EasyBand2.0: A Framework with Context-Aware Recommendation Mechanism for Safety-Aware Mobility during Pandemic Outbreaks

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Outline of the Talk

- Introduction
- Social Distancing & Enabling Technologies
- Related Prior Research
- Novel Contributions of Current Paper
- Proposed EasyBand2.0 Mechanism
- Log Normal Shadow Model
- Proposed CARS Mechanism
- Implementation & Results
- Conclusions & Future Research

Introduction

Technologies in Pandemic Management

ISQED Symposium 2022

IoMT

Internet-of-Medical-Things, healthcare, remote patient monitoring, reporting etc.

IoT

Applications for detection and prevention, alerting systems, safe mobility systems, contact tracing, social distancing applications etc.

Blockchain

Decentralized system for healthcare data, patient data provding security and privacy.

GPS

Location specific applications, preventive applications, travel logging, contact tracing etc.

Artificial Intelligence

Data modelling, Medical systems,, recommendation systems etc.

UAV

Unmanned Ariel Vehicle, crowd monitoring, delivery of emergency aid etc.

Bluetooth

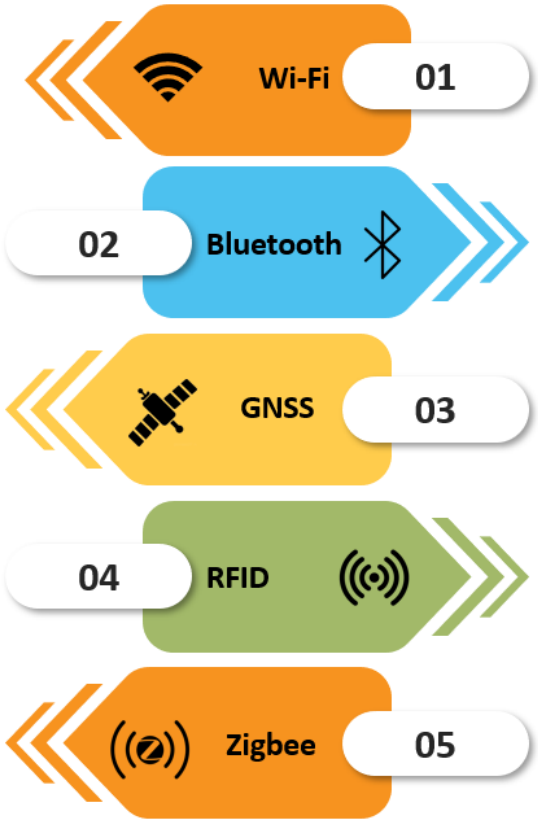
Low power, Low cost, interoperable applications for social distancing, notification systems etc.

5G

Enabler for IoT and IoMT based applications

Social Distancing & Enabling Technologies

- Wireless Technology:
  - Crowd Monitoring
  - Social Distancing
  - Alerting Systems
- Image and Visualization technologies:
  - Social Distance Monitoring
  - Mask Detection
  - Monitor COVID Safety Measures



Related Prior Research

Research	Medium	Algorithm	Application
Tripathy et al.	Sensors and BLE	RSSI	Indoor & outdoor Spaces
Hou et al.	Video Feed	Deep CNN	Public Spaces
Ziran et al.	Stereo Vision	HOG Algorithm	Public Spaces
Sharma et al.	Video Feed	DNN	Public Spaces & Indoor Spaces
Kobayashi et al.	BLE Packets	RSSI	University Campus
EasyBand2.0	BLE signal	RSSI	Indoor & outdoor Spaces

Novel Contributions of Current Paper

Bluetooth based distance estimation using RSSI (Received Signal Strength Indicator)

Log Normal Shadow Model for distance estimation

An alerting mechanism which notifies the user of different conditions during contacts, like safe, mildly suspect, and highly suspect

A vibrator to alert the user of proximity to a suspect

A Context Aware Recommender System designed on the 5W-1H code dimension tree model for safe mobility

Problem Addressed in the Current Paper

The need for a user friendly and more approachable design

Low cost and low power consuming application

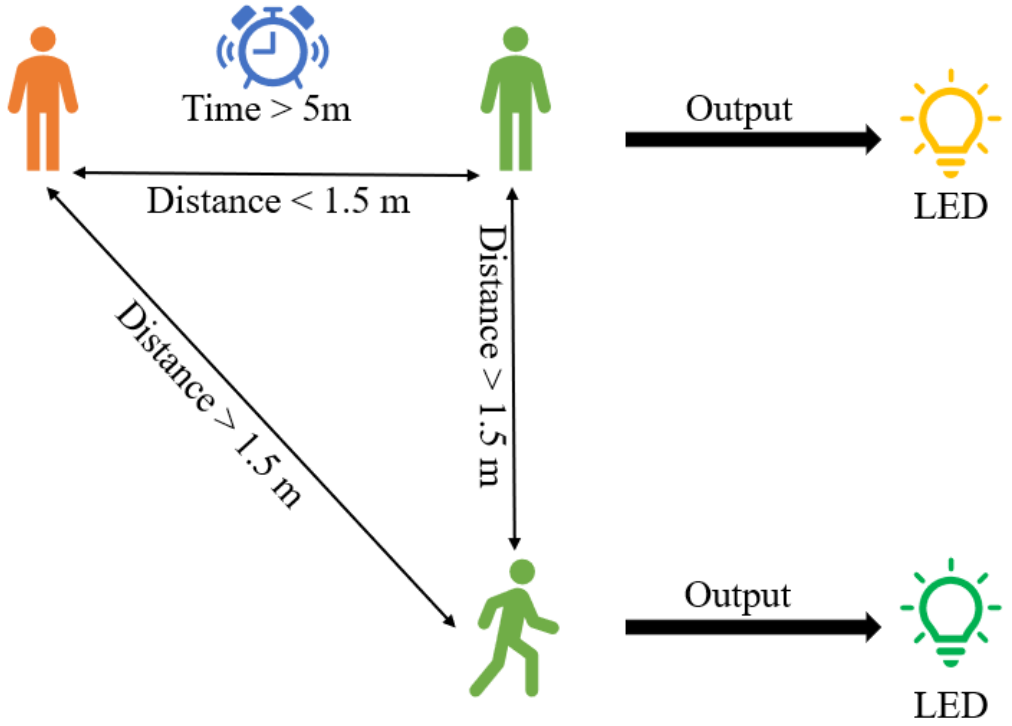
Easily deployable, interoperable and adaptive application

Safety-aware application that aids in safe mobility

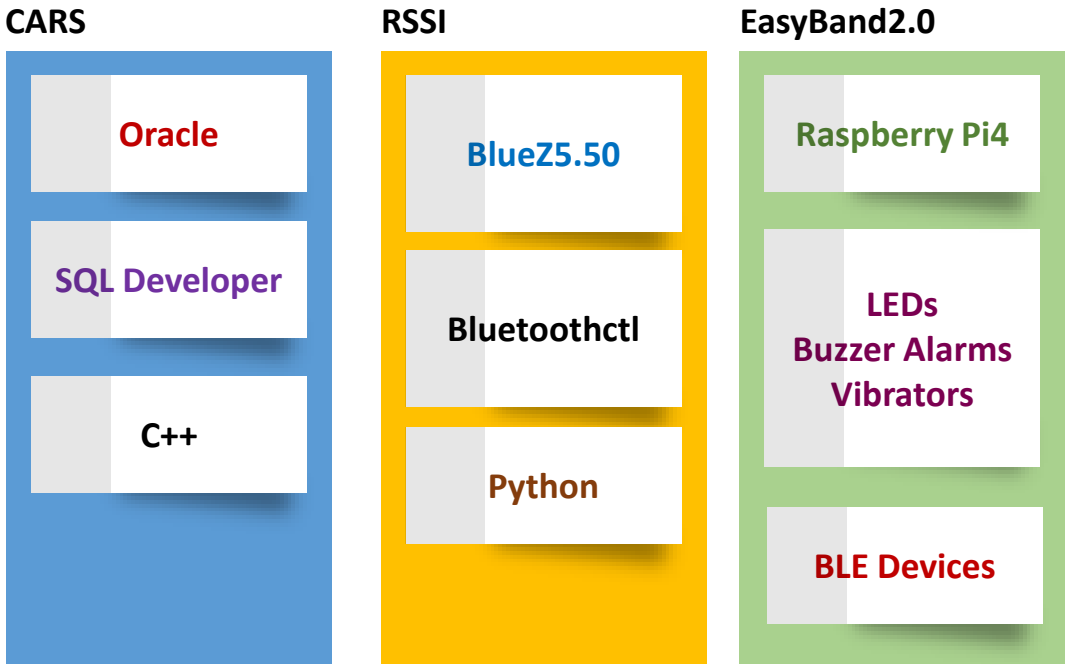
Proposed EasyBand2.0 Mechanism

RSSI of the Bluetooth signal is used to estimate the distance of the device from a client node

The client node also enables data transfer from the Bluetooth devices upon detection



Software & Hardware Used



Log Normal Shadow Model

The most common range-based technology for distance estimation is based on RSSI measurements

To estimate the distance of a transmitter to a receiver using the power of the received signal along with a path loss model

Unreliable estimation due to path loss and shadowing in localization can be modeled considering environmental variables and calibrating path loss exponents

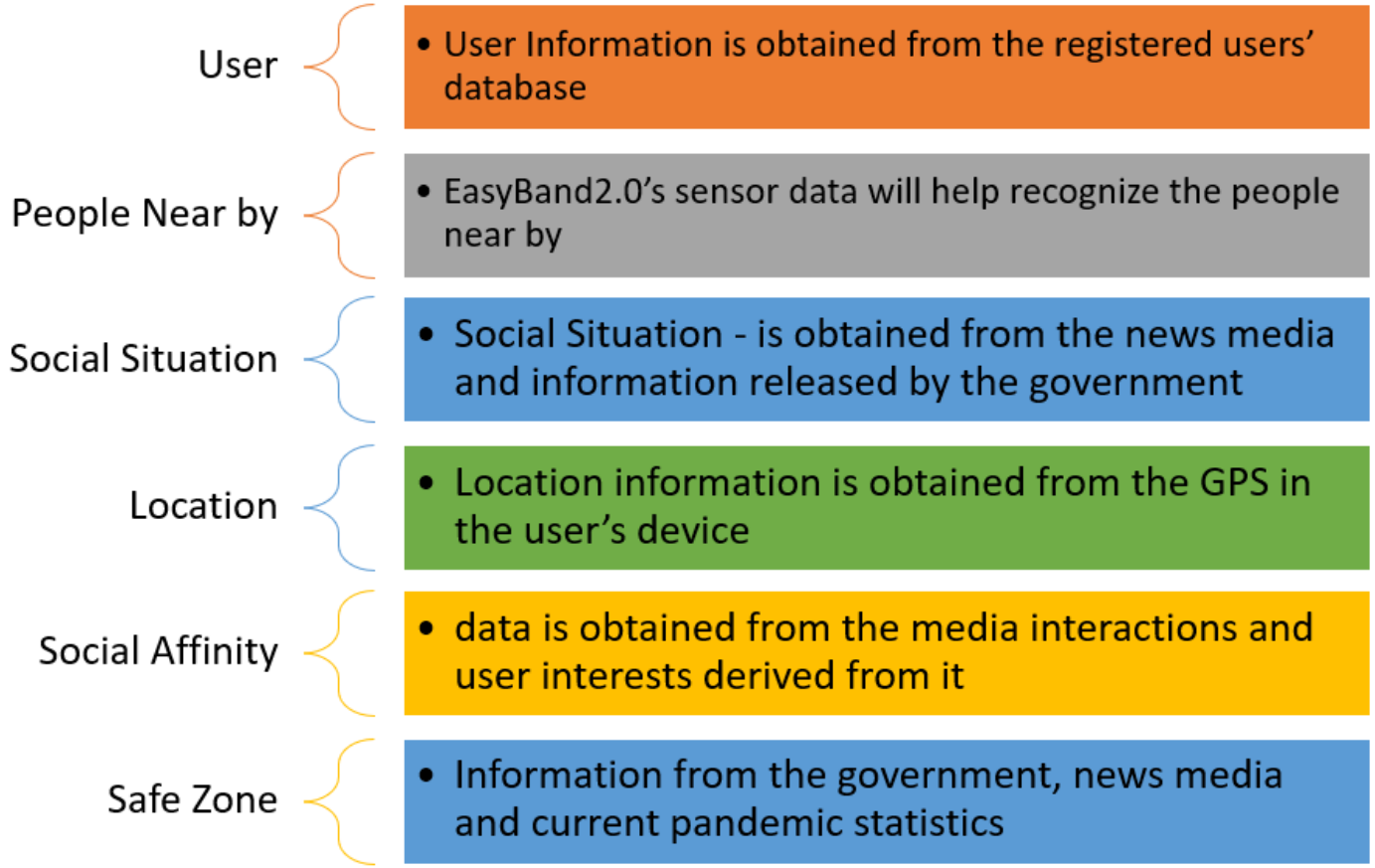
Log Normal Shadow Model

$$PL(d)=PL(d_0 - 10n \log_{10}(d/d_0)) + X(\sigma)$$

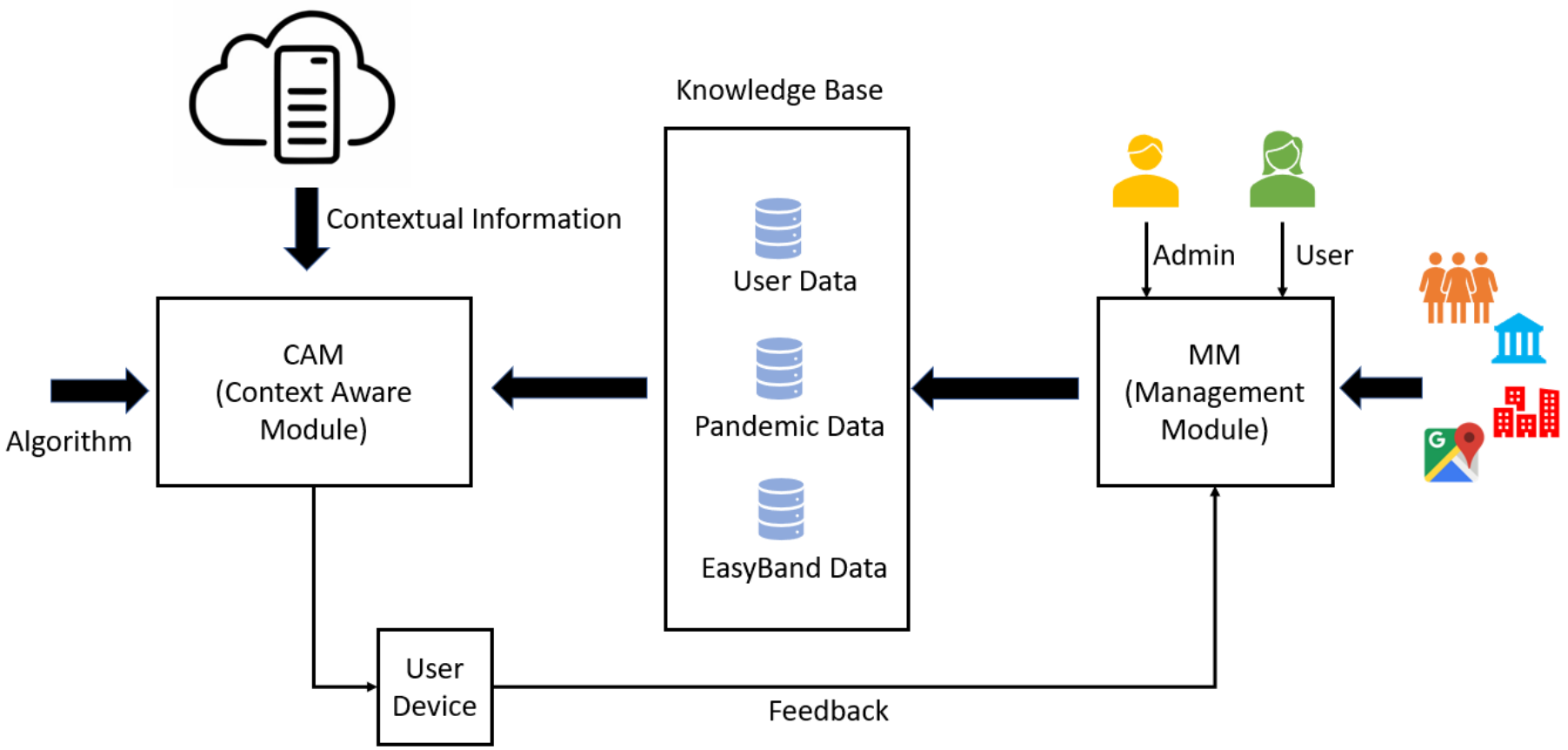
- PL(d) - The received signal power loss (expressed in dBm)
- d - The distance between a transmitter and receiver
- d_0 - The reference distance, typically 1m
- $PL(d_0)$ - The path loss (expressed in dBm) at the reference distance
- n - The path loss exponent
- X(σ) - Is a Gaussian random variable with zero mean and standard deviation σ that reflects the random variation in the path and shadow fading

Context Aware Recommendation System

Applications Fields: e-commerce, e-learning, Tourism, IoMT, Smart Cities etc.

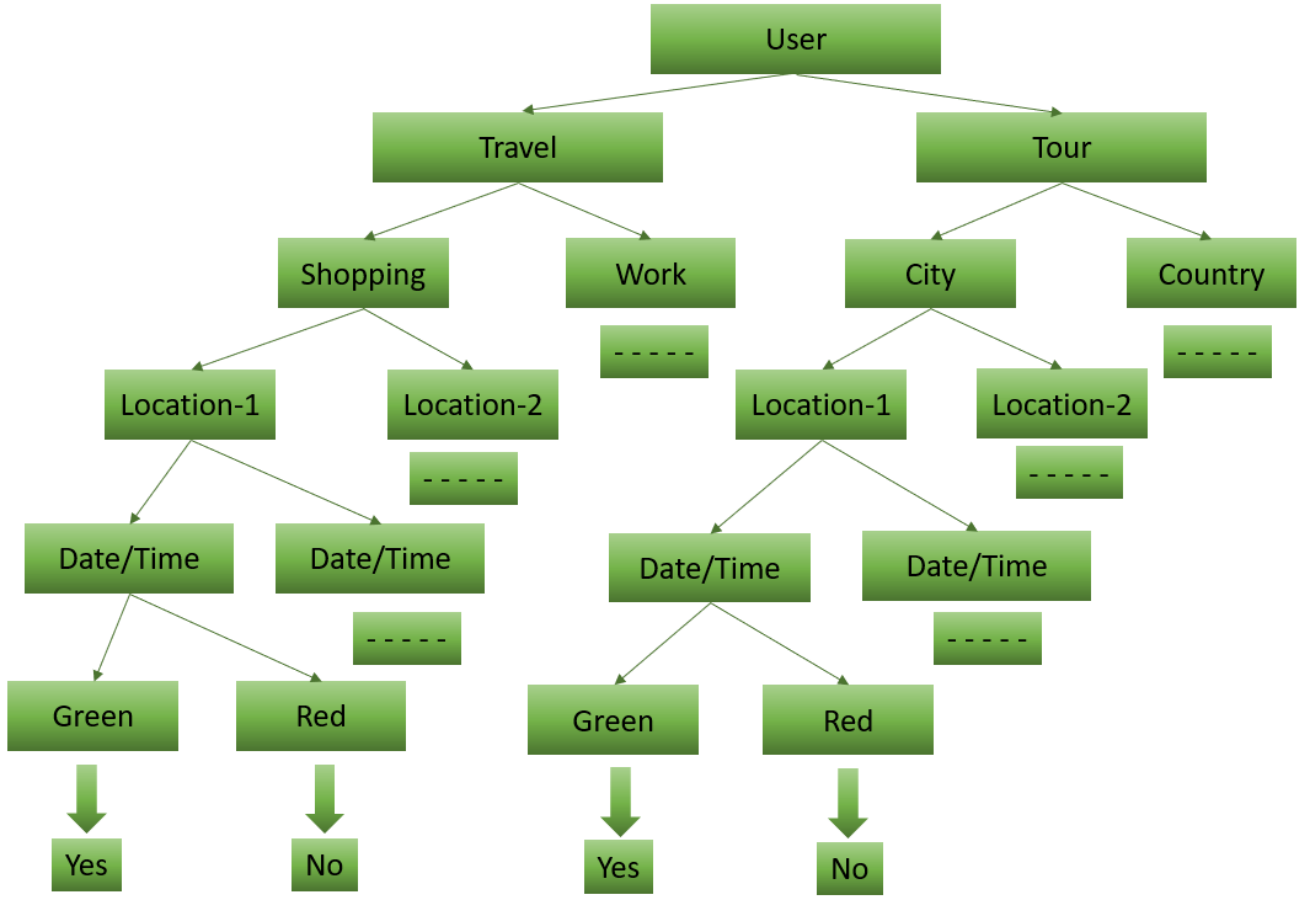


Proposed CARS Mechanism

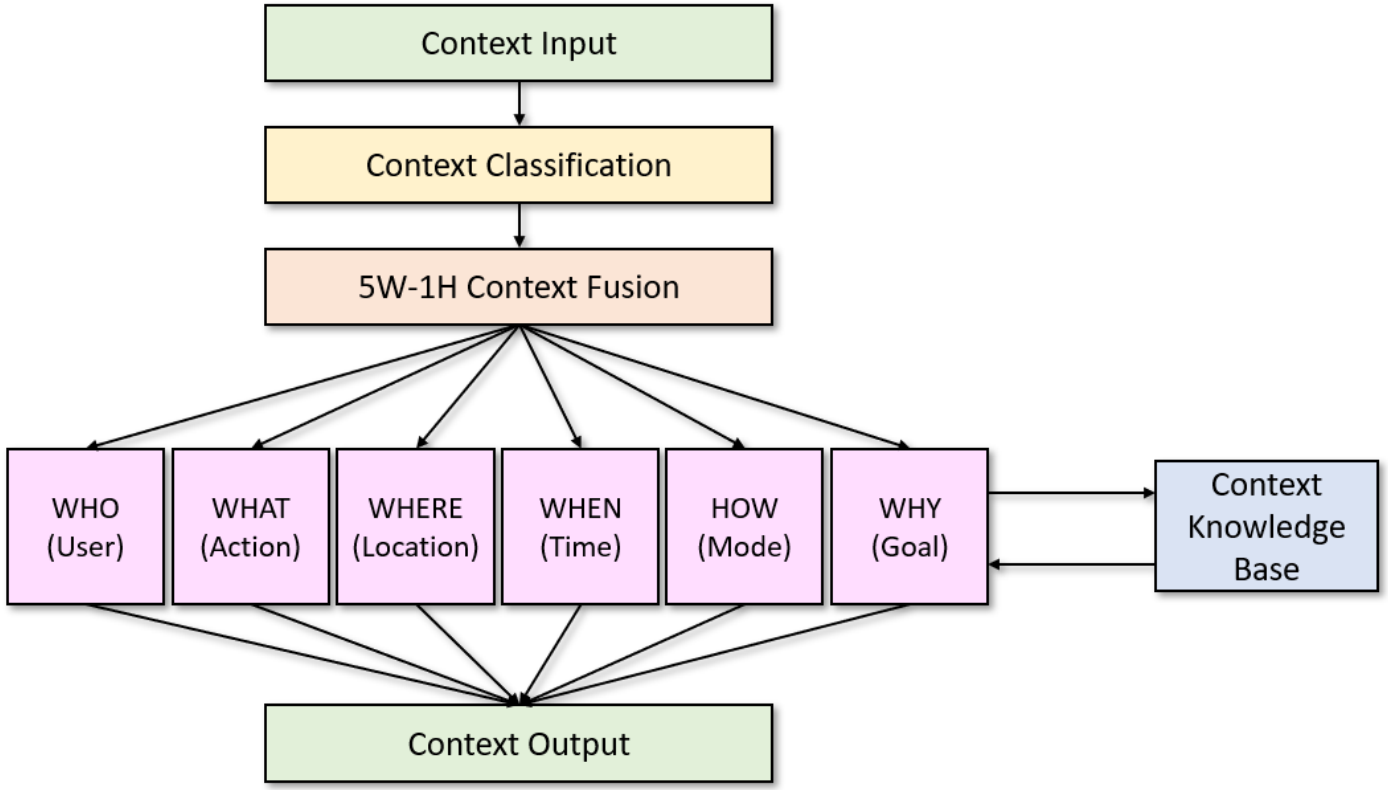


Implementation of 5W-1H Recommender System

- The 5W-1H are:
  - Location (WHERE)
  - Role (WHO)
  - Time (WHEN)
  - Interest (WHAT)
  - Utilization (WHY) and
  - Situation (HOW)

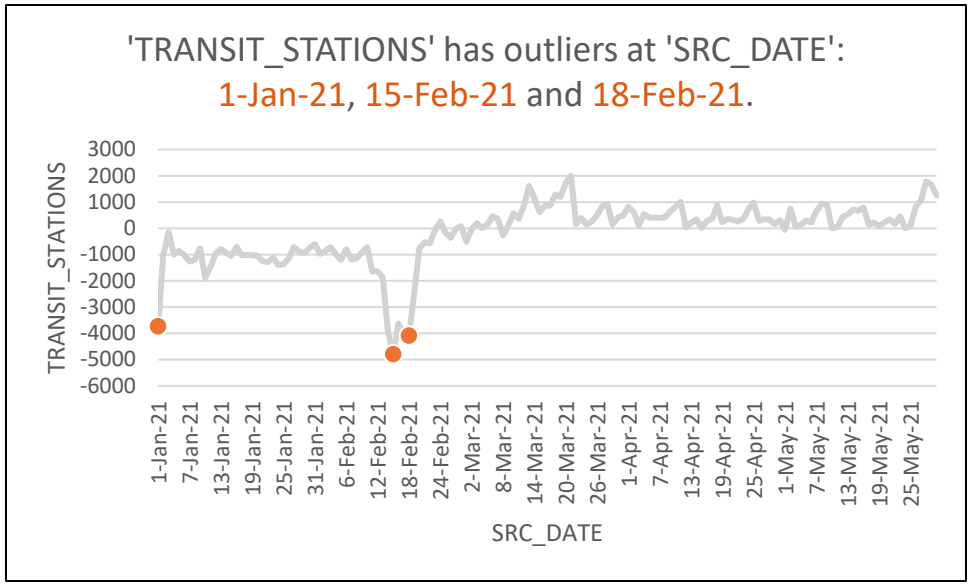


5W-1H Recommender System Design



Context Knowledge Base

- 100K dataset from Google's Community Mobility Reports
- 23K dataset which consists of all the COVID-19 measures taken from governments across the globe
- 300K COVID-19 Dataset from Kaggle



Algorithm -1

Algorithm 1: Algorithm for Extracting Information from Context Knowledge Base

Input: Location data of user device, date, Action item looked up by user
Output: Information Extracted and Exported to *.CSV file

```
/* The COVID Database is queried based on the algorithm to extract the revelevant
   COVID-19 data from the Context Knowledge Base                              */
Get User Location Ul, date Ud, Action Item Ai /* SQl Query and Procedures used to query the
   COVID data tables in the Database to extract information From Table A
   (Gov_Measures)                                                             */
while Check== True do
    if A.Location == Ul then
        Gm=A.Measures
    else
        Output = "Data Not Found, Try Again!";
        check = False;
/* Extarcting Mobility Data from Table B                                      */
for Ai in C and Location ==Ul and date== Rl do
    if A.Location=B.Location and A.date=B.date and C.Action==B.Action then
        Md = B.MobilityData
    else
        Output ="Data Not Found, Try Again!";
        check = False;
/* Accessing Table D to extract Number of cases in the location               */
while D.Location==Ul do
    Cc=D.ConfirmedCases
/* After Joiners on tables the resulting data is exported as *.CSV file for further
   Processing                                                                 */
```

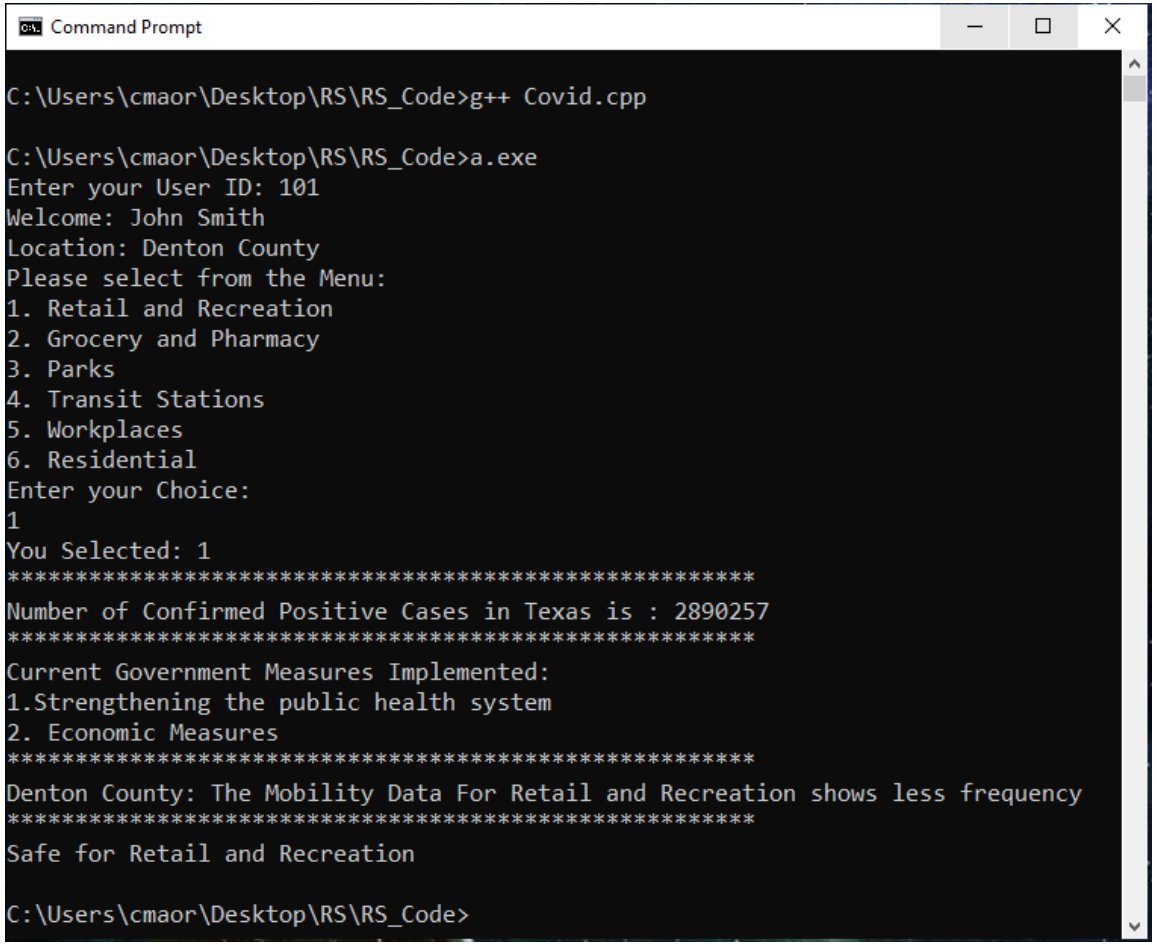
Algorithm-2

Algorithm 2: Algorithm for Context Fusion and Context Output

Input: Verifying User ID, Extracting user data like Location, Date, Time, Action Item
Output: Information Processed and Output Displayed

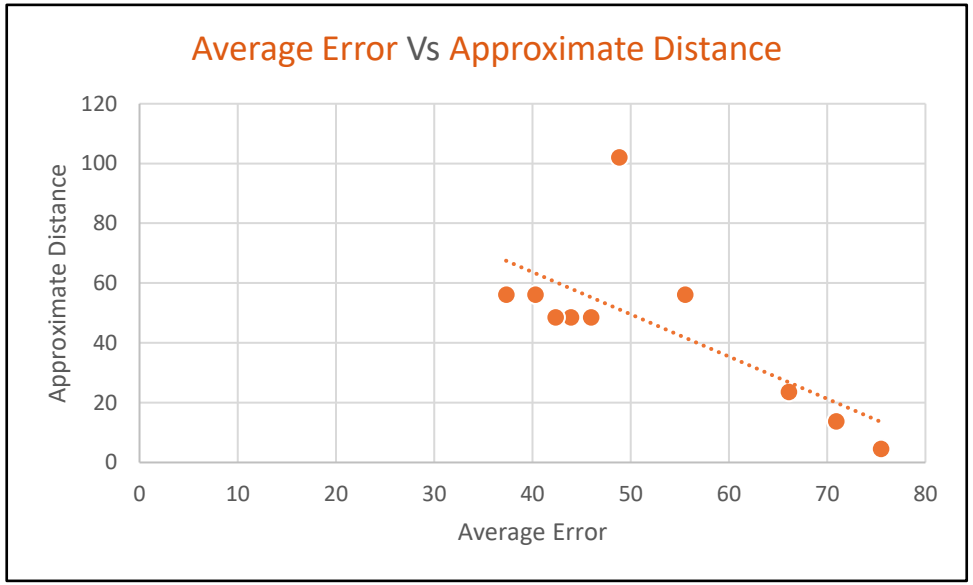
```
/* C++ Program which verifies the User ID and Calls the appropriate functions based
   on the user choice of action                                                    */
while Repeat==True do
    if ID==Ui then
        Output="Select From the Options";
    else
        Output="User not Identified"; Repeat = True;
    Input = UserChoice;
    Repeat = False;
while Location==Ul do
    CaseData=Cd;
    CKBdata =Kr;
/* Switch Block to call funtions based on UserChoice                               */
if UserChoice==1 then
    call funtion RetailandRecreation();
if UserChoice==2 then
    Call function GroceryandPharmacy();
if UserChoice==3 then
    Call function Parks();
if UserChoice==4 then
    Call function TransitStations();
if UserChoice==5 then
    Call function Workplaces();
if UserChoice==6 then
    Call function Residential();
/* Each function retrieves the exported data from database, analyzes the mobility
   data and anything above baseline is considered populated by people and outputs
   the suitable message.                                                           */
```

Algorithm Verification

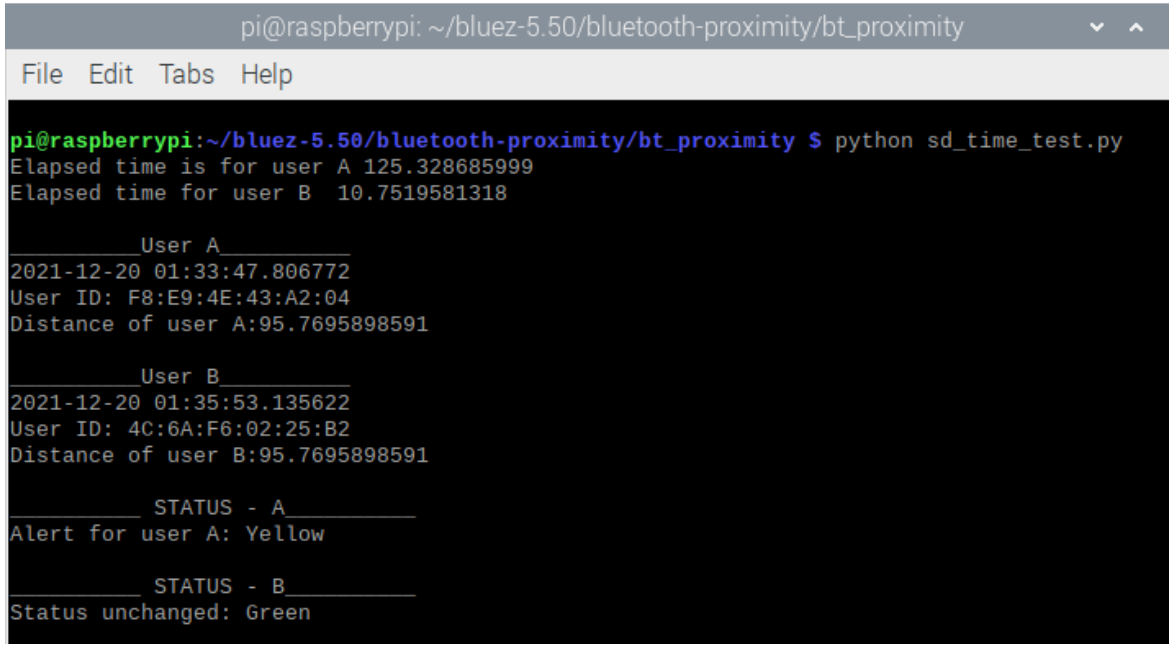


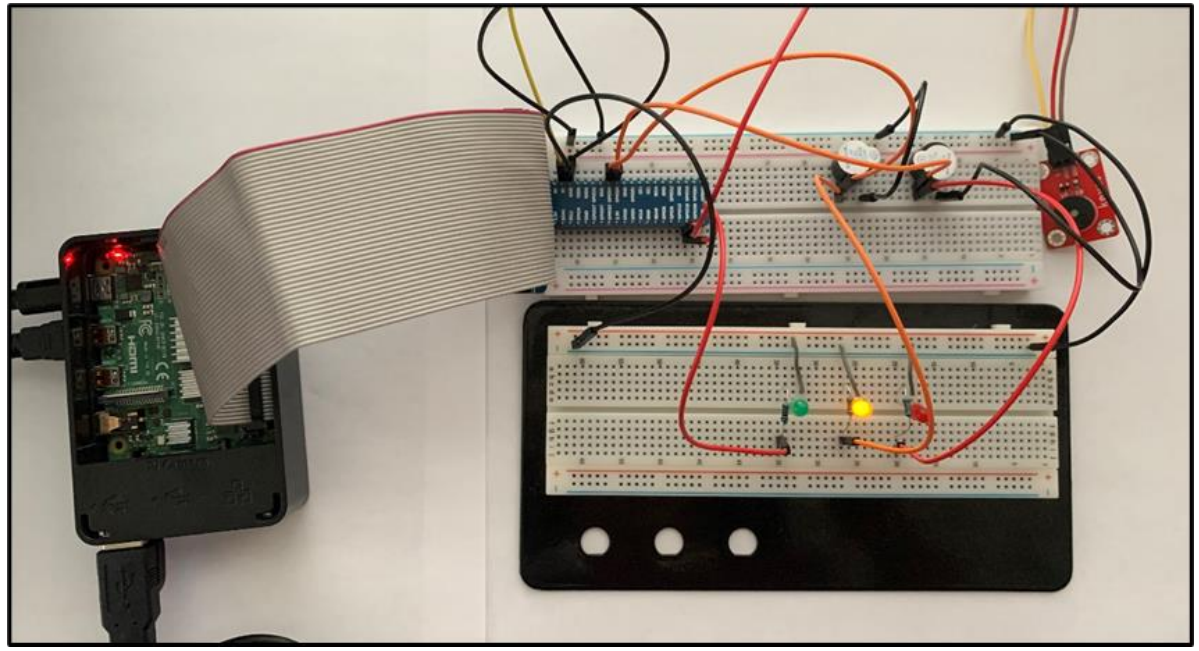
RSSI Values and Estimated Distance

Count	RSSI	Average Error	Approximate Distance
1	25.00	75.488	4.511
2	15.00	70.9144	13.659
3	11.00	66.094	23.544
4	5.00	55.541	56.116
5	1.00	48.833	102
6	6.00	45.958	48.415
7	6.00	43.905	48.415
8	6.00	42.365	48.415
9	5.00	40.311	56.116
10	5.00	37.324	56.116



EasyBand2.0 Validation





Conclusions & Future Research

- The application is low power consuming and easily deployable
- In future the software can be quickly modified and deployed to assist in any other similar pandemic situation
- CARS recommendation system will ensure safe mobility during pandemic
- The RSSI based distance estimation used is sufficient for accurate distance estimation and alerting
- Under the Internet-of-Medical-Things the application can be modified to work as a case monitoring and reporting tool
- Further research towards data security & privacy
- User-friendly graphical interface

Questions?

Contact Information

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Thank you!