log in to the system using their email address and password.
- 6.1.3.2 The admin should be able to log out of the system.
- 6.1.3.3 - The admin should be able to reset their password by entering their email address
- 6.1.3.4 - The admin should be able to create new municipal employee account by providing its name, phone number, email address, and password.
- 6.1.3.5- The admin should be able to view their own profile, which includes their name, email address, phone number and password.
- 6.1.3.6- The admin should be able to edit their own profile information (name, email address, phone number and password).
- 6.1.3.7- The admin should be able to edit the profiles information (name, email address, phone number) of municipal employees.
- 6.1.3.8- The admin should be able to edit the profiles information (name, email address, phone number) of users.
- 6.1.3.9- The admin should be able to delete accounts of municipal employees.
- 6.1.3.10- The admin should be able to delete accounts of users.
- 6.1.3.11- The admin should be able to view the profiles information (name, email address, phone number) of municipal employees.
- 6.1.3.12- The admin should be able to view the profiles information (name, email address, phone number) of users.

6.2 - non-Functional Requirements

6.2.1. Performance:

- 6.2.1.1- Average system response time should be less than 10 seconds.

6.2.2-Security:

- 6.2.2.1- Password shall be required to access Municipal Employee and user screens.

6.2.3- Usability:

- 6.2.3.1- The new user shall be able to learn all system functionality in less than 20 minutes.

6.2.4-Availability:

- 6.2.4.1-The system should be available 24/7, with minimal downtime for maintenance and updates, to ensure that users can report potholes and track their status at any time.

7-ALGORITHMS

Our system relies on artificial intelligence and machine learning technology, specifically YOLO technology, to accurately identify objects in images and videos in real-time. A dash camera is used to provide visual data to the system.

A Jetson Nano computer is installed on top of the dash camera to provide the necessary computing power to run the YOLO technology, which is an advanced algorithm that uses deep learning to analyze images and identify areas that contain potholes on the streets. The YOLO model is trained using a large dataset of images that contain potholes, allowing the system to accurately detect and classify potholes in images and videos in real-time."

How does yolo algorithms work?

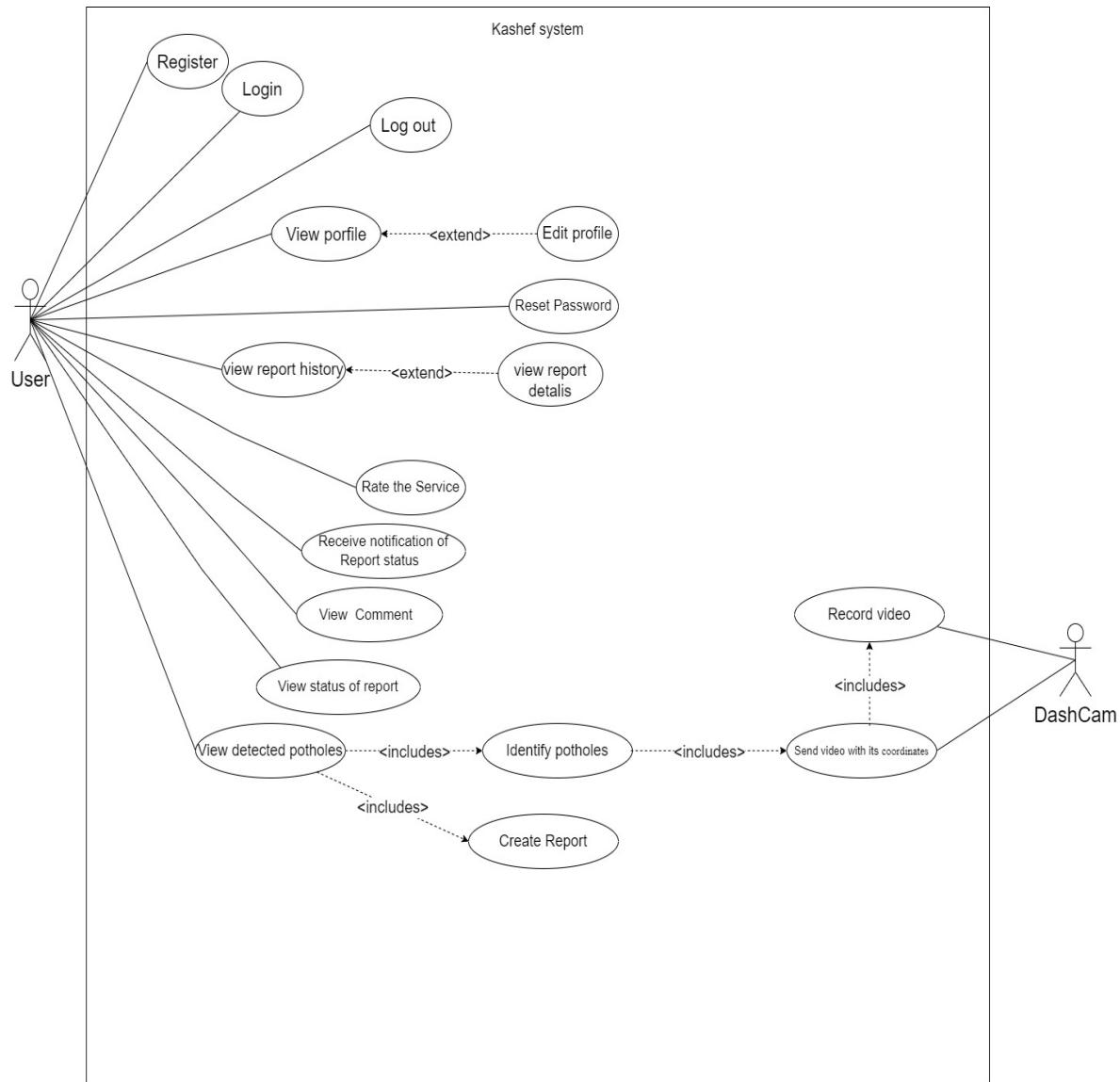
YOLO divides the input image or video frame into a grid of cells and predicts a set of bounding boxes for each cell. Each bounding box represents a candidate object.

Object classification: YOLO then predicts the probability that each candidate object belongs to a certain class (such as "pothole").

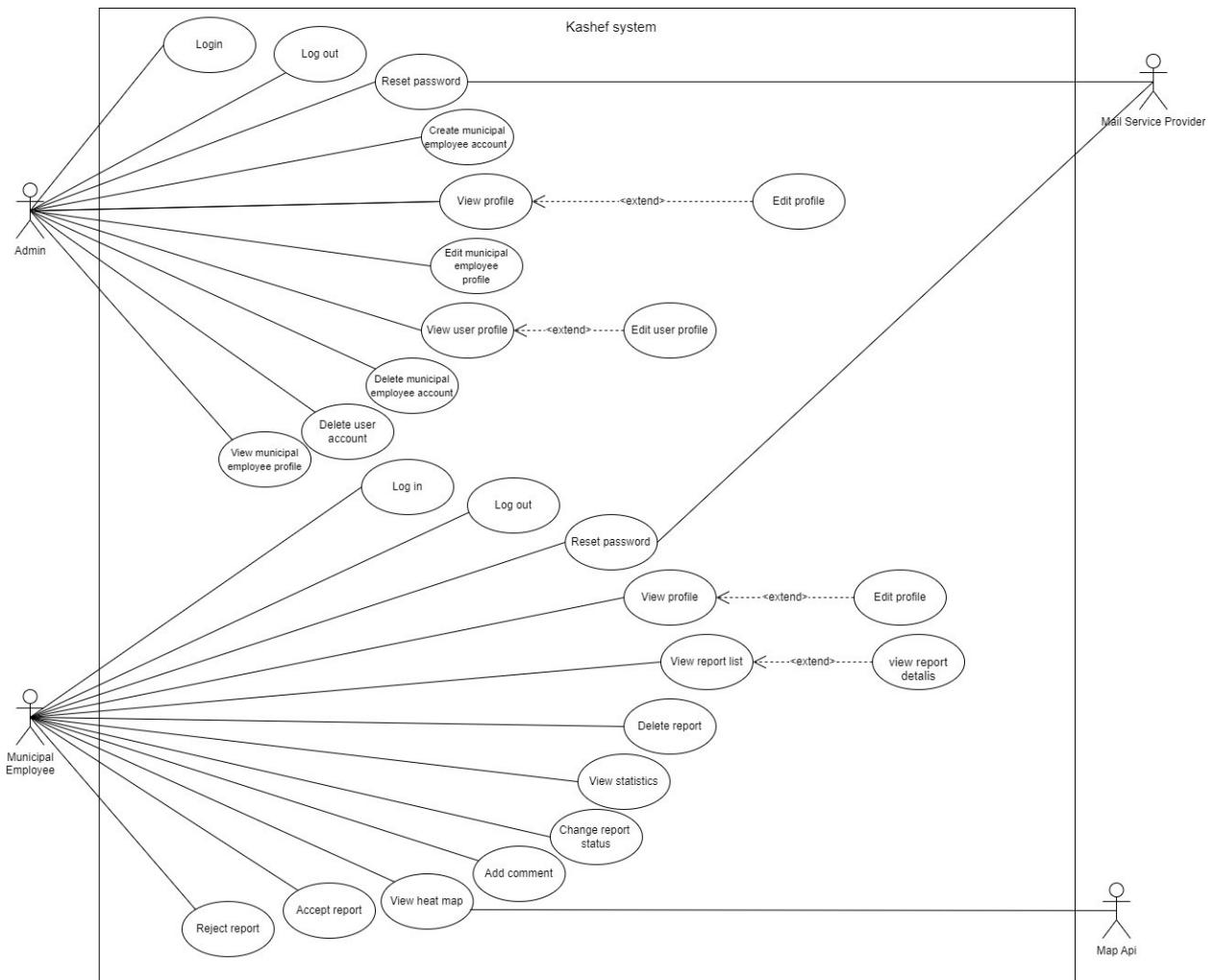
This is done using a SoftMax function that assigns a probability score to each class based on the features of the candidate object.

Output: Finally, the detected and classified potholes

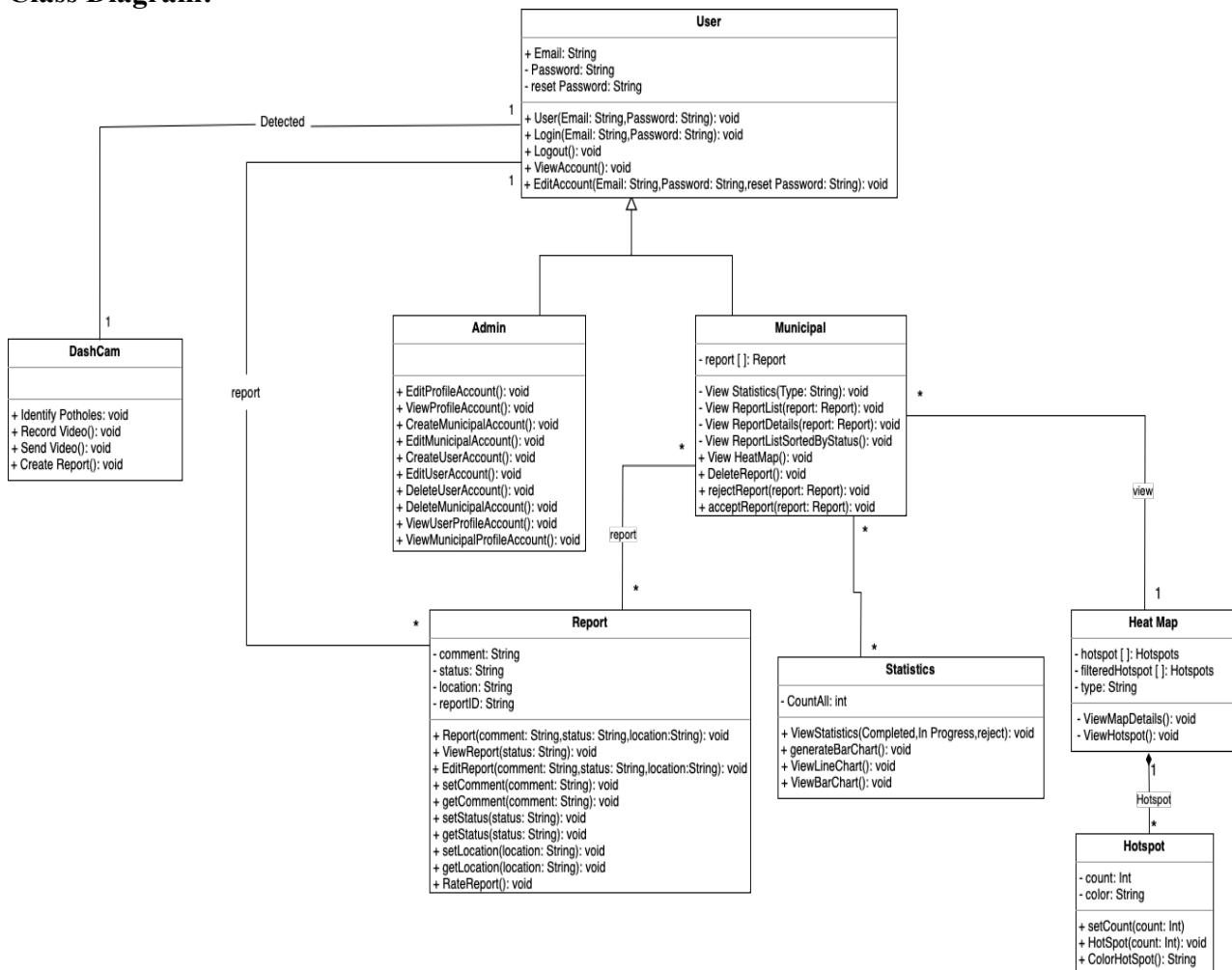
Use Case 1:



Use Case 2:



Class Diagram:



6. Reference

- [1] Contribute to improving the quality of municipal services provided, and raising customer satisfaction; to achieve Saudi Vision 2030. (no date) Home | Balady Platform. Available at: <https://new.balady.gov.sa/en> (Accessed: April 5, 2023).
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- [6] T. Hamilton, "Integration testing: What is, types with example," Guru99, 04-Mar-2023. [Online]. Available: <https://www.guru99.com/integration-testing.html>. [Accessed: 05-Apr-2023].
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7. APPENDIX

Appendix 1

Phase 1 (Proposal) inspection table.

Table 3: Phase 1 (Proposal) inspection table

Task	Author	Inspector	Inspector comments
Introduction	Renad	Jouri, Monerah, Sara, Fai	Unify some words
Domain Analysis	Jouri	Renad, Monerah, Sara, Fai	Rephrase some sentences.
Risk/Constraints	Monerah	Jouri, Reand, Sara, Fai	Delete some sentences.
Project Plan	Sara	Jouri, Monerah, Renad, Fai	Rephrase some sentences.
Quality Assurance plan	Fai	Jouri, Monerah, Sara, Renad	Rephrase some sentences.

Appendix 2

Phase 1 (Proposal) walkthrough table.

Table 4: Phase 1 (Proposal) walkthrough table

Task	Done by	Examined by	comments
Introduction	Renad	Jouri	-
Domain Analysis	Jouri	Renad	Rephrase some sentences.
Risk/Constraints	Monerah	Sara	Delete some sentences.
Project Plan	Sara	Fai	-
Quality Assurance plan	Fai	Monerah	Rephrase some sentences.

Appendix 3

Survey Summary and Charts

١- هل أنت موظف في أمانة منطقة الرياض؟

26 ردًا

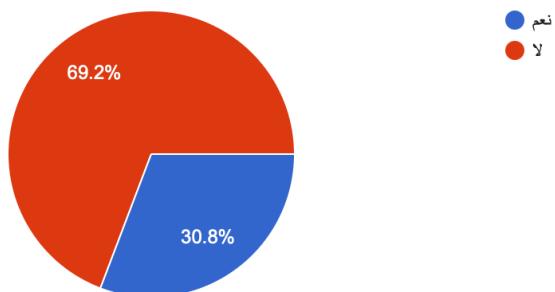


Figure 1: Surveys Question #1 Answers

٢- هل أنت؟

26 ردًا

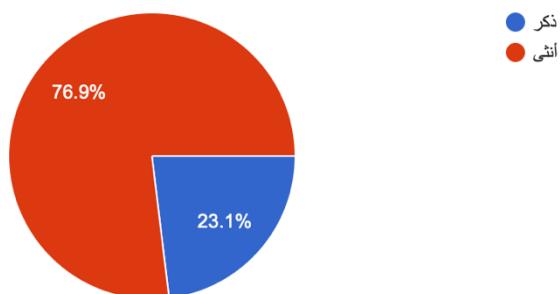


Figure 2: Surveys Question #2 Answers

٣- هل تملك داش كام؟

(الداش كام : هي عبارة عن كاميرا تسجل باستمرار تثبت على الزجاج الأمامي لسيارتك الخاصة وأحياناً في النوافذ الخلفية أو النوافذ الأخرى)

26 ردًا

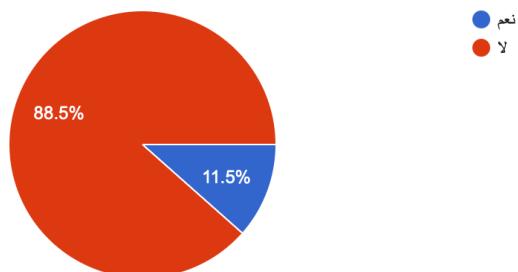


Figure 3: Surveys Question #3 Answers

٤- هل سبق لك وان قدمت بلاغ عن حفرة بالطريق العامة؟

26 ردًا

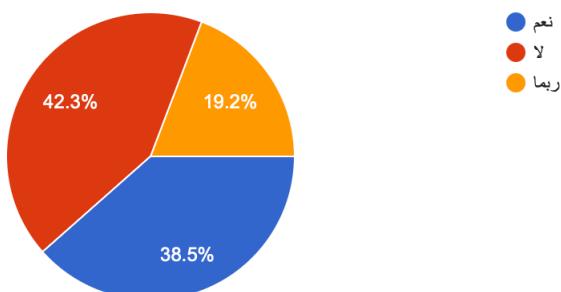


Figure 4: Surveys Question #4 Answers

٥- كيف كانت تجربة تقديم البلاغ؟

(التقييم من ١ - ٥ حيث :

١- غير راضي/ة

٢- راضي/ة

٣- جيد/ة

٤- جيد جداً/ة

٥- ممتاز/ة)

26 ردًا

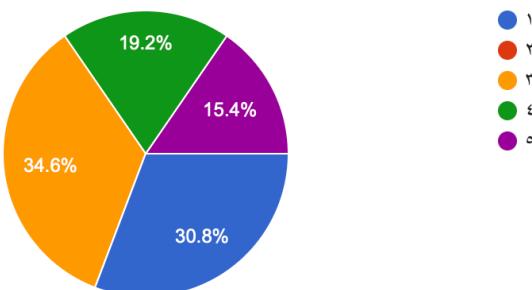


Figure 5: Surveys Question #5 Answers

نسخ

٦- ماهي الاسباب التي تمنعك من تقديم البلاغ؟

(اختر جميع ما ينطبق)

26 ردًا

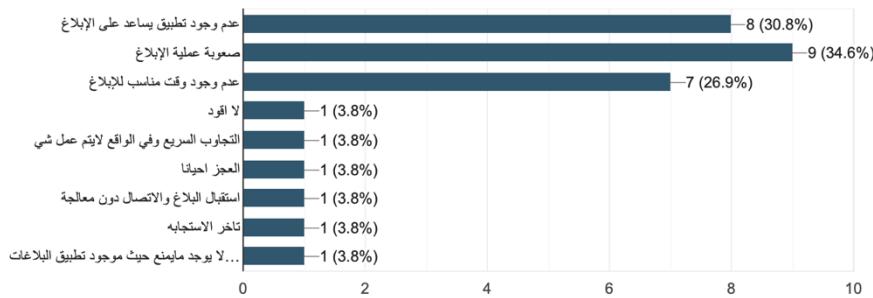


Figure 6: Surveys Question #6 Answers

٧- ما مدى احتمالية استخدامك لتطبيق يسهل الإبلاغ عن الحفرة المؤذية بالطريق العام باستخدام الذكاء الاصطناعي عن طريق الداش كام بالإستغناء عن العنصر البشري؟

رداً 26

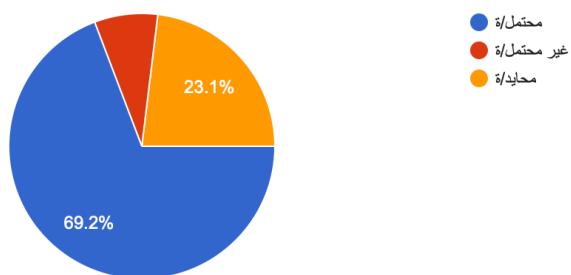


Figure 7: Surveys Question #7 Answers

نسخ

٨- إذا كانت الإجابة محتمل، فما هي المميزات التي ستجدها مفيدة في التطبيق؟
(اختر كل ما ينطبق)

رداً 24

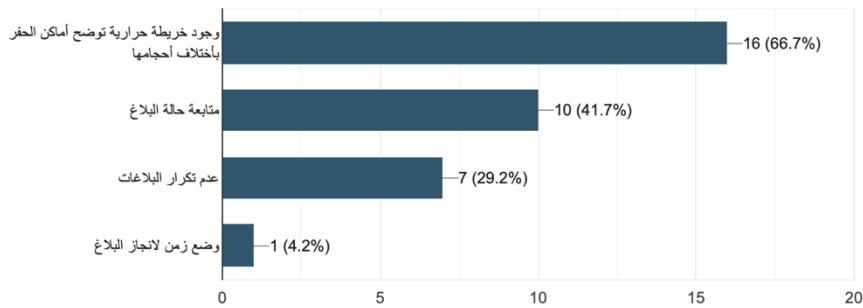


Figure 8: Surveys Question #8 Answers

نسخ

٩- إذا كانت الإجابة غير محتمل ، فما هي أسباب عدم رغبتك في استخدام التطبيق؟
(اختر كل ما ينطبق)

رداً 18

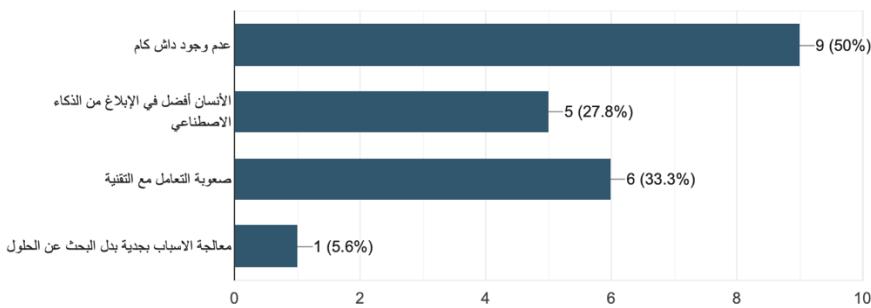


Figure 9: Surveys Question #9 Answers

نسبة



هل لديك/ي أي اقتراحات أو مميزات تساعدنا في تطبيق كاشف؟

رداً 15

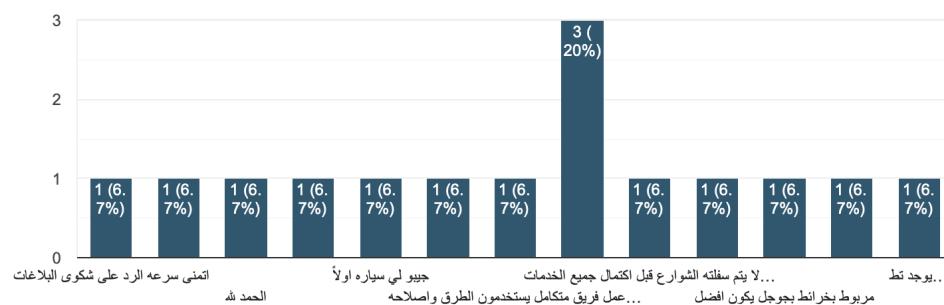


Figure 10: Surveys Question #10 Answers