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# HIGH-LEVEL TRANSPORTATION FRAMEWORK FOR OUTDOOR CONTEXT-AWARE RECOMMENDER

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**Abstract**

In smart transportation era, user journey is considered one of major aspect where researchers introduced different frameworks and systems to deliver level of optimization that satisfy drivers at outdoor environment. Context-aware recommendation is one of the techniques used to accomplish such an optimization for a trip by utilizing driver's and location's information. Many scenarios were covered in the previous studies, in particular, gas station scenario. In this paper, we highlight recent academia that focus on context-aware recommendation systems for the purpose of introducing an optimized high-level and conceptual context-aware recommender based on real-time feed specification, user feedback, dynamic profile insertion, dynamic radius search and deep neural network modules.

Keywords: Context-aware, Gas Station, Location information, Path planning, Recommender system, Real-time feed specification.

## 1. Introduction

In-car-Information provides rich data to a vehicle driver and it is very important aspect that shapes the development and advances in intelligent transportation systems (ITS) [1]. With the existence of smart cities this information is a key feature to support driver experience such as navigation info, fuel level info, temperature info, Internet, …, etc. Systems providing this information are built-in car infotainment system. The advancement of mobile applications even makes it another source that further provides useful information especially when integrated with the car infotainment system. One of the major systems and information that will have our focus is the navigation system. A driver can use the navigation system either using the car built-in system, his mobile or user personal navigation system. Usually the information needed on this regard is a location about a certain destination. The focus is on a one-to-many case where a driver needs to reach an optimal destination among several others available.

Regarding the information delivered to the driver based on destinations, it could be very distracting if you keep in mind the huge amount of information provided to the driver during the driving process, but they get primary information, that is not updated in the right time. Without any information about the availability of the service they are going to have, the status of the desired place (Open or Close), or whether there is a certain payment method, the driver may get in trouble and in an embarrassing situation.

Additionally, as drivers focus on what is happening outside of the car, they are presented with a variety of attention-demanding information sources. Since the human attention is limited, too much information might affect their experience of driving and make it unhappy or unsatisfying.

So, what we rely on when delivering the information to the driver is the importance and value of the information delivered during the process of driving.

The number of gas stations in many large cities has multiplied (e.g. in China) to meet population's demand [2]. Some gas stations have limited capacity, especially at rush hours while others are completely idle. this can be considered as unbalanced capacities and drivers lack information on the real-time status of the nearby gas stations. Enough information about nearest gas station is vital to enhance driver experience and to save fuel [3]. Furthermore, a driver is always looking for the best scenarios which help him save time, money, or both.

There are different categories that affect the importance of information in that case, such as:

i. Availability of the location: (open/close)
ii. Services and Items: (Service provided, or items provided)
iii. Payment method: (the available payment service and method used for making payments) [4].
iv. Traffic. (Concerns the traffic in the desired fixed location).

This can be noticed from understanding gas station queuing system [2]. Providing real-time information to drivers is helpful to optimize the management and reduce the impact delay resulted from queuing at gas stations and should be considered in relevant sectors.

All these factors are important while driving to a destination using the GPS system. The use of GPS system determines the driver's current location. Such information is considered as context-aware. A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task. [5].

Let us also keep in mind that most places right now, such as hotels, hospitals, restaurants, gas stations, schools, universities, etc. are displayed all in Google maps. Whenever you click on a location it will provide you with directions, estimated time of arrival (ETA), and the voiced system helps a lot while guiding you to the destination.

There are also different forms of location information system. What this approach first does is the location acquisition. There are two forms of architecture for location acquisition. The first one uses Self-positioning devices, which requires the processing at the device. The second one uses infrastructure-based solution, which requires transmission at the device, the devices continuously report their positions to a centralized location server. In order to apply all that, there has to be a usage for technologies, core positioning technologies, GPS based technologies, cellular network based, Internet and IoT. The technology and information systems have a big role in assisting the driver with information that would help him making or taking the right decision.

This research will focus on the matters of the location information/attributes, and how the information for transportation, routing, traffic, services, and payments can assist the driver through his/her journey and to show how to relate such a work to the driver. For example, at urban area, a study shown that the efficient optimization and management of the gas stations greatly impact transportation networks, and gas station as an energy supply is considered an important component of urban and national traffic systems [2]. The study provided the importance of two main factors; queuing information guidance and real-time queuing information.

The driver is an essential part of the ITS, without a doubt the driver is the most important link of this process because we get all the feedback from the driver, which will help us in improving our system and shape future work. However, since the driver is the most important part of this study, he should be more satisfied and comfortable when moving from a source to a destination. It is vital that the smart system have enough information that helps the driver moving from a source to a destination, not only through short distance, but also through providing driver's needs when reaching his destination. Recommender system is an example of such smart system that can be implemented in ITS domain to deliver best recommendation location based on driver's criteria.

Nowadays, location information system has become really messed up, and people are trying to save as much time and effort as possible. Important attributes of a type of data must be collected or revealed in the data [6]. For example, location information related to accident and crime data sets. With such valuable information regarding the place the user is heading to, it shall make the job or task easy for any driver or user especially at outdoor.

The purpose of this paper is to review some of the current literature who considers location information using IoT for drivers with an emphasis on possible developments in the field of optimization techniques in intelligent transportation systems. The aim is not to deliver a wide range of all existing researches, instead, we hope to describe the major key elements in the area of location information using IoT for drivers and to propose our idea.

The contributions of this study are as follows; what we aim for through this article, is to show our work as for the information associated with location and how helpful it could be for drivers and users worldwide. We focused on four categories: traffic, payment, service/items and Availability. It is also possible adding another category such as user feedback. Some researches area such as waste management, gas station and smart car parking focused on the availability, payment, traffic and service.

The main problem is the information that is being delivered to the driver is not always enough to make the driver satisfied. Automobile gasoline purchase is the common problem people who have cars must face nowadays [7]. For reasons of saving time, people often purchase gasoline on the way when they need going out, but frequently there is no gas station just on the way, so they may do a detour to approach a nearby gas station, thus waste more fuel and the valuable time.

This problem has a worldwide effect for all drivers using the streets nowadays. Everyone can notice such an incident because we all come across with such problems while driving. In order to make the research realistic, we limit the location information to four major things: 1) availability; 2) traffic; 3) payment and 4) service/item. In addition, limitation will also be on the driver and the outdoor user mostly as the beneficial side of this article. Major questions are accordingly inferred; 1) Did these categories considered when delivering an optimized path planning approaches using IoT? Is there a conceptual approach on how to consider this information and possibly others of user interests in a dynamic way for the purpose of path planning optimization?

The remaining sections of this study introduce related work followed by the proposed framework. Next, conceptual discussion and analysis section is presented followed by a conclusion section.

## 2. Related Work

Recent researches were reviewed by focusing on domain that covers context-aware recommendations which uses gas station as a case study. Articles search was based on online English accessible resources from Google Scholar, ACM, IEEE Explore, Science Direct, Spring and MDPI. The results were filtered by focusing on abstract and main body which explicitly includes gas station case studies. Furthermore, discussions and case studies with related topics were investigated and analysed.

Enough information about nearest gas station is vital to enhance driver experience and to save fuel [3]. Moreover, a driver is always looking for the best scenarios which help him save time, money, or both.

One of the early works [8] discussed a collaborative context-aware recommender application for vehicular ad-hoc networks. The purpose of the study was to deliver inter-networked cars that can exchange information about sensor data in order to increase traffic safety. A context-aware gas station recommender service was highlighted. Each user can have a vector of attributes (user profile). An item that is associated with a user can be location, price range and opening hours.

Price of gas is considered such that if fuel is below a certain level the system recommends surrounded cheap gas stations. A gas station is considered as item with added meta data such as location, available fuel and name of the gas station chain. Context attributes can include the current position, car route, current gas price, current fuel consumption and fuel level.

A context-aware recommender system was introduced by [9] that recommends nearby gas stations in vehicular ad-hoc networks. The recommender system utilizes driver preferences, drivers' ratings and context information such as car's fuel level and current location. The data sources for the recommender can also include a gas station chain, gas stations nearby certain landmarks, gas prices, list of gas stations with their geolocation (using GPS) and driving range. Drivers can by themselves extend the data set for their point of interests. Preference can be also a quality of service, cleanness and safety standards. Prototype of this system was developed as an application which has many features and able to add customized elements such as fuel type, however, the system was not built to acquire real-time data.

A research on [3] proposed a smart fuel system to help a driver and a vehicle owner in the case of a car rental to best utilize gas consumption. Technologies such as Bluetooth, 3G and Raspberry Pie where used in the system to deliver IoT experience. The car fuel level is displayed to the user using an Android app. The driver and the vehicle owner will be able to see the fuel volume used during a trip. If the fuel is below a threshold value (below 5%) then the system generates a notification for the driver. After that, the system calculates and provides a route to the nearest gas station (radius < 30 km) from the driver location using GoogleMaps application. The system however did not consider payment methods, traffic that could be available inside the gas station which may consume further fuel and if the gas station is closed or opened. In [10], researchers also introduced a quite similar fuel consumption system that uses IoT to guide a vehicle driver to a nearby gas station where fuel level in the car and fuel price are considered in the route planning. An android app is used as an interface to show the user how to get information about surrounded gas stations. Raspberry Pie-3 and Bluetooth where also used for a mean of communication. The later article did not consider the availability of gas stations (closed or opened), traffic inside and payment methods.

Researcher in [11] proposed a petrol station management system that facilitates the activity between the drivers and the petrol station. The driver can get the information about the nearest station and the quantity of the fuel in it. The magneto sensors work on defining the quantity of the fuel in the station. It sends signals to the system and then details are shown using a device platform. This system manages the activity between the wells and the pumps depending on magneto sensors to perform Hall Effect sensing, direct link with the current loop between pump and tank, and through fibre optic sensors. The method can help owners to monitor the activity in the fuel station and manage the fuel inventory. It also provides the user with the real-time petrol operations. However, the researcher did not consider location change or unavailability.

A study in [12] proposed a context-aware ontology-based route-finding algorithm in real-time for self-driving tourists. Based on tourist needs, two ontologies were defined driver's experience and tourist demanded services. The purpose is to deliver an optimal route with a shorter time. The algorithm covers multiple destinations scenario and considers surrounding services for each midway destination during a journey. Authors demonstrate clearly a gas station example, where a driver wants to drive from a location A to a destination B passing through a gas station and a closed by restaurant. The algorithm will look sequentially to the nearby gas station that surrounded with a restaurant. Then the route will be calculated from A to the gas station to the restaurant to B using Euclidian distance and network distance. The study also categorized the fuel type and fuel capacity needed for the car. Opening hours also considered. However, traffic inside the gas station where not considered and payment methods where not clearly identified. Likewise, in [13], authors focused on gas station scenario. They develop an app that can satisfy driver's needs (like for example visiting a gas station) when moving from a location A to a destination B for the purpose of saving time and cost. The app can recommend an optimal route that includes an optimal gas station selection as a transit before arriving to their intended location. The system does not provide much attributes about the transit service location such as fuel type, opening hours and traffic for a gas station location.

A smart navigation model for Plug-in Hybrid Electric Vehicles (PHEVs) was provided in [14]. It provides efficient recharging schedule to allow the driver to get an optimal route. Fuel/charging cost and location of nearby stations were considered for the navigation. A price load balancer algorithm was introduced to tackle traffic in the roads. It is important to mention that the study considered queuing in charging stations while queuing in fuel stations were not. On other hand, the type of fuel mentioned is either gasoline or electrical power whereas gasoline types are not considered.

Authors in [15] introduced a model and prototype of a context-aware recommender system. The system uses IoT to recommend for user three types of items; gas stations, restaurants, and attractions. The purpose is to provide high quality recommendation for both a walking user and a driver scenario. The system collects different data like for example GPS location of the driver, time, if it is a holiday, car gas sensor, … etc.. A dataset is used for training a neural network who is responsible for reasoning phase to deliver scores for each category and based on the user context. More importantly, the system can decide when it is the good time to trigger a notification to recommend the intended categories. Similar study was done by [16] to introduce a mobile app that can proactively send multi-type recommendations to a car driver. The types in this system are gas stations, restaurants, attractions, cinemas, and health care centres. The appearance of the types on the screen is subjected to a pre-defined priority. Major contextual information as inputs are car gas level and its associated remaining distance in km, time, outside temperature, weekend or weekday, car is on/off, out of home, blood pressure, human temperature and weather (raining/cloudy/sunny). The recommender system is trained using Naïve Bayes Classifier to determine when to trigger each type based on the right context. Services, traffic and payment methods for the gas stations are important parameters that were not considered in the design of both systems.

Researchers in [17] described how IoT platforms are becoming interoperable, and how sharing economy applications can leverage the use of data acquired by IoT environment. They discussed a case study on car sharing that incorporated different technologies such as IoT, M2M, GPS and NFC. They described how OpenMTC (open IoT platform) enable car sharing applications. Car sensors such as door control sensors, tire pressure sensors, fuel level sensors and GPS can be used to automate and streamline the process of using shared cars for the drivers. Sensor data is linked to a cloud-based IoT platform through a gateway (a smartphone in this case). The information needed for this kind of service are location, health and fuel status of the car. When a user plans to use a shared car, the location of the nearest available car from the smartphone application will be obtained. The application also communicates the route to the nearest gas station to the IoT platform. At the gas station, the user can make the payment through the smartphone's NFC interface. Many technologies were introduced in this case study but were not utilized as expected and lack the availability of payment type, traffic inside the gas station and open/close status of the gas station.

A gas station recommendation case study was discussed [7] in the field of Mobile Opportunistic Commerce (MOC). MOC is a type of information service depends on location service. The service saves time and path cost for drivers by providing opportunity commerce information and forming the opportunity benefits. Authors discussed one of the MOC first applications called recommendation service for automobile gasoline purchase which is used in Mobile Commodities project. This project is developed jointly by the Microsoft Research, University of Washington, and Harvard University. The application can obtain car's fuel tank level, the driver also can set manually the trip path and the schedule, and further can set the fuel tank level threshold. If the fuel tank level reaches the threshold, the application checks the driver's location via the positioning terminal device, hence finds out the available gas station according to the driver's travel route, then recommends the suitable time to the driver for gas purchase. Finally, the driver can select the suitable station from the recommendation list. The application could be enhanced further if destination status, fuel type and traffic were added as features.

A study in [18] presented Car e-Talka as a fleet maintenance system that utilizes IoT and cloud computing technologies to monitor vehicle health in real-time, provide information about nearby maintenance centre using context awareness and report any irregularities. The recommendation context attributes are a driver context where low fuel level or low tire pressure is presented, and geographical context. The geographical context used to recommend gas station or workshop proximity along with information about its distance and travel time. Car e-Talk application has many benefits but lack major location attributes such payment, explicit location availability, location traffic and fuel type.

A hardware-based system using IoT was introduced by [19] to deliver rich information about gas stations. The purpose is to obtain real-time data including tanks status, guns' status and billing information from gas stations via sensor devices placed on each station. The system is meant to be integrated with WeChat (a typical instant message software that can also provide online services for people in China). Users of WeChat acknowledge the real-time status of each gas stations quickly and easily to make sure WeChat users can get the true refuelling information such that they can save time and money. The system delivers an easy way for users to collaborate and to exchange information about gas stations status, however, this information is not enough to provide/recommend a gas station with users' needs especially fuel type, payment methods and traffic inside.

A smart system (Smart Petrol Pump) was developed to monitor and control the fuel tanks in gas stations as well as to control prices by the owner (central authority) using IoT [20]. One of the advantages is to let a driver knows if a certain gas station has a fuel or not before approaching. Another benefit is if the tank declines to certain level then authority will provide fuel supply to that station. Sensor is used to measure the fuel depth. The acquired data is sent to a website that can be managed by admins and users. Subscribed users can use the website to monitor the fuel level in a depot. The website is integrated with Google Map API to facilitate mapping and direction to travel to the depot. The system is simple and easy to implement; however, it could be enhanced if more sensors were used to cover traffic and fuel type in the station. Payment type was also not provided.

A methodology and a mobile application for driver monitoring, analysis, and recommendations were proposed by [21]. The major idea of this system is to provide safety for a driver and help to prevent road accidents. A driver in his car can perceive different alerts to prevent urgent road situations, and in the same time a recommender will invoke certain procedures such as stop the car and have a nap at nearby restaurant or gas station using GPS. If the driver is in an urban area in a motorway the system can search within certain radius after checking the arrival time and will recommend nearby services for example gas stations. However, the application does not check further details such as fuel type and availability of rooms before approaching the location.

Authors in [22] discussed Waze as community-based navigation app. Waze is a mobile application that delivers indirect context awareness for drivers. It can gather routes, traffic, and travel-related information of other drivers and share it via centralized Waze server. Furthermore, it allows Wazers to provide updated events such as accidents and traffic jams together with the landmarks. Waze can also coordinate you with your friends who are heading toward the same destination. With the help of community-shared gas price data, it also suggests the location of cheapest nearby gas station on the user's path. Waze is an amazing real-time app that utilizes the crowd-sensed data to extract the context and recommends the users to act accordingly. However, Waze is considered a biased recommender because it depends on users who visited a location. If new location arises, new services added to existed location then without visiting and acknowledging it there will not be any updates.

A practical implementation, benchmarks and a programming technique were employed to solve vehicle routing problem (VRP) in convenience stores business [23]. The purpose of the study is to optimize goods distribution process of convenience stores which include products delivery, garbage collection and passing by a gas station for refuelling. To achieve optimal route for the convenience stores' networking problem, a web-based delivery navigation system was developed using Google API. An iterative algorithm was developed to find the optimal location of a gas station to fulfil the possible re-fuelling requirement of the delivery vehicle during its route. Even though GPS used for This research mainly relies on NAVITIME website by the NAVITIME Japan Company for its data source which is obtained in regular bases. IoT and real-time data collection must be employed to enhance learning for data pattern. Furthermore, close and open for gas stations are not considered when planning the truck's route. Traffic inside the gas station can cause improper path planning when time is considered in VRP scenario.

Service-oriented context ontology framework for ITS was formulated [24]. The framework identifies appropriate services needed by drivers who travel on regular bases to work in transit. The services are determined based on their situation, preference and ITS environmental information. The system was used to develop a smart payment application to automate billings when utilizing services in ITS, it requires a subscription to the service with a credit balance for paying a bill. A close look at gas station scenario was illustrated. Based on a driver request (using the ITS application) to search for a nearby gas station, the system can extract and display a list of stations in his proximity. The driver then can select his favourite petrol supplier among others and within certain manually pre-defined distance. Even though user experience and personalized search results were considered in the system's ranking algorithm (which considers drivers' feedback, shortest distance and opening hours), the search level could be enhanced deeper by checking for example fuel type, price, traffic inside the gas station and other services inside the gas station.

The following table summarizes the reviewed gas station case study literature based on design (type of the design), use of real-time data, location's traffic (any factors that explicitly define if there is traffic inside the gas station), payment type (type of payments available such as Visa), availability of the station (close/open), items/services (e.g. fuel type and service such as car wash) and None community biased (the system is community independent when delivering information about the gas station), see Table 1.

**Table 1. Gap analysis and investigation of gas station use case literature.**

| Authors | Year | Design | RT Data | Location's Traffic | Payment | Close /open | Service /item | Non Community - Biased |
|---|---|---|---|---|---|---|---|---|
| G. Premsankar, and M. di Francesco | 2020 | System App | ✓ | □ | □ | □ | □ | ✓ |
| S. Hussain, U. Mahmud, and S.J.I.I.o.T.J. Yang | 2020 | AC Recommender | ✓ | □ | □ | □ | □ | ✓ |
| M. Barzegar, A. Sadeghi-Niaraki, M. Shakeri, and S.-M.J.E. Choi | 2019 | CA Ontology-based | □ | □ | □ | ✓ | ✓ | ✓ |
| M.A. Rahman, M.H. Shahriar, E. Al-Shaer, and Q.J.a.p.a. Zhu | 2019 | Navigation model | □ | ✓ | □ | □ | ✓ | ✓ |
| A. Kashevnik, I. Lashkov, and A.J.I.T.o.I.T.S. Gurtov | 2019 | Mobile App recommender | □ | □ | □ | □ | □ | ✓ |
| V. Venkatesh, P. Balakrishnan, and P.J.I.P.C.S.f.S. H. Raj | 2019 | Community-based navigation app | ✓ | □ | □ | □ | □ | □ |
| S. Pattar, C. Sandhya, D. Vala, R. Buyya, K. Venugopal, S. Iyenger, and L. Patnaik | 2019 | Service-oriented context ontology framework | □ | □ | ✓ | ✓ | □ | ✓ |
| E.J.I.J.o.I.M.T. Husni | 2017 | System | ✓ | □ | □ | □ | ✓ | ✓ |
| A. Weis, M. Strandskov, K. Yelamarthi, M.S. Aman, and A. Abdelgawad | 2017 | System | ✓ | □ | □ | □ | ✓ | ✓ |
| Peter Gutierrez | 2017 | System | ✓ | □ | □ | □ | ✓ | ✓ |

| Authors | Year | Design | RT Data | Location's Traffic | Payment | Close /open | Service /item | Non Community - Biased |
|---|---|---|---|---|---|---|---|---|
| Y. Salman, A. Abu-Issa, I. Tumar, and Y. Hassouneh | 2017 | CA Recommender | ✓ | ☐ | ☐ | ☐ | ☐ | ✓ |
| A. Abu-Issa, H. Nawawreh, L. Shreteh, Y. Salman, Y. Hassouneh, I. Tumar, and M. Hussein | 2017 | CA Recommender | ☐ | ☐ | ☐ | ☐ | ☐ | ✓ |
| F. Yuan, X. Song, and J. Lindqvist | 2016 | System App | ☐ | ☐ | ☐ | ☐ | ✓ | ✓ |
| H. Cui, T. Xu, X. Jiang, and L. Fang | 2016 | System | ✓ | ☐ | ☐ | ☐ | ✓ | ☐ |
| P. Gupta, S. Patodiya, D. Singh, J. Chhabra, and A. Shukla | 2016 | System | ✓ | ☐ | ☐ | ☐ | ✓ | ✓ |
| L. Pucong, Z. Yuansheng, and Z. Wenqiang | 2015 | Location service recommender | ☐ | ☐ | ☐ | ☐ | ☐ | ✓ |
| T.Q. Le, and D. Pishva | 2015 | web-based delivery navigation system | ☐ | ☐ | ☐ | ☐ | ☐ | ✓ |
| W. Woerndl, M. Brocco, R.J.I.J.o.I.T. Eigner | 2009 | CA Recommender | ☐ | ☐ | ☐ | ☐ | ✓ | ✓ |
| W. Woerndl, and R. Eigner: | 2007 | CA Recommender | ✓ | ☐ | ☐ | ☐ | ✓ | ✓ |

It can be noticed from Table 1 that no single system was able to consider all characteristics. Moreover, real-time change of item's/service's availability and open/close status of a location between the start time of path planning to the arrival time at the desired destination is partially considered for some items. In addition, major items/services are not totally considered in one non-community-biased system.

It can also be noticed that the reviewed studies can be optimized by considering additional techniques such as data acquisition using real-time feed specification, dynamic radius search, user dynamic profile insertion and deep neural network.

## 3. Proposed Framework

Before going into the abstraction design of the proposed system, it is important to highlight how a path planning works using a navigation system. Figure 1 illustrates an ordinary path planning process inspired from Google Map process for path planning and navigation [25, 26].

As shown in Fig. 1, the data availability check is a database block where the data input by the user is checked for data availability. Sources of the database can be from known locations provided by partners and from general transport feeds such as Google Transit Feed Specification (GTFS) and Apple Maps Transit. Moreover, an enhanced version for GTFS called GTFS-Real Time provides real-time information about different transport means. However, these platforms are only meant for public transportation usage. Another method provided by Google is called product feed specification. It is used as a catalog of one's products and product data such as titles and descriptions. Google uses this description to fuel the results of what a potential shopper types into Google [27]. Nevertheless, the information fed into the system is not in real-time (static).

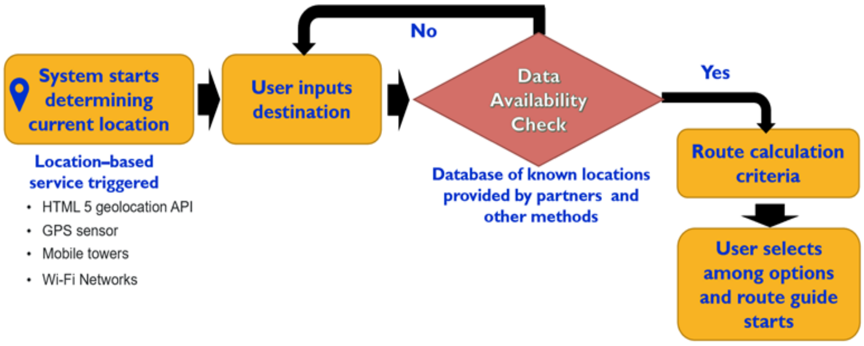


**Fig. 1. Tradition high level flow chart of major path planning process inspired from Google Map process for path planning and navigation [25, 26].**

Major building blocks of the proposed system are RT-CFS database, data acquisition, dynamic profile insertion module, dynamic radius search and deep neural network module.

## 3.1. Real-tie feed specification

In this section, the proposed abstract approach is presented. The idea is centered around the source of information as a major building block. A standardized database named Real-Time Commercial Feed Specification (RT-CFS) is proposed. The RT-CFS hosts locations' information in real-time. The information as mentioned above will be limited in this research to open/close, traffic, payment and items/services availability. These categories can be increased as needed. For example, a gas station can upload this information to RT-CFS to attract more customers. A gas station owner can use different information technology methods to automate the upload process by using for example IoT, head count devices, sensors, etc. As much as the business owner upload much more info to the RT-CFS as much as he can get more customers. The modified approach can be seen in Fig. 2.

The RT-CFS database includes information about each gas station; type of payment (credit card, cash, prepaid cards, …etc.), traffic inside the gas station, type of fuel (ultra, super, diesel, …etc.) and services (car wash, convenience store, … etc.). At any time, this information must exactly reflect what is there in the gas station in real-time. It is the gas station owner's choice in how to keep such information updated automatically. In addition, location of the gas station (defined by latitude and longitude) is also a key needed data in the database. The creation/existence of the database is the responsibility of a service provider who own and deliver such architecture. The service provider facilitates the integration between business owners' data and how to acquire these data in the general database. The creation and programming of such a database can be done by following the Google's GTFS real-time. However, the creation and the implementation of the database is out of the scope in this research. Figure 3 depicts major system components.

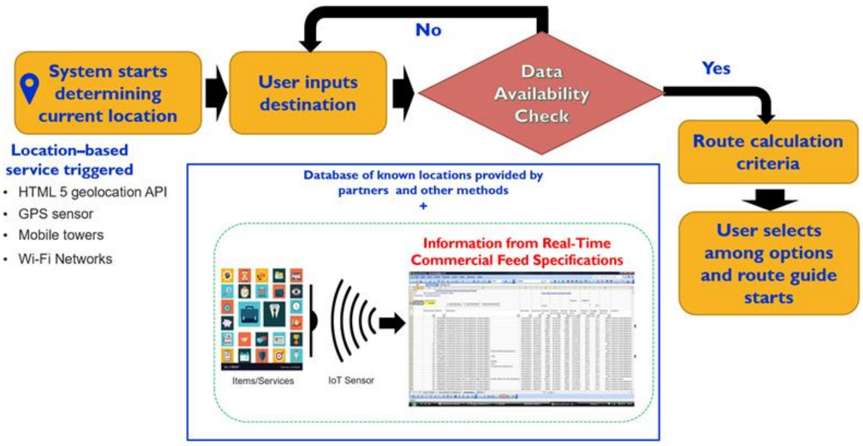


**Fig. 2. High level flow chart of path planning process with RT-CTFS as standardized database.**

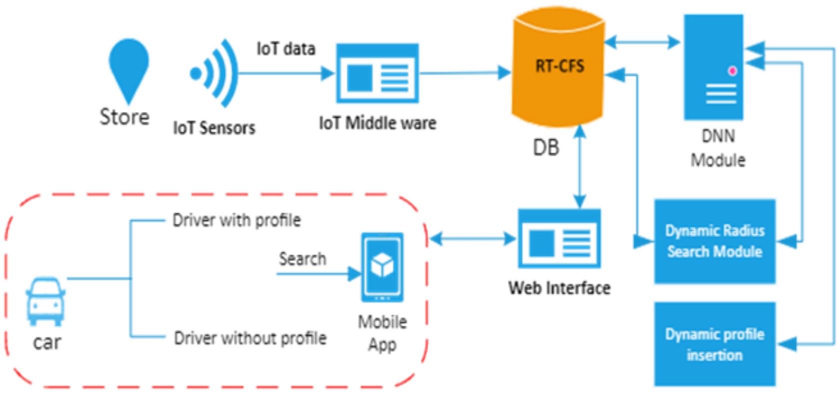


**Fig. 3. high level diagram for the proposed systems.**

## 3.2. Data acquisition

Our abstract approach is based on IoT sensors, where sensors can be any technology (Bluetooth devices, cameras and other devices being used in IoT) that can sense data from environment and transfer it to an IoT platform, then the IoT platform will move it to the web service (can be central database but it is out of the scope of this study) that corresponds to the location where the data is being collected.

## 3.3. User dynamic profile insertion

Drivers and their feedbacks are vital component in the model. The driver can create his own profile/user profile (UP) by specifying what he needs from items and services associated with the gas station. The driver's/user's profile can also be created dynamically. A user always has needs that fulfills his satisfaction level with less effort. In addition to ordinary method of profile creation, a dynamic profile formation can be of a good practice for a user especially in a mobile and a versatile environment. It also operates in a separate module to improve future work. After number of searches done by the user, a profile will be created and suggested to the user. The user has the choice to select or reject the recommend profile.

### 3.4. Dynamic radius search

It is important to have a dynamic radius search that will reduce computation and can also find the cluster associated with search done by the user. It is dedicated in a separate module for future enhancement and integration. Major literatures applied a fixed radius to do the search to find nearby locations. Other literatures ask the user to input manually the needed search radius. To optimize the contextual-aware performance which characterizes the proposed framework, an algorithm is needed to control the search radius dynamically in a smart way such that no intervention from the user/driver is required.

## 3.5. Deep neural network module

Deep neural network (DNN) is one of the major artificial intelligence approaches used in recommendation systems. This module serves the recommendation system to deliver best outcomes for a driver when doing a search for a location. It also supports other modules such as dynamic profile and dynamic radius when needed. Time of the search, location of the driver and visited locations by other drivers are input to the DNN layers.

## 4. Discussion and Analysis

In the previous section we introduced a high-level framework that has four contributions to optimize the recommendation process for a driver's path planning. In this section we analyse the proposed solution from expectation point of view.

The general idea of having a real-time commercial feed database is not new, however, the concept of delivering items/services in a centralised open database for commercial purposes used by drivers can be considered as a new three-dimensional (3D) search model. First and second dimensions are the target location and the user context respectively. In addition, the third dimension represents items/services (and possibly further location's attributes) that would affect the search output. In this research we focused on fore main parameters (service/item, traffic, payment and availability), however, these items are limited for the purpose of the abstraction design and layout. The system can be tested with more parameters (depend on the business type). The more parameters the better recommendation results, however, system complexity can be increased in this case.

IoT technology as a tool for data acquisition devices is expected to deliver sensitive and real-time information. These devices must be placed in the right place to avoid errors in data acquisition process. The IoT can be extended to Internet of

Everything [28], where digital transactions become part of the required data. Furthermore, Web of Everything [29] plays a wider role to act as main platform to host the physical, the digital transactions and data. Standardising the data coming from different sources can be a challenge and needs robust requirements to fitch in the RT-CFS database.

Many users reject the idea of creating a profile. The dynamic profile insertion module can solve such a problem. A carful design for this module is essential since the driver/user is a major part of the whole framework. The effectiveness of profile creation can lead to a better usage of the expected application. The user/driver can focus on his needs rather than thinking how to fill in a profile! Accordingly, the framework autonomicity level can be increased which can give a space for developing self-property techniques such as self-configuration [30]. Self-configuration is a process where a computer system or a network can adapt to the surrounded environment and adjust its configuration without human intervention [30]. Nevertheless, having a way of creating a manual profile can be available for those who really care and have a time to do that. Proposing a profile automatically to the user/driver can deliver enhancement to the framework if number of profile acceptance and rejection rate are considered.

Getting all results in a search consumes time and increases complexity. On the other hand, filtering such results can reduce complexity. When a driver searches for an item/service, the search result should be maintained within a predetermined radius value. Careful selection of the radius value must be considered in a dynamic way such that no intervention is accepted from the user. Moreover, not only the predetermined radius value but also other parameters can be considered in the design of this module such as competition between store locations and fairness.

The DNN module is an essential part that optimises the performance of the framework. It acts as a problem solver when there is no previous data associated with a new user (cold start problem). In addition, it speeds up the recommendation by avoiding an expected radius incremental process for the search. Furthermore, the DNN module can manage a possible existence of hybrid-recommender system where different type of recommenders are possibly used within the same framework. Careful selection of weights for the entire DNN layers can deliver better results and controls overfitting [31].

Developing the expected application for the purpose of testing the proposed framework is a good idea, however, a preliminary simulation and testing can deliver satisfied results as a first stage. In later stages the development of the application can be implemented. Comparison between simulation result and actual use of the application can lead to the understanding and the effectiveness of the framework. Adoption of such a framework in real environment is a challenge, however, by delivering and raising its importance and motivation the framework can be accepted.

## 5. Conclusion

In this research, we investigated recent studies in the domain of context-aware recommender systems in the transportation application. Gas station scenario was the case study introduced. We proposed a high level and a possible practical implementation for a model that can optimize a driver trip. Such a framework can create an ecosystem where data are available openly and transparently. Furthermore, the proposed modules can enhance the richness of information needed for a journey. However, user feedback can be challenging, the driver may not provide any information after doing a purchase process. Moreover, security concerns can arise such as confidentiality and privacy associated with data.

As a future work, artificial intelligence such as fuzzy logic and deep neural network can be used for the dynamic insertion method. Furthermore, generated IoT data from the gas stations can be utilized to facilitate gas station site selection by providing rich information about refuelling events. The refuelling events mechanism is a major factor that can help researchers in defining methods for careful site selection of gas stations for urban planning. Next area of research will introduce details about each module and its associated algorithms and mechanisms.

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