PROJECT REPORT

SB8040-PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTRPRENEURSHIP

PROJECT NAME: SQUID-Street Quality Identification

TEAM ID: NM2023TMID22230

PROJECT REPORT SUBMITTED BY:

- SHRUTHI B K (513120106078) – Team Lead
- VINITHA K (513120106095)
- PAVITHRA B (513120106063)

INDUSTRY MENTORS: Baradwaj, Santhoshi, Nikhitha

FACULTY MENTOR: R Kesavraj

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1. INTRODUCTION

1.1 Project Overview:

Street quality identification is a process that involves assessing and analyzing the condition of road surfaces to determine their level of deterioration or maintenance needs. It plays a crucial role in urban planning, transportation management, and infrastructure maintenance. By accurately identifying the quality of streets, authorities can prioritize and allocate resources effectively for repairs, rehabilitation, or reconstruction.

Various techniques and technologies are employed for street quality identification. One common approach is visual inspection, where trained personnel visually assess the surface condition, including cracks, potholes, and other signs of distress. This method, while effective, can be subjective and time-consuming.

To enhance accuracy and efficiency, advanced technologies such as pavement management systems and data-driven analysis are utilized. These systems use specialized equipment like laser profilers, accelerometers, and cameras mounted on vehicles to collect data on road surface conditions. The collected data is then processed and analyzed using algorithms to quantify the quality of the street.

Machine learning and artificial intelligence algorithms have also been applied to street quality identification. By training models on large datasets that include road condition information, these algorithms can identify patterns and indicators of street quality. This approach allows for faster and more accurate assessment of street conditions, enabling authorities to make informed decisions regarding maintenance and repair priorities.

Overall, street quality identification is a vital component of urban infrastructure management. By utilizing various techniques and technologies, it provides valuable insights into the condition of road surfaces, enabling timely maintenance interventions and ensuring safe and efficient transportation networks for communities.

1.2 Purpose:

The purpose of street quality identification using IoT (Internet of Things) is to gather real-time data and information about the condition of roads and streets. By deploying IoT sensors and devices on roads, various parameters can be monitored and measured, such as potholes, cracks, surface roughness, traffic congestion, and environmental conditions. This data can be collected and analyzed to assess the quality and maintenance needs of the streets.

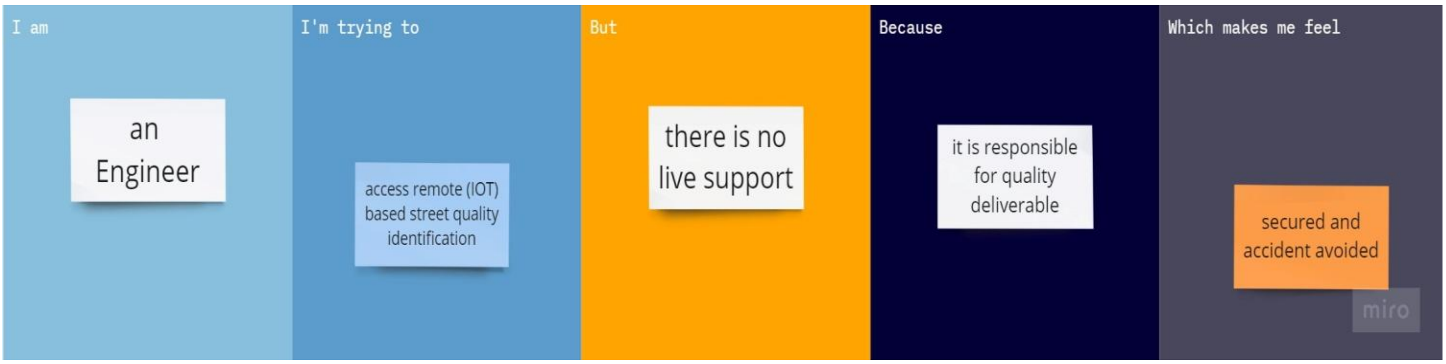
The main objectives of street quality identification using IoT include:

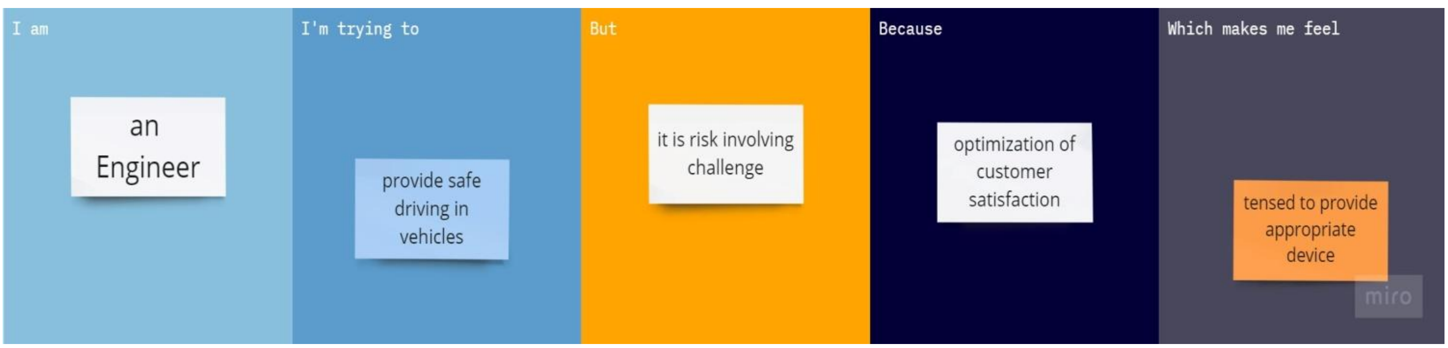
1. Infrastructure Maintenance: By continuously monitoring street conditions, authorities can identify areas that require maintenance or repairs. Timely detection of issues such as potholes or cracks enables proactive maintenance, minimizing road hazards and reducing the risk of accidents.
2. Resource Optimization: IoT-based street quality identification helps optimize resource allocation by providing accurate and up-to-date information about road conditions. Governments and transportation agencies can prioritize repairs based on the severity and impact of road deterioration, ensuring efficient use of resources.
3. Cost Savings: By identifying street quality issues early on, IoT technologies can help prevent minor problems from escalating into major infrastructure issues. Timely repairs and maintenance can save significant costs associated with major road repairs or reconstruction.
4. Enhanced Safety: Accurate identification of road quality issues contributes to safer driving conditions. Potholes, uneven surfaces, or other road defects can lead to accidents or vehicle damage. By addressing these issues promptly, IoT-enabled monitoring systems improve road safety for motorists, cyclists, and pedestrians.
5. Data-Driven Decision Making: IoT-based street quality identification provides a wealth of data that can be analyzed to gain insights into long-term road performance, patterns, and trends. This information can guide urban planning, infrastructure development, and transportation policies for more effective decision-making.
6. Citizen Engagement: IoT technology can engage citizens in the process of identifying and reporting street quality issues. Through mobile apps or online platforms, users can provide feedback on road conditions, enabling authorities to prioritize repairs based on public input and improve overall transparency.

Overall, street quality identification using IoT enhances infrastructure management, promotes safety, optimizes resource allocation, and enables data-driven decision-making, leading to more efficient and well-maintained road networks.

2. IDEATION & PROPOSED SOLUTION

2.1 Problem Statement Definition





Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	An Engineer	Access remote (IOT) based street quality identification	There is no live support	It is responsible for quality deliverable	Secured and accident avoided
PS-2	An Engineer	Provide safe driving in vehicles	It is risk involving challenge	Optimization of customer satisfaction	Tensed to provide appropriate device

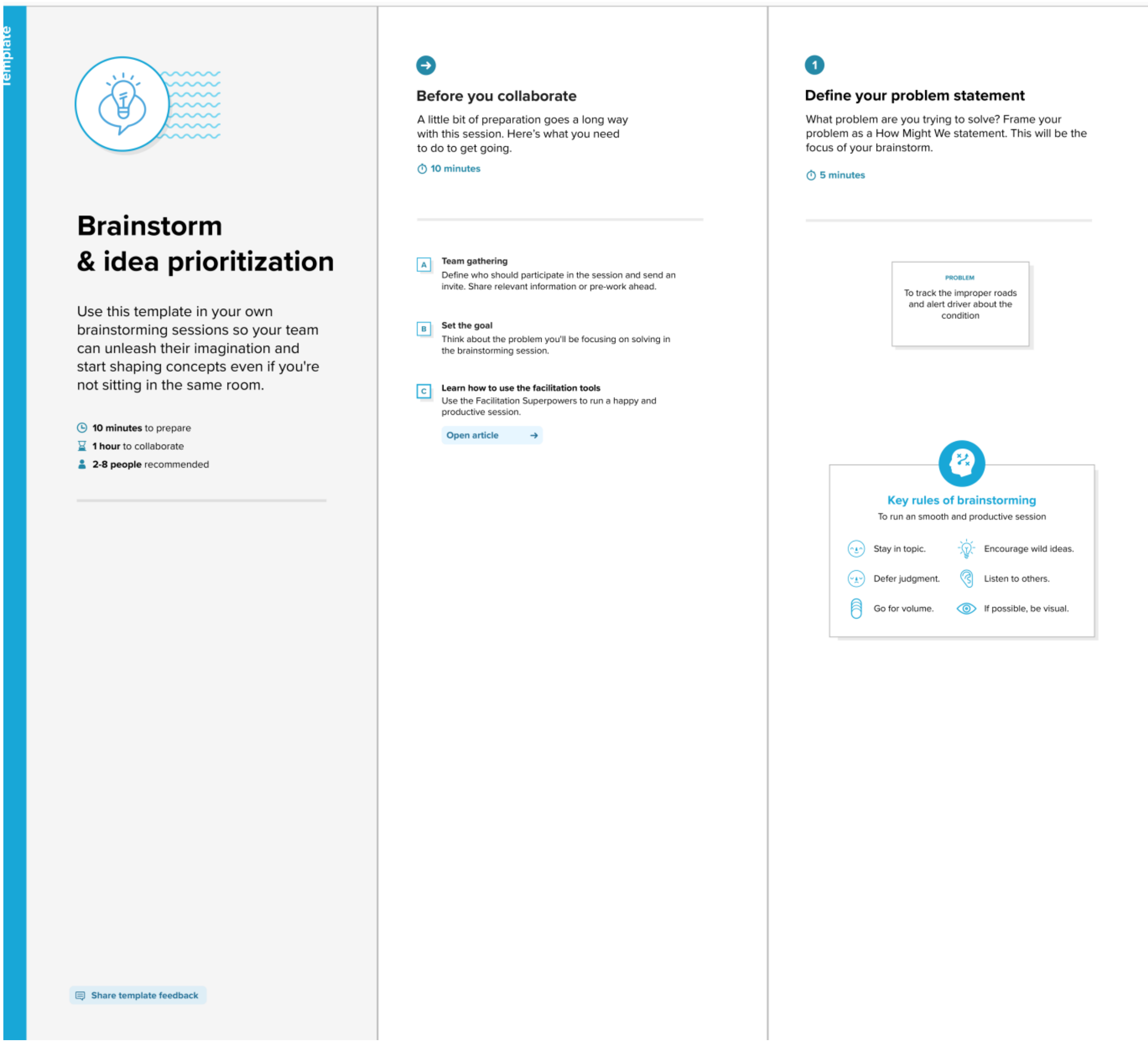
2.2 Empathy Map Canvas

https://app.mural.co/t/shruthi7692/m/shruthi7692/1682872500942/96e1ee1c7af44c22a0892fb5e2880b6b066fad24?sender=u4170e50ac73941020b7a1236

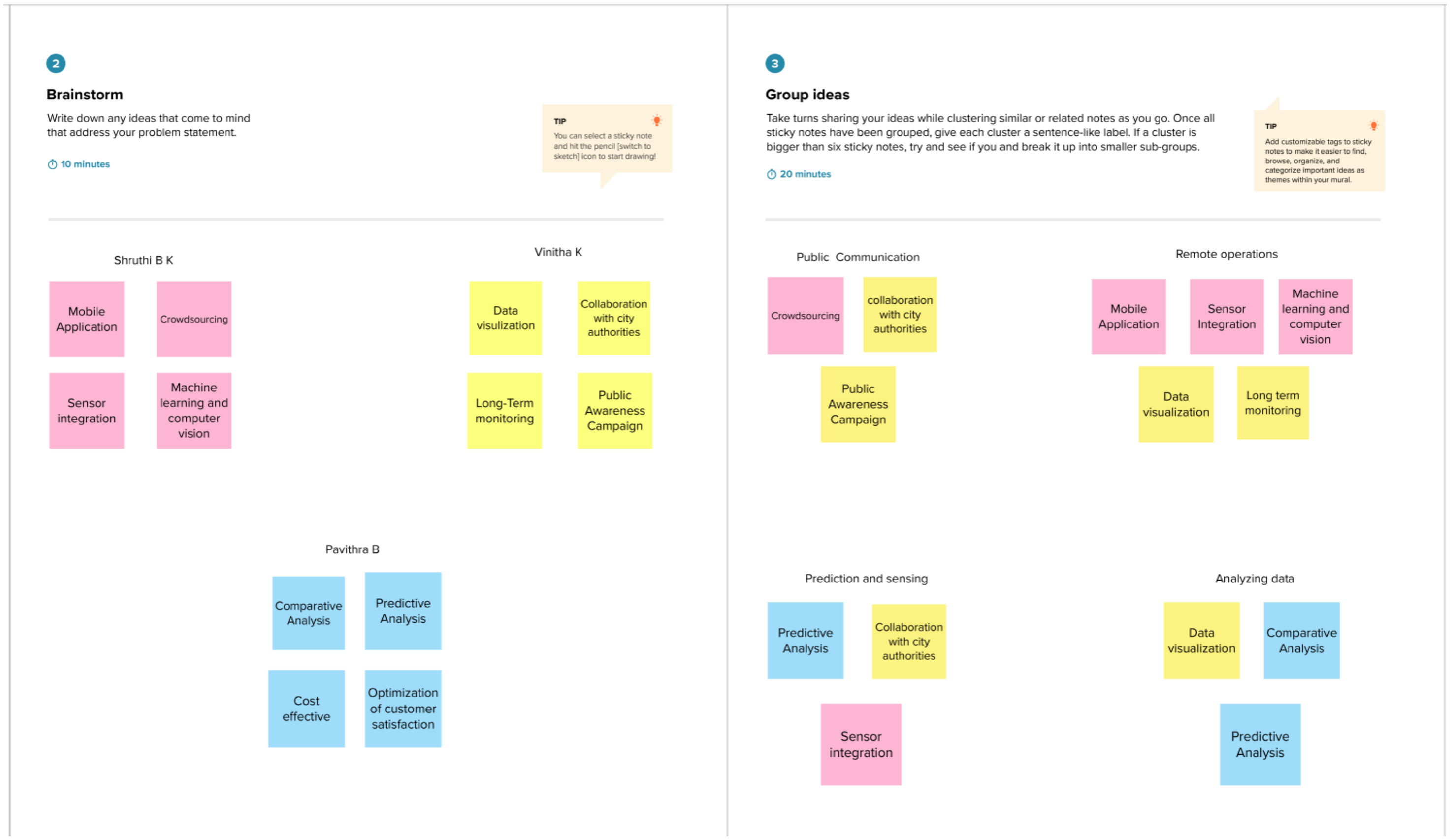
2.3 Ideation & Brainstorming

https://app.mural.co/t/shruthi7692/m/shruthi7692/1682930031369/1ba2da111bd4f1e33cd85ff883edbd2a6fad8933?sender=u4170e50ac73941020b7a1236

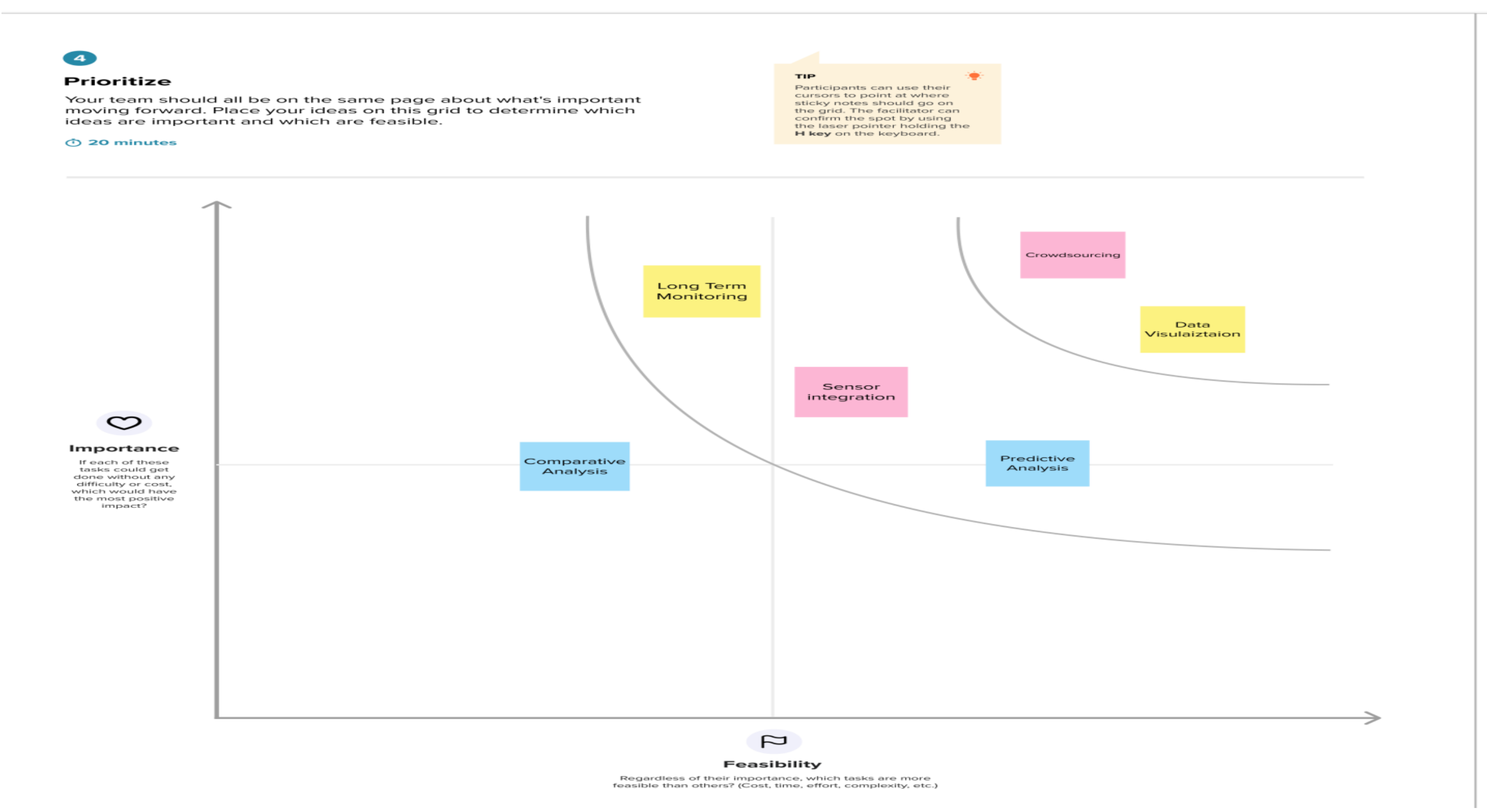
Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



2.4 Proposed Solution

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The main challenge is to devise a system that can collect data from various sources and analyze it in real-time to provide a Comprehensive report on the quality of streets in a given area. The system should be able to identify factors such as potholes, cracks, bumps, and other deformities that affect the quality of the street.
2.	Idea / Solution description	An IoT based system can be developed that incorporates the use of various sensors and data collection devices. Sensors in the form of cameras, vibration sensors can be deployed in streets. This data collected by sensors can be transmitted to a central server through Wi-Fi, cellular networks etc. Machine learning algorithms can be used to analyze the data and classify the quality of streets. These analysed results are visualized in a map or other geographical view to provide comprehensive view of the street quality. The system can also generate reports that highlight specific issues and recommend remedial actions. It is also configured to send alerts to maintenance personnel when issues are detected. These can ultimately lead to safer and more comfortable driving conditions.
3.	Novelty / Uniqueness	Real-time monitoring, Comprehensive data collection, Machine learning algorithms, Automated alerting and scheduling are some of the unique and novel aspects that set it apart from traditional methods of assessing street quality.
4.	Social Impact / Customer Satisfaction	Safer driving conditions, improved quality of life, better resource allocation, increased customer satisfaction, environmental benefits like lower fuel consumption, reducing greenhouse gas emissions and improving air quality.
5.	Business Model (Revenue Model)	Government-funded model where the project is funded by government or municipality, public-private partnership model where government

		partners private companies through various means such as subscription fees, licensing, and consulting services, Asset monetization model where these are sold to third part vendors, Value added services where services such as real-time traffic information, road safety alerts etc. are provided through subscription generating revenue.
6.	Scalability of the Solution	The design is scalable depending on size of roads and customizable to the specific needs of city. When large data are detected it can be stored in cloud-based infrastructure. Wireless connections such as cellular networks, LoRaWAN can be used to transmit data to deploy many sensors.

3. REQUIREMENT ANALYSIS

3.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Sensor Deployment and Data Collection	1. Identify the appropriate type and number of sensors needed to capture data related to street quality 2. Develop a deployment plan for installing sensors in the targeted area 3. Ensure sensors are properly calibrated and functioning correctly to capture accurate data 4. Establish a method for transmitting sensor data to a central server for processing
FR-2	Data Processing and Analysis	1. Develop algorithms to process and analyze sensor data, such as identifying potholes, cracks, and bumps 2. Identify thresholds or criteria for defining street quality, such as the number or severity of potholes 3. Develop models to predict how street quality may change over time based on the collected data 4. Analyze trends and patterns in the data to identify areas or factors that may contribute to poor street quality
FR-3	Data Visualization and Reporting	1. Develop dashboards or other visualizations that provide real-time updates on street quality to stakeholders 2. Develop reports that summarize trends and patterns in the data over time 3. Allow stakeholders to customize visualizations or reports to meet their specific needs
FR-4	Maintenance and Repair Management	1. Develop a method for prioritizing maintenance and repair tasks based on the severity and location of street quality issues 2. Establish communication channels with maintenance and repair teams to ensure timely and accurate repairs 3. Monitor and track maintenance and repair activities to ensure they are completed as expected
FR-5	Data Security and Privacy	1. Establish appropriate access controls to ensure only

		authorized users can access and modify data 2. Implement measures to protect data privacy, such as anonymizing or aggregating data to prevent identification of individual vehicles or drivers 3. Develop a disaster recovery plan to ensure data can be recovered in the event of a system failure or other disaster.

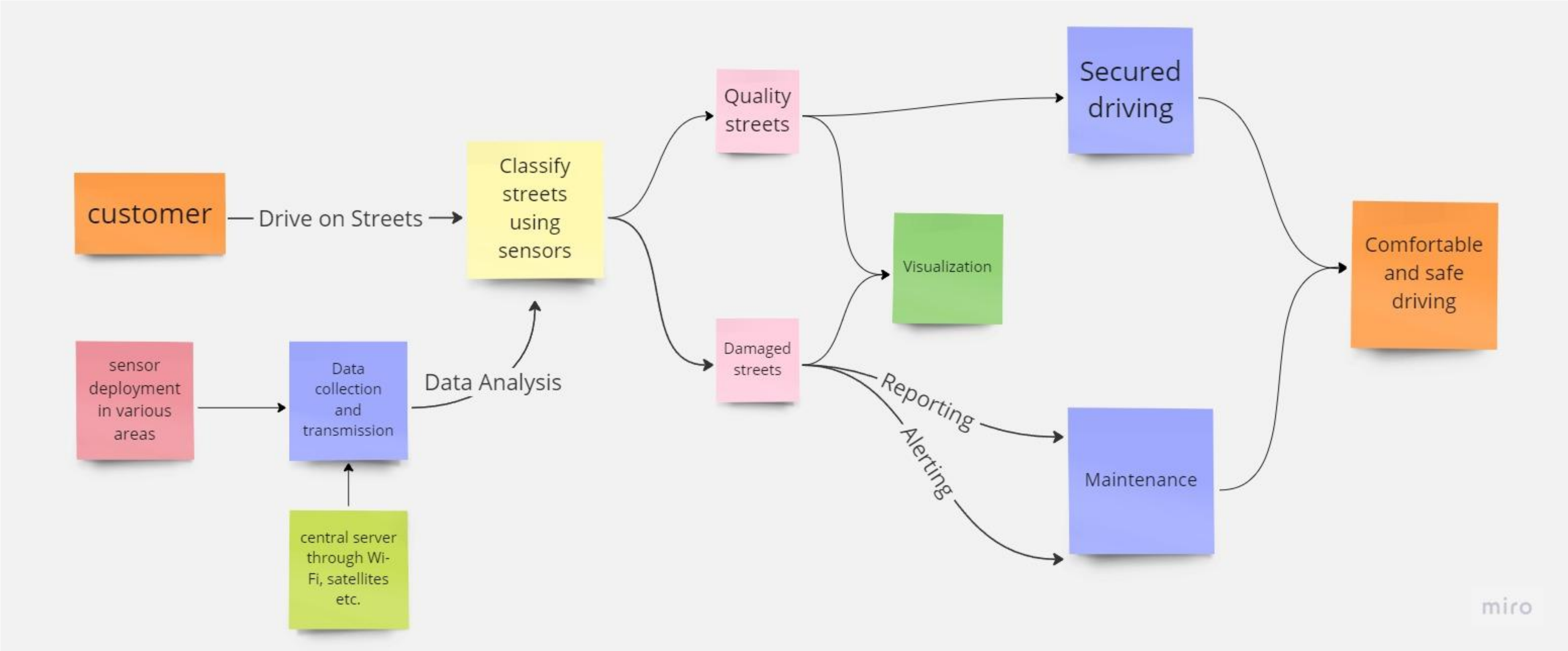
3.2 Non-Functional requirements

Following are the non-functional requirements of the proposed solution.

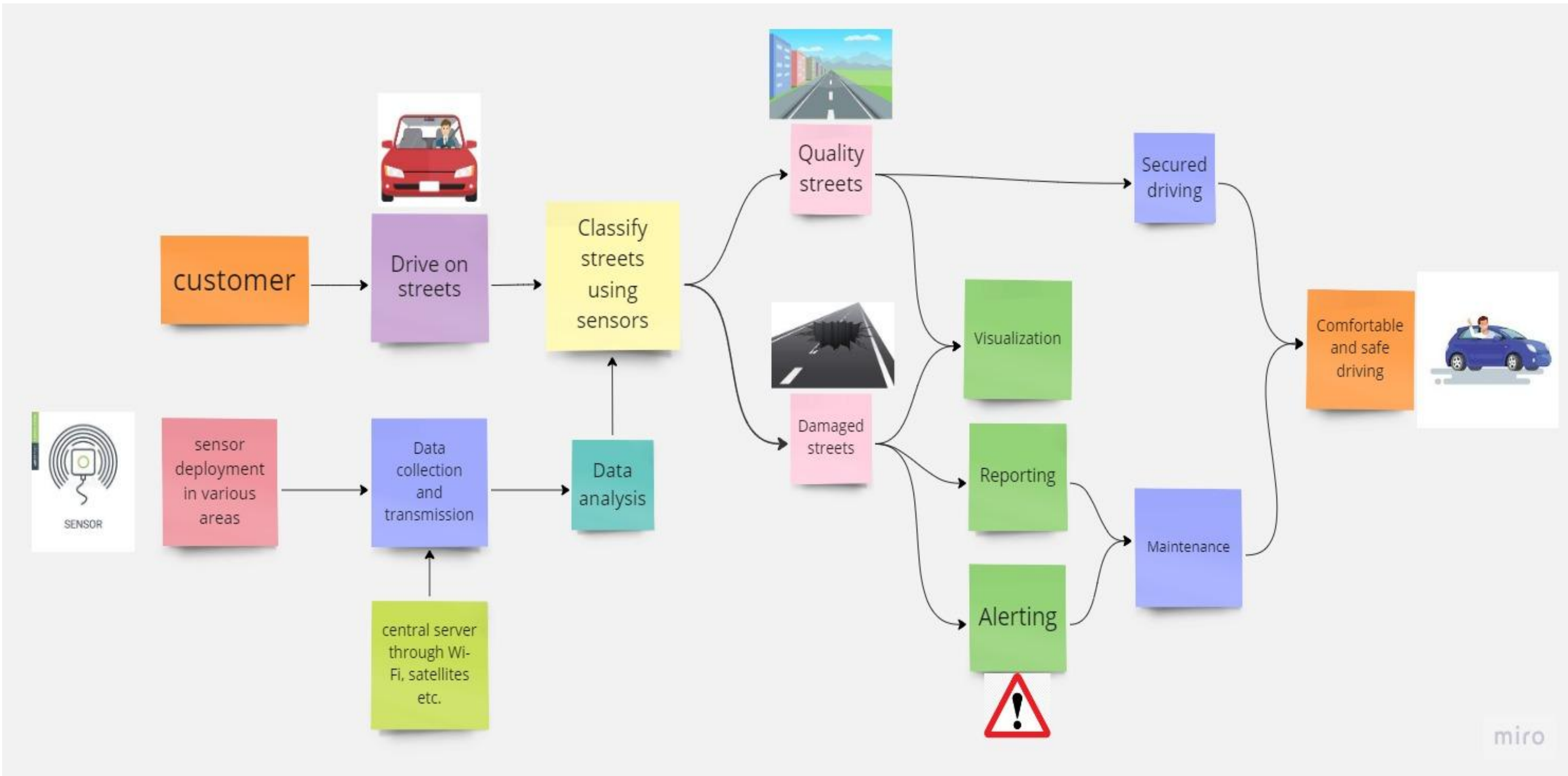
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The solution should be easy to use and accessible to different types of users, such as maintenance personnel, decision-makers, and the general public.
NFR-2	**Security**	The solution should ensure data privacy and confidentiality by implementing secure communication protocols, access control, and data encryption.
NFR-3	**Reliability**	The solution should be reliable and able to consistently collect, process, and analyze data from IoT sensors to identify street quality parameters.
NFR-4	**Performance**	The solution should have optimal performance to ensure timely data processing and analysis. It should also be able to handle peak loads during high traffic periods.
NFR-5	**Availability**	The solution should have high availability to ensure that it is accessible to users and stakeholders at all times. This requires robust infrastructure and redundancy measures to avoid downtime.
NFR-6	**Scalability**	The solution should be scalable to accommodate additional IoT sensors as needed without compromising the system's availability.

4. PROJECT DESIGN

4.1 Data Flow Diagrams



4.2 Solution & Technical Architecture



4.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
City Residents	The mobile app should allow users to submit pictures and descriptions of the street quality issue, along with their location data.	USN-1	As a city resident, I want to be able to report poor street quality through a mobile app, so that the city can efficiently prioritize repairs and maintenance.	The app should be easy to use and intuitive, and should provide confirmation that the report has been submitted successfully.	High	Shruthi B K
City Planners	The system should store all street quality data in a central database that can be easily accessed and analyzed.	USN-2	As a city planner, I want to be able to access historical street quality data, so that I can make informed decisions about future infrastructure investments.	The database should be easy to navigate and search, and should provide useful data visualizations.	Medium	Shruthi B K
Business owner	Map of parking spots	USN-3	As a business owner, I want to be able to view a map of parking spots	Map should be easy to navigate and show	Low	Shruthi B K

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
	near businesses.		near my business, so that my customers can find parking easily.	locations of parking near businesses.		
City Government	The IoT sensors should be able to detect and report on a range of street quality issues, such as cracks, and uneven surfaces.	USN-4	As a city government, I want to be able to track and monitor the condition of all streets in the city, so that we can allocate resources for repairs and maintenance.	The sensors should be able to accurately detect street quality issues, and should be able to report this data back to a central dashboard.	High	Vinitha K
Delivery driver	Map of loading zones and parking spots.	USN-5	As a delivery driver, I want to be able to view a map of loading zones and parking spots, so that I can make deliveries more efficiently.	Map should be easy to navigate and show locations of loading zones and parking spots.	Medium	Vinitha K
Tourist	Map of popular attractions and landmarks	USN-6	As a tourist, I want to be able to view a map of popular attractions and landmarks, so that I can explore the city more easily.	Map should be easy to navigate and show locations of popular attractions and landmarks.	Low	Vinitha K
Pedestrian	Mobile app for reporting	USN-7	As a pedestrian, I want to be able to report potholes and other street	App should allow users to easily report	High	Pavithra B

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
	street quality issues		quality issues using a mobile app, so that the city can address them in a timely manner.	street quality issues and send a notification to the city government.		
Public transit user	Map of bus and train routes	USN-8	As a public transit user, I want to be able to view a map of bus and train routes, so that I can plan my commute more easily.	Map should be easy to navigate and show routes for different bus and train lines.	Medium	Pavithra B
Cyclist	Map of bike-friendly streets	USN-9	As a cyclist, I want to be able to view a map of bike-friendly streets, so that I can plan my route more easily and avoid unsafe roads.	Map should show bike lanes, routes, and trails, and highlight unsafe streets.	Low	Pavithra B

5. CODING & SOLUTIONING

FEATURE:

The images are shown of two types, the original and an output image which is shown to the user for better resolution and understanding.

CODE:

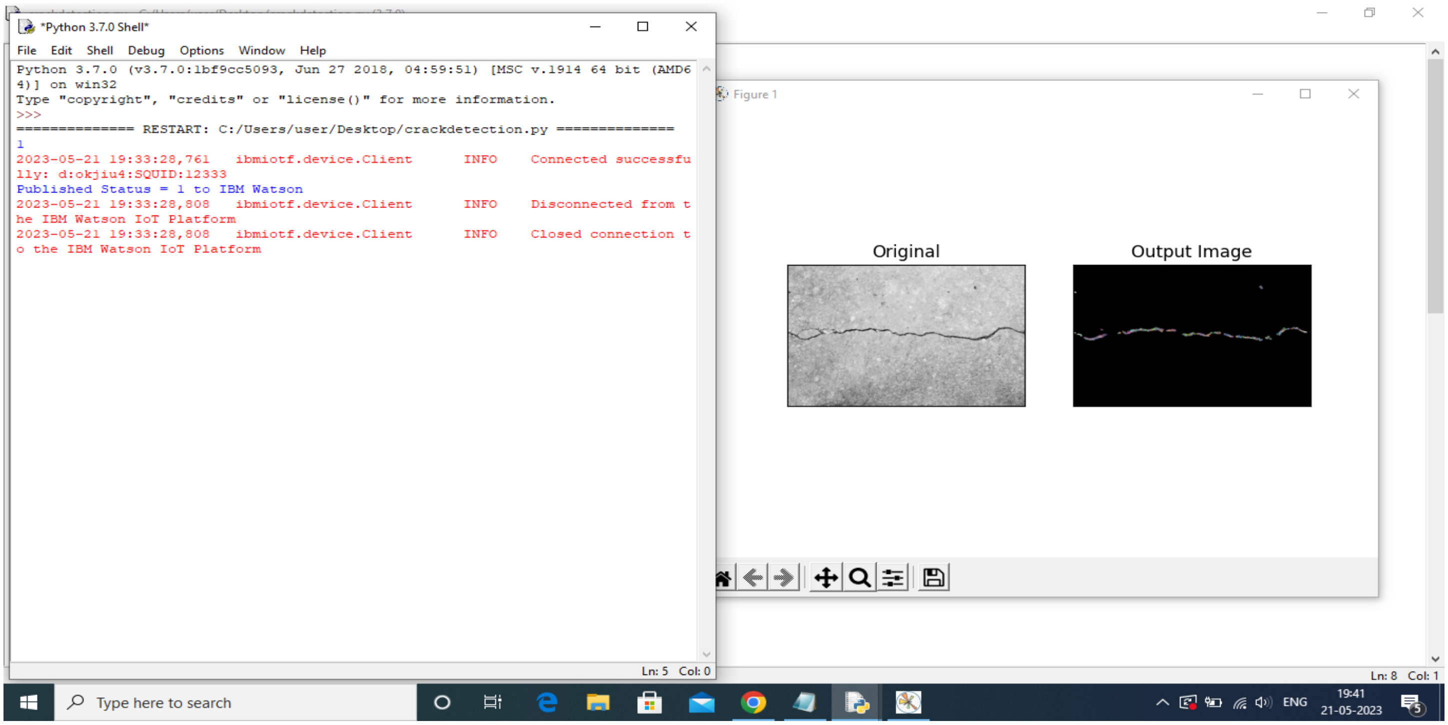
```
# read a cracked sample image
img = cv2.imread('Input Set/Cracked_07.jpg')
flag=0
# Convert into gray scale
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# Image processing ( smoothing )
# Averaging
blur = cv2.blur(gray,(3,3))

# Apply logarithmic transform
img_log = (np.log(blur+1)/(np.log(1+np.max(blur))))*255

# Specify the data type
img_log = np.array(img_log,dtype=np.uint8)

# Image smoothing: bilateral filter
bilateral = cv2.bilateralFilter(img_log, 5, 75, 75)

# Canny Edge Detection
edges = cv2.Canny(bilateral,100,200)

# Morphological Closing Operator
kernel = np.ones((5,5),np.uint8)
closing = cv2.morphologyEx(edges, cv2.MORPH_CLOSE, kernel)

# Create feature detecting method
# sift = cv2.xfeatures2d.SIFT_create()
# surf = cv2.xfeatures2d.SURF_create()
```

```
orb = cv2.ORB_create(nfeatures=1500)

# Make featured Image
keypoints, descriptors = orb.detectAndCompute(closing, None)
featuredImg = cv2.drawKeypoints(closing, keypoints, None)

# Create an output image
cv2.imwrite('Output Set/CrackDetected-7.jpg', featuredImg)
flag=1
```

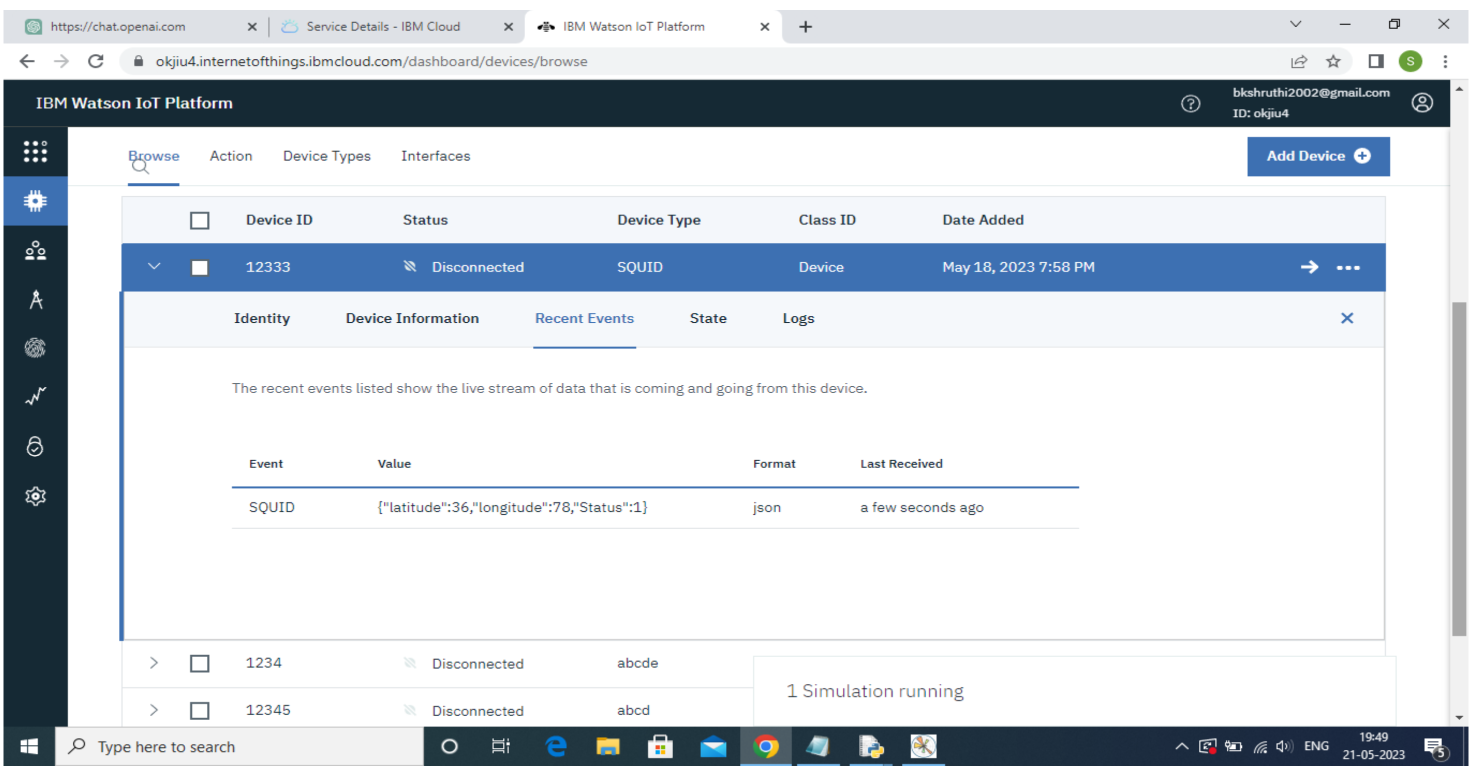
6. RESULTS

6.1 Performance Metrics

PYTHON OUTPUT SCREENSHOT:



IBM ACCURACY SCREENSHOT:



7. ADVANTAGES & DISADVANTAGES

Advantages:

1. Real-time monitoring: IoT-based street quality identification enables real-time monitoring of road conditions. This allows authorities to identify and address issues promptly, improving the overall quality of the streets.

2. Cost-effective: Traditional methods of road condition assessment often require manual inspections or expensive equipment. IoT-based systems can provide cost-effective solutions by using sensors embedded in vehicles or street infrastructure to collect data continuously.

3. Efficient maintenance planning: By analyzing the data collected through IoT sensors, authorities can gain insights into road deterioration patterns and prioritize maintenance efforts accordingly. This helps optimize resource allocation and reduces unnecessary repairs.

4. Enhanced safety: Poor road conditions can pose significant risks to drivers and pedestrians. IoT-based street quality identification can help identify hazardous areas and prompt timely repairs, thus enhancing safety for road users.

5. Improved transportation infrastructure: Access to accurate and up-to-date data on street quality can assist urban planners and policymakers in making informed decisions about infrastructure development and expansion. This can lead to the construction of better roads and transportation systems.

Disadvantages:

1. Deployment and maintenance challenges: Implementing an IoT-based street quality identification system requires significant infrastructure and ongoing maintenance. This includes installing sensors, ensuring data connectivity, and managing the system's operation and security.

2. Data privacy and security concerns: Collecting and transmitting data through IoT devices raises privacy and security issues. Safeguarding sensitive information from unauthorized access and ensuring compliance with privacy regulations are crucial challenges that need to be addressed.

3. Reliance on technology: IoT systems are dependent on technology, and any malfunction or disruption in the network or sensor devices can affect the accuracy and reliability of street quality identification. Backup systems and contingency plans are necessary to mitigate such risks.

8. CONCLUSION

Street quality identification using IoT offers numerous advantages in terms of real-time monitoring, cost-effectiveness, efficient maintenance planning, enhanced safety, and improved transportation infrastructure. It enables authorities to make data-driven decisions, optimize resources, and proactively address road maintenance issues. However, there are challenges related to deployment, maintenance, data privacy, and security that need to be carefully considered and addressed. With proper planning and implementation, IoT-based street quality identification has the potential to revolutionize the way road conditions are monitored and maintained.

9. FUTURE SCOPE

The future of street quality identification using IoT holds immense potential for further advancements. Here are a few areas that could be explored:

1. Advanced sensor technologies: Continued research and development in sensor technologies can lead to the creation of more accurate and robust IoT devices for street quality identification. This could include the use of advanced imaging sensors, machine learning algorithms, and predictive analytics to improve data collection and analysis.

2. Integration with smart city initiatives: IoT-based street quality identification can be integrated into broader smart city initiatives. This integration can enable better coordination between various urban systems, such as transportation, energy, and waste management, leading to more efficient and sustainable urban environments.

3. Citizen engagement and crowdsourcing: Involving citizens in the street quality identification process through mobile applications or citizen reporting platforms can enhance data collection and provide a more comprehensive understanding of road conditions. Crowdsourcing can also help in identifying localized issues that may not be detected by automated systems.

4. Autonomous vehicles and infrastructure communication: As autonomous vehicles become more prevalent, the integration of IoT-based street quality identification with autonomous systems can enable vehicles to adapt their routes and driving behavior based on real-time road condition data. This can contribute to safer and more efficient transportation.

Overall, the future of street quality identification using IoT lies in the continuous improvement of sensor technologies, the integration with smart city initiatives, citizen engagement, and the collaboration between IoT systems and emerging transportation technologies.

10. APPENDIX

Source Code

```
# importing necessary libraries
import numpy as np
import cv2
import matplotlib.pyplot as plt

import time
import sys
#import ibmiotf.application
import ibmiotf.device
import random

#Provide your IBM Watson Device Credentials
organization = "okjiu4"
deviceType = "SQUID"
deviceId = "12333"
authMethod = "token"
authToken = "27042023"


def ibmstart(x):

    def myCommandCallback(cmd):
        print("Command received: %s" % cmd.data['command'])
        print(cmd)

    try:
      deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-
method": authMethod, "auth-token": authToken}
```

```
      deviceCli = ibmiotf.device.Client(deviceOptions)
      #.............................................

    except Exception as e:
      print("Caught exception connecting device: %s" % str(e))
      sys.exit()

    deviceCli.connect()
    lat=random.randint(9,37)
    long=random.randint(68,97)
    data = { 'latitude' : lat, 'longitude': long ,'Status': x}
    #data = { 'Status' : x}
    #print data
    def myOnPublishCallback():
        print ("Published Status = %s" % x, "to IBM Watson")

    success = deviceCli.publishEvent("SQUID", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoTF")



    deviceCli.commandCallback = myCommandCallback
    deviceCli.disconnect()



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# surf = cv2.xfeatures2d.SURF_create()
orb = cv2.ORB_create(nfeatures=1500)

# Make featured Image
keypoints, descriptors = orb.detectAndCompute(closing, None)
featuredImg = cv2.drawKeypoints(closing, keypoints, None)

# Create an output image
cv2.imwrite('Output Set/CrackDetected-7.jpg', featuredImg)
flag=1
```

```
# Use plot to show original and output image
plt.subplot(121),plt.imshow(img)
plt.title('Original'),plt.xticks([]), plt.yticks([])
plt.subplot(122),plt.imshow(featuredImg,cmap='gray')
plt.title('Output Image'),plt.xticks([]), plt.yticks([])
print(flag)
ibmstart(flag)
plt.show()
```

GitHub Link:

https://github.com/naanmudhalvan-SI/IBM--11262-1682570477

Project Video Link:

https://drive.google.com/file/d/1WmrqOBQ-RhFkHOJjB5Gui67NzvJ0a-LS/view?usp=share_link