SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY

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1. INTRODUCTION

a. Project Overview

Recent years have seen a rise in the national calamity of traffic accidents in growing nations that are overpopulated. One of the main causes of accidents in sensitive public spaces, such as schools, colleges, hospitals, etc., and acute turning points, is the overspeed of vehicles that disobey the posted speed limit. Drivers endanger the lives of passengers, pedestrians, and other drivers by failing to slow down in these sensitive public places. The main objective of the proposed system is to operate the vehicles at a safe pace in critical locations while minimizing the risk of unintentional accidents and casualties. This project creates a system to alert drivers to speed limits in certain areas and to automatically slow down vehicles in sensitive public areas. The regular switching of traffic lights is therefore not a workable solution, and an IoT-based traffic control system is required to interface with the current traffic management system. The issue will worsen as the population increases and more people are in need of public transit. Additionally, it is essential to improve the traffic management system's overall effectiveness that pedestrian walkability and traffic mobility are safe and secure. As an alternative to getting around the drawbacks of the current traffic system, the IoT-based traffic system, which takes into consideration all these aspects, is welcomed.

b. Purpose:

Road accidents are defined as accidents that occurred or originated on a highway or street open to public traffic. These collisions result in injury or death between automobiles or humans. This is a major problem worldwide resulting in significant morbidity and mortality. This project proposes a system which has digital sign boards on which the signs can be changed dynamically. If there is rainfall or unexpected critical weather condition, then the roads will be slippery, and the speed limit would be decreased, and it will be indicated in the app. There is a webapp through which you can enter the data of the device credentials, location, and the other information. Then data is retrieved and display on the app like current weather condition, speed limits, etc., which helps Ro the person to choose easy destination path. The purpose of this study was to develop a system that uses a smartphone to notify drivers about road signs ahead.

2. LITERATURE SURVEY

2.1.Existing problem

The speed limits and road signage in use today are static. However, under specific circumstances, the signs may be modified. If the road signs are digitalized, we may consider situations when there are detours due to traffic congestion or accidents and adjust the signs accordingly. This proposal suggests a system that uses digital sign boards with constantly changing signs. Rainfall causes the roads to become slick, and the speed restriction is lowered. There is a web application that allows you to enter information about road detours, accident prone regions, and informational sign boards. Python IDLE is required software.

System needed IS RAM: 4GB Minimum Processor: Configuration OS-Windows/Linux/MAC. Smart connected sign boards are used to replace static signboards. These intelligent connected sign boards update automatically and obtain the speed restrictions from a web application utilizing weather API. The speed may rise or fall depending on weather changes. The display of the diversion signs depends on the flow of traffic and potential fatalities. The appropriate guide, warning, and service signs are also posted at hospitals and restaurants. With the use of buttons, many operating modes can be chosen. This project will drastically change the poor road management into a better one, this will benefit the drivers, passengers and elderly people who are using roads to travel with ease and safety.

2.2. References

[1] W. E. Marshall, “Understanding international road safety disparities: Why is Australia so much safer than the United States?” accident an analysis & prevention, 2018

[2]World Health Organization, “Save LIVES - A road safety technical package,”2017.

[3] World Health Organization, “Global status report on road safety 2015.”

[4] Dariusz Grabowski & Andrzej Czyzewski in their paper titled "System for monitoring road slippery based on CCTV cameras and convolutional neural networks", Springer Publications 2020, made use of Convolutional Neural Networks to identify slippery roads using CCTV cameras.

[5] European road assessment program (Euro RAP), “European Road Safety atlas”.

2.3. Problem Statement Definition

Problem defines that due static board it may or may not be visible to the drivers that leads to accidents and even during critical weather condition , the speed limits of drivers while driving varies frequently that may also leads to road accidents and even in some cases like road works may lead to road diversion and this causes delay to reach destination .To overcome this , we need to replace the static sign boards to smart connected sign boards or digitalized sign boards are need to be used. These smart connected sign boards get the speed limitations from a web app using weather API and update automatically. Based on the weather changes the speed may increase or decrease that will be indicated to drivers. Based on the traffic and fatal situations the diversion signs in this project are alert message, buzzer sound are displayed where it helps the driver to reach their destination at right time. While considering Guide (Schools), Warning and Service (Hospitals, Restaurant) signs which are located nearby means it is also indicated with help of location service and in meanwhile we can periodically view the traffic situation, weather condition and accordingly the speed limits will also vary. Like this, different modes of operations can be selected with the help of app that has been created with device credentials and enter the details of location to check to it.

3. IDEATION AND PROPOSED SOLUTION

An empathy map is a collaborative visualization used to articulate what we know about a particular type of user. It externalizes knowledge about users in order to

1) Create a shared understanding of user needs.

2) Aid in decision making.

3) Empathy maps are split into quadrants (Says, Thinks, Does, Hear, Feels), with the user.

3.1 Empathy Map Canvas

3.2 Ideation & Brainstorming

Ideation is the process of forming ideas from conception to implementation, most often in a business setting. Ideation is expressed via graphical, written, or verbal methods, and arises from past or present knowledge, influences, opinions, experiences, and personal convictions. Ideation is usually derived from brainstorming sessions, online forums, seminars, surveys, social media platforms, and team-building exercises. In this project the ideas are discussed and listed:

- It gives an accurate update on weather monitoring which gives an idea for IoT drivers in route finding and deciding speed limits.
- Suggestion of nearby crowded places such as schools, colleges, hospitals.
- Weather report will be displayed in the sign board using the weather API.
- Traffic density can be viewed using GPS in mobile phone

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

Step-2: Brainstorm, Idea Listing and Grouping

Step-3: Idea Prioritization

3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	● Signs with Smart Connectivity for Better Road Safety is used to educate the drivers digitally using IOT who do not have knowledge about traffic signs and weather indication for the drivers and passengers convenience. ● To prevent the road accidents from happening using IOT.
2.	Idea / Solution description	● Replacing the man-made painted signs into digital as well as their name which is more visible compared to current signs and indicating weather in the same sign boards for driver where weather is not predictable.
3.	Novelty / Uniqueness	● Weather indication on sign boards is unique which will help mostly the two wheelers from unfortunate heavy rains and winds. Digital traffic signs also educates the drivers to follow traffic rules easily. ● The smart signs consists of temperature, humidity, wind speed. ● This information are received from weather monitoring app. ● It also gives information about nearby places such as hospitals, schools etc.., so that the users can decide their

		speeding according to that information.
4.	Social Impact / Customer Satisfaction	● It makes the people to know about traffic signs if they don’t know, it shows signs digitally to avoid the accidents and weather indication based on IOT to avoid accidents. ● By deciding a speed limit for the user, there is significant chance in reducing the accidents.
5.	Business Model (Revenue Model)	● This project can make revenue by selling much equipment’s to the government sector and also private sectors(educational &medical institutions).Maintain services are also taken by the company.
6.	Scalability of the Solution	● It makes the daily life of drivers and passengers better. The product can be scalable by adding new features to the product makes more revenue. ● It has greater chance in reducing the risk for the people as it is more visible than the normal signs, which saves a lot of lives at stake.

4. REQUIREMENT ANALYSIS

The process of determining user expectations for a new or modified product. These features, called requirements that must be quantifiable, relevant, and detailed. This is known as requirement analysis. Requirements analysis involves frequent communication with system users to determine specific feature expectations, resolution of conflict or ambiguity in requirements as demanded by the various users or groups of users. Here the requirement analysis splits into two types:

4.1 Functional requirement

A Functional Requirement (FR) is a description of the service that the software must offer. It describes a software system or its component. A function is nothing but inputs to the software system, its behaviors, and outputs. Based on user stories, the epic requirements are stated based on proposed problem statements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	User Registration can be done through a Website or Gmail.
FR-2	User Confirmation	Confirmation via Email, phone, OTP
FR-3	Travelers Registration	Registration in the platform needs for communicating with customer through their mobile
FR-4	Transport Agency Registration	Register for getting approval to implement the smart sign boards for better road safety
FR-5	Weather Monitoring	Open weather API implemented to monitor weather reports and update in database
FR-6	Sensor implementation	Monitoring traffic density and road condition, pedestrian monitoring and controls traffic signals.
FR-7	Database Management	Updating information in the database to intimate the users about the abnormal situations

FR-8	Database Management	Once the situation detected the user get information via the digital display who travels along the road also it will update in the platform, so others plan accordingly.

4.2 Non-Functional requirements

FR No.	**Non-Functional Requirement**	**Description**
NFR-1	**Usability**	Easy to follow instructions displays on the board. Understanding the signs should be clear.
NFR-2	**Security**	Provide better security, any other third party can't able to display information in the board, Users data are kept confidential.
NFR-3	**Reliability**	It can be able to withstand in any weather condition and the hardware parts require periodic monitoring to avoid any damage. It is dynamic in nature and reduce traffic congestion.
NFR-4	**Performance**	The smart display improves the safety, and it makes user tense free and keep them in a comfort zone. Also, quality of service is improved.
NFR-5	**Availability**	The solution is available 24X7 and withstand any climate changes
NFR-6	**Scalability**	It can be implemented efficiently in anywhere and data execution will be faster. Provides better safety

Non- functional Requirements (NFRs) define system attributes such as security, reliability, performance, maintainability, scalability, and usability. They serve as constraints or restrictions on the design of the system across the different backlogs. Also known as system qualities, non - functional requirements are just as critical as functional Epics, Capabilities, Features, and Stories. They ensure the usability and effectiveness of the entire system. Based on problem statement define this requirement analysis is stated as:

5. PROJECT DESIGN

Project design is an early phase of the project lifecycle where ideas, processes, resources, and deliverables are planned out. A project design comes before a project plan as it’s a broad overview whereas a project plan includes more detailed information. Here project is designed based on circumstances and preferences like Data Flow Diagrams; Solution & Technical Architecture; User Stories.

5.1 Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

5.2 Solution & Technical Architecture

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

Solution Architecture Diagram:

5.3 User Stories

A user story is an informal, general explanation of a software feature written from the perspective of the end user. Its purpose is to articulate how a software feature will provide value to the customer

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	Login into the application.	I can access dashboard.	High	Sprint-1

	Login	USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm.	High	Sprint-1
		USN-3	Through OpenWeather Map, speed limitation is controlled.	I can access weather API.	High	Sprint-2
		USN-4	As a user, I can control my driving speed.	I can decrease / increase speed.	Medium	Sprint-1
		USN-5	I can get traffic diversions signs through smart sign board.	I can get traffic status.	Medium	Sprint-1
	Dashboard	USN-6	I can get new updated routes due to traffic / accidents.	I can handle the situation.	Low	Sprint-1
Customer (Web user)	Data generation	USN-7	Use of OpenWeather map.	Weather related Information.	High	Sprint-1
		USN-8	Use of Node-Red.	To connect devices.	High	Sprint-2
Data validation	Checking accuracy	USN-9	As a user, I can check the ability and accuracy of the model in obtaining the required information.	Check the capability of the model.	High	Sprint-2
Data extraction	Obtaining the data	USN-10	As a user, I can retrieve the result data from the application for data storage for further uses.	Download the result in the form of data.	High	Sprint-3
Administrator	Problem Solving	USN-11	Future updating and monitoring.	Can monitor sign board.	Medium	Sprint-2

6. PROJECT PLANNING & SCHEDULING

Fundamentally, ‘Project planning’ is all about choosing and designing effective policies and methodologies to attain project objectives. While ‘Project scheduling’ is a procedure of assigning tasks to get them completed by allocating appropriate resources within an estimated budget and time-frame.

a. Sprint Planning & Estimation

7.7. CODING & SOLUTIONING:

FEATURE 1. IBM WATSON & NODE-RED

```
import time

import sys

import ibmiotf.application

import ibmiotf.device import random

#Provide your IBM Watson Device Credentials

organization = "7a4i8ha"

deviceType = "sabi"

deviceId = "sabi"

authMethod = "token"

authToken = "Sa&n13juSa!b5iB!t+"

# Initialize GPIO

temp=random.randint(20,50)
```

```
humid=random.randint(20,50)

lat =random.uniform(10.781377,10.78643)

lon = random.uniform(79.781377,79.78643)

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()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times

deviceCli.connect()

while True:

data = {"d":{ 'temp' : temp,"lat":lat,"lon":lon}}

#print data
```

```
def myOnPublishCallback():
print ("Published Temperature = %s C" % temp, "Humidity = %s %%" %humid,
"to IBM Watson")
success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
if not success:
print("Not connected to IoTF") time.sleep(1)
deviceCli.commandCallback = myCommandCallback
```

OUTPUT:

FEATURE 2: SPEED DETECTION

By implementing a location sensor in MIT APP INVENTOR, with changes in the location with respect to time, speed can easily be detected and displayed in the app to the user.

This requires location settings from user’s phone to be active. An image of normal speed limit is also displayed which means that, travelling within that range would be safe.

FEATURE 3:MAP AND NAVIGATION

By implementing same location sensor, current location can be detected. This also requires location settings in user’s phone to be active. By dragging the green marker to start location and red marker to the destination location to be reached and clicking on the navigate button, displays the street path that connects the start and end point specified. In addition to this, it also displays the directions to be followed to reach the destination.

FEATURE 4: ZONAL CLASSIFICATION

Here, displays few sign boards indicating different zones like school zone, hospital zone, railway track etc. By clicking on the button below the sign displays the meaning and instruction to be followed in the region. This provides the user with better understanding about the sign boards and to act accordingly.

FEATURE 5: DETERMINING TRAFFIC

Since hardware sensors are not implemented, we have used random function to generate values for the distance between the user and the vehicle ahead. • If the distance is below 20, it instructs the driver or the user to stop immediately and try moving forward with different direction or to take diversion.

8. TESTING

8.1 Test Cases

A test case documents strategy that will be used to verify and ensure that a product or system meets its design specification and other requirements. A test case is usually prepared by or with significant input from the engineer. This document describes the plans for testing the architectural prototype of System. In my Project the system has to be tested to get the Desired Output. I use different speed for testing the system.

8.2 User Acceptance Testing

In engineering and its various sub disciplines, acceptance testing is black-box testing performed on a system (e.g. software, lots of manufactured mechanical parts, or batches of chemical products) prior to its delivery. It is also known as functional testing, black-box testing, release acceptance, QA testing, application testing, confidence testing, final testing, validation testing, or factory acceptance testing. In software development, acceptance testing by the system provider is often distinguished from acceptance testing by the customer (the user or client) prior to accepting transfer of ownership. In such environments, acceptance testing performed by the customer is known as user acceptance testing (UAT). This is also known as end-user testing, site (acceptance) testing, or field (acceptance) testing.

A smoke test is used as an acceptance test prior to introducing a build to the main testing process. Acceptance test cards are ideally created during sprint planning or iteration planning meeting, before development begins so that the developers have a clear idea of what to develop. Sometimes (due to bad planning!) acceptance tests may span multiple stories (that are not implemented in the same sprint) and there are different ways to test them out during actual sprints.

One popular technique is to mock external interfaces or data to mimick other stories which might not be played out during an iteration (as those stories may have been relatively lower business priority). A user story is not considered complete until the acceptance tests have passed. The acceptance test suite is run against the supplied input data or using an acceptance test script to direct the testers. Then the results obtained are compared with the expected results. If there is a correct match for every case, the test suite is said to pass. If not, the system may either be rejected or accepted on conditions previously agreed between the sponsor and the manufacturer.

The objective is to provide confidence that the delivered system meets the business requirements of both sponsors and users. The acceptance phase may also act as the final quality gateway, where any quality defects not previously detected may be uncovered.

In these testing procedures the project is given to the customer to test whether all requirements have been fulfilled and after the user is fully satisfied. The project is perfectly ready. If the user makes request for any change and if they found any errors those all errors has to be taken into consideration and to be correct it to make a project a perfect project.

User Acceptance Testing (UAT) is a type of testing performed by the end user or the client to verify/accept the software system before moving the software application to the production environment. UAT is done in the final phase of testing after functional, integration and system testing is done.

9. RESULTS

9.1 Performance Metrics

Performance metrics are defined as figures and data representative of an organization’s actions, abilities, and overall quality. There are many different forms of performance metrics, including sales, profit, return on investment, customer happiness, customer reviews, personal reviews, overall quality, and reputation in a marketplace. Performance metrics can vary considerably when viewed through different industries.

10. ADVANTAGES & DISADVANTAGES

Advantages :

- Signs with smart connectivity are an inexpensive and flexible medium that can help transmit information according to situation and entertain passengers.
- The digital signboards helps in reducing the air pollution due the emission of vehicles in heavy traffic area.
- The drivers can able to know about the weather condition and accordingly follow the speed limit displayed on the sign boards.
- The increased flexibility of these digital sign boards makes it easy for any private or government department to change the message as per the need of the hour.
- The driver can easily find the route and navigation instructions to reach the destination.The speed of the vehicle can be identified using location sensor.
- The digitals sign boards and the app are user-friendly.

Disadvantages:

- The digital signboards involves high Installation Costs.
- Getting digital signboards up and running is a far more involved process than print media.
- If the people managing the screens are not graphic designers, it can be

difficult to update the content regularly on the screen.

- The digital sign boards are still new and developing technology in the road safety sector.
- While digital sign boards require power and therefore can’t claim to be green, there is high energy use in the printing, erecting and replacement of traditional print media.

11. CONCLUSION

The chapters taken into account which includes the potential user of connected technologies : individual drivers, commercial drivers, pedestrians, cyclist and motor cyclist.

The task force decided to studied first the potential of connected technologies in high and middle income countries. Indeed, middle - income countries represent 72% of the world population, 80% of road traffic death and 47% of registered motorized vehicles, while high income countries are leader in development of connected vehicles. Since the road isn’t said to be safe let’s make it safer with the technologies present and available to us. The Internet of Things is one of the technologies that can lead us to travel on enhanced safe roads. So let's come together to create a better world with no accidents and a smart road for the future generation.

12. FUTURE SCOPE

One of the benefits of digital road signs is that they can be updated in real-time, which means that they can be used to provide motorists with up-to-the-minute information about conditions on the road ahead. This can be particularly useful in the case of accidents or other incidents that might cause delays. In the future, digital road signs could also be used to provide information about alternative routes that might be available in the event of a problem on the road. This could be particularly useful in the case of major incidents, such as road closures due to bad weather. Finally, digital road signs could be used to provide motorists with information about the best times to travel in order to avoid traffic congestion. This could be particularly useful in areas where there is a lot of traffic.

The future digital reality as follows with these technologies and ideas are :

1. Solar powered roadways
2. Smart Roads
3. Glow in the dark roads
4. Interactive lights
5. Traffic detection

13. APPENDIX

CODE:

```
import requests #importing a library

import json

import ibmiotf.application

import ibmiotf.device

import time

import random

import sys

# watson device details

organization = "2s7yy7" devicType = "project" deviceId = "projectid"
authMethod= "token" authToken= "projecttoken" #generate random values for
```

```
randomo variables (temperature&humidity)
def myCommandCallback(cmd):
global a
#print("command recieved:%s" %cmd.data['command'])
#status=cmd.data['command']
print("command recieved:%s"%cmd.data['command'])
control=cmd.data['command']
print(control)
try:
deviceOptions={"org": organization, "type": devicType,"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()
#connect and send a datapoint "temp" with value integer value into the cloudas
a type of
event for every 10 seconds
deviceCli.connect()
```

```
while True:
#get sensor data from DHT11
a ="https://api.openweathermap.org/data/2.5/weather?q=Chennai,%20IN&appid=e
2bea247ed9ad643a04d9a8e55499d5f"
r=requests.get(url=a)
data=r.json()
Temp= data['main']['temp']
Humd=data['main']['humidity']
data= {'temp':Temp,'humid':Humd}
dist=random.randint(0,20)
dis={'dista':dist}
if(Humd<100):
warn={'alert':'PLEASE SLOW DOWN!!!!!!'}
if(dist<20):
insta={'inst':'stop'}
def myOnPublishCallback():
print("published Temperature = %s c" %Temp,"humidity:%s %%" %Humd)
print(warn); print(dis); print(insta)
success=deviceCli.publishEvent("IoTSensor","json",insta,qos=0,on_publish=
myOnPublishCallback)

success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish=
myOnPublishCallback)

success=deviceCli.publishEvent

("IoTSensor","json",warn,qos=0,on_publish=myOnPublishCallback)

success=deviceCli.publishEvent ("IoTSensor","json",dis,qos=0,on_publish=
myOnPublishCallback)=

if not success:

print("not connected to ibmiot") time.sleep(5)

deviceCli.commandCallback=myCommandCallback

#disconnect the device

deviceCli.disconnect()
```

<u>GIT HUB LINK:</u>

https://github.com/IBM-EPBL/IBM-Project-43357-1660716348

<u>DEMO VIDEO LINK:</u>

https://drive.google.com/file/d/1fVjf30kmEfMOLnIbLsUZVmmZANhxMwgb/view?usp=sharing