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Research paper



An Integrated Vehicle Servicing and Breakdown Assistance System

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Abstract

Integrated connected car management system (ICCMS) technology focused on the car management. The system of ICCMS is the inevitable development trend of the next generation connected car diagnostic system, it is important for drivers to be connected of the cars details and as well convenient possibilities. This paper is based on a system development, to manage car internal states, requesting for service/towing and to operate in centralized database. At the end of the paper, the technical development prospect was discussed.

Keywords: *vehicle servicing; breakdown assistance; integrated system; cloud services*

1. Introduction

Vehicles are considerably modern and smarter than they were years back. Car manufacturers and the automotive industry innovation centers are battling to come up with new technology consistently considering the end goal to make the vehicle more intelligent, vitally more secure. With the wide utilization of the smart gadgets like telephone, tablets, PCs and other electronic gadgets, car manufacturers needed to outline and create applications and projects to integrate their cars to the drivers' smart gadgets [1].

Advancement within hardware and software enables the driver to get assistant on the highway all through the driving voyage. The information on the vehicle condition and status can be viewed and planned ahead on service appointment using a smart gadget. Nonetheless, the drawback is on the point of interaction between the driver and the auto and car manufacturers. More consumer particularly smartphone owners demonstrates the need for Internet of Things (IoT) fix for vehicle [2]. It has become a constant trend and priority to have a vehicle with an embedded system that allow the driver to get aide on the road, get data about the vehicle condition and keep the car owner updated on the service appointment and the vehicle condition [3]. From 2016 on, the huge part of buyers considered Internet connectivity in vehicle as a key factor when purchasing a vehicle. By 2020 the quantity of vehicle integrated with the Internet will increase from 23 million presently to 152 million [4].

With the upcoming of Internet of Cars (IoC), there have been rivalry to cater services that can help the driver on the road and keep car manufacturers and service centre up to date with the vehicle status, yet the current system have significant usability on the disadvantages in term of similarity with different platform and operating system including other towing services together with communication between the driver and the car together with service centre and car manufacturer [5].

The proposed technique depends on the responsive application that can be accessed from any web browser using any smart gadgets regardless of the operating system. The technique shows distinctive styles rules for various media type and gadget. Such technique does not only just guarantee compatibility with different platforms yet additionally together with wearable gadgets, for example, smartwatches. With the utilization of the Internet of Things (IoT) and Internet of Cars (IoC), it will keep the system linked with other towing cars including car manufacturers and service centres, which benefits connected vehicles.

2. Literature Review

The world today is getting hyper-connected. Numerous aspects are powering this, for example, the Internet, wired and wireless network connectivity and quality coming to far corners of the world with the pervasiveness of smartphones. With such achievement in the advancement of innovation alongside demands from the society, transportation is nearly a noteworthy change [6]. In a latest press conference with Wall Street Journal, Apple CEO Tim Cook expressed that the automotive industry is in for a "huge change" within built software are turning into "a progressively crucial component of the vehicle without bounds" [7]. Connected vehicles have huge potential as some car manufacturers offer drivers comfort services like crisis dispatch, maps, and Internet radio. Lately, Tesla Motors presented semi-self-driving vehicles. Basically, a vehicle needs an approach to communicate with the outside world. While there are various innovations attached all through the vehicle, the telematics control unit is the centre segment in vehicles that empowers the vehicle to communicate [8].

There are three essential integration of connected vehicle: embedded, tethered, and smartphone. There is SIM card alongside hardware and software in the embedded system which is needed to be connected, General Motors' OnStar system for an example. A tethered system is very much alike to an embedded system, just that in this case it does not have a SIM card and depends on the

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driver [9]. Up to 2015, MirrorLink is the main player offering car manufacturers a connected smartphone. Over the time with advancement of technology, this may need changes with the entry of gigantic companies such as Apple and Google. However, another channel of connectivity is by Onboard Diagnostics (OBD); new vehicles are being outfitted with standard OBD ports that enable drivers to plug-in modules to promptly analyze breakdowns by getting to the vehicle's instrumented information [10].

Regardless of knowing connected cars have a bright future, it still has a few obstacles as well. In a latest wired news article, it is stated that hackers could control a Jeep Cherokee by hacking and sending orders through the Jeep's infotainment system to its dashboard functions, steering, brakes, and transmission. This issue has raised administrators to begin tightening the computerized security standard for vehicles. This security hazard will be an obstruction to the connected vehicle, as it will require time to bring it to implementation. In the event that a satisfactory arrangement is not proposed properly, it will raise alarm and scale down the acceptance of connected vehicles and its features [11].

2.1. Development

Development of the system is at the essential phase of assuring there is no associated device, for example, OBD or sensors. Nonetheless, there will be integration between the ICCMS system and towing cars and car service. This integration will likewise be connected with the cloud to guarantee all information are brought together to be recovered by special authorities. One of the important point, which can be caught from the findings, is the system compatibility and accessibility issue. The purpose of custom stage is to make an immersive design environment that will go along with the developer's requirement. It is clear that an immersive system needs the blend of hardware and software segments. The primary contemplation about software concern is also by it being user friendly with necessary function. A general overview is presented in the following in the present section.

Entering the period of Internet of Things, the utilization of suitable and affordable computer equipment, which in this proposed work is Raspberry Pi. It is a completely adjustable and programmable mini PC board. Comparative analysis of its key components and performances with some of existing prototype platform have demonstrated that the Raspberry Pi remains an affordable mini PC with it is effectively use in various scope of research applications. In Table 1 shows the comparison of single board computer hardwares.

Table 1: Comparison of Single Board Computer Hardware

Hardware	Raspberry Pi	Beagle Board	Odroid
Model	B	Rev A5	C1
Price	RM 150	RM 370	RM 245
Compatibility	Ubuntu, Android, Linux Mint , Fedora, RISC OS, Raspbian, Arch Linux, FreeBSD	Linux Angstrom	Linux and Android
Programming Language	C, C++, Java, Python	C, C++, Python, Perl, Ruby, Java, Scripting	C, C++, Java, Python
Customizable	Yes	Yes	Yes

Usually, the evolution of a system depends on the compatibility and its responsiveness. The proposed work expects to deliver a cross platform accessibility to permit less usage of space since the main purpose of the user interface is to convert the information into a comprehensible form to the car owners. Recently, the use of android and iOS has been considered for car display interface taking it in about the cost and compatibility. Foreseeing those factors, web based system is proposed to be executed with raspberry pi equipment. In Table 2 shows a comparison of available operating system platform.

Table 2: Comparison of Available Operating System Platform

Platform	Web-Based	Android	iOS
Source	Open	Open	Close
User Friendliness	Yes	Yes	No
Programming Language	HTML5, CSS3, JS	Java	Swift
Support	Basic and Tutorial	Tutorial	Tutorial
Compatible	All	Limited	Limited

Firebase is a backend cloud service provider from Google designed to power and build real-time applications like notifications, authentication and any other services on the frontend without writing any server-side code. When it comes to managing backend servers and hosting, it takes a huge burden away from developers and automatically configures the backend storage with a simple NoSQL database. In this development, firebase is chosen to be the backend cloud service. In Table 3 shows a comparison of available cloud services.

Table 3: Comparison of Available Cloud Services

Cloud Services	Firebase	Backendless	Back4App
Open source	Yes	No	Yes
Features	Realtime Database, User Authentication, Cloud Messaging, Data Storage, Push Notifications, AdWords & AdMob, Remote Config	Social login for your app, Relational data storage, Query-based data search, Constraints & Validators, User Authentication, Send Push Notifications	Facebook and Twitter Integration, Automatic E-mails, Class Level Permissions (CLPs), Push Config, Scheduling, and segmenting Push Notifications, Global Config, Parse Server Dashboard
Support	Yes	Yes	Yes
Documentation	Yes	Yes	Yes

2.2. Configuration

Raspberry pi does not have in built memory for storing operating system and software packages, so it is necessary to boot a SD with raspbian operating system. Raspbian is a Debian-derived free OS optimizing specially for the Raspberry Pi hardware. Raspbian mostly uses a Linux kernel also popular as the Debian GNU/Linux distribution. It comes along with over 35,000 packages and precompiled software bundled in a format that is easy for installation on the Raspberry Pi. The raspbian OS file can be directly downloaded from Raspberry Pi official website. After downloading this ZIP file, it is necessary to extract the OS image file into the SD memory card, for that purpose an image writer application. The win32-downloader is software that is used to write a raw disk image to a removable memory device. It is a free of cost and the program for it is open source. It is useful for any embedded development because of the source code can be branched and modified as per the requirement. After writing to SD card is finished, it is put in the SD card slot of Raspberry Pi and switch it on so that initial booting of raspberry pi can start.

The Raspberry Pi 7-Inch Touch Screen does not have socket that can be straight away plugged in, however need to be connected using ribbon and jumpers. For the connection of the touch screen with raspberry pi board, the white ribbon cable need to be connected on the board of the raspberry pi with the blue mark on end towards the back of the screen. Besides, there will be four jumper wires to the 5V, GND, SCL and SDA pins on the touch screen display board respectively. Finally, to power the screen and Pi, a good power supply that is able to support 5V will be sufficient.

The development of the system is made-up of interfacing raspberry pi with 7-inch touch screen for display purpose. The latest raspberry pi 3 has built-in with WiFi and Bluetooth for wireless accessing system. The development of the system is web-based as it is compatible across all platforms. Besides, the system also requires integration of a cloud service platform, Firebase where different data can be displayed, accessed and shared from anywhere. The data stored on Firebase cloud service platform will be inter connected with the administrator/car careline center system. For the administrator/car careline side system, the development of the system is also in web-based. However, the interface design will different from the user/driver side system.

3. Proposed Design and Implementation

In Fig.1 shows the overall process of the ICCMS system which involves of car owners and car service centre's careline. The proposed system allows car owner access the modules displayed on their car dashboard. On the other hand, car service centre's careline will acknowledge and assign the request made by the car owner. Moreover, all these details are stored in Cloud. Information about the important elements about the car is displayed on the car dashboard as shown in Fig. 2. The elements are inclusive of engine status, battery status, tyre pressure, oil pressure, mileage and timing advance.

There are few processes on how the car service request is made and acknowledgement from car care line as shown in Fig. 3. Once the request is made successfully, car care line will assign a person in charge according to the preferred time and date by the owner. Once the service session is over, the person in charge will update details of next service into the car system. Later, the details are stored in the Cloud. Status of the request from the car owner's dash is shown in Fig. 4.

Meanwhile for the towing request, the process is quite similar as the car service request. Car owner need to select the module of towing request. Once the request is made, car care line assigns a person in charge based on the location of the stranded car. Later, car owner will receive details of the towing car while data is stored in the Cloud. The whole process is illustrated in Fig. 5. The updated towing request for the car owner is shown in Fig. 6.

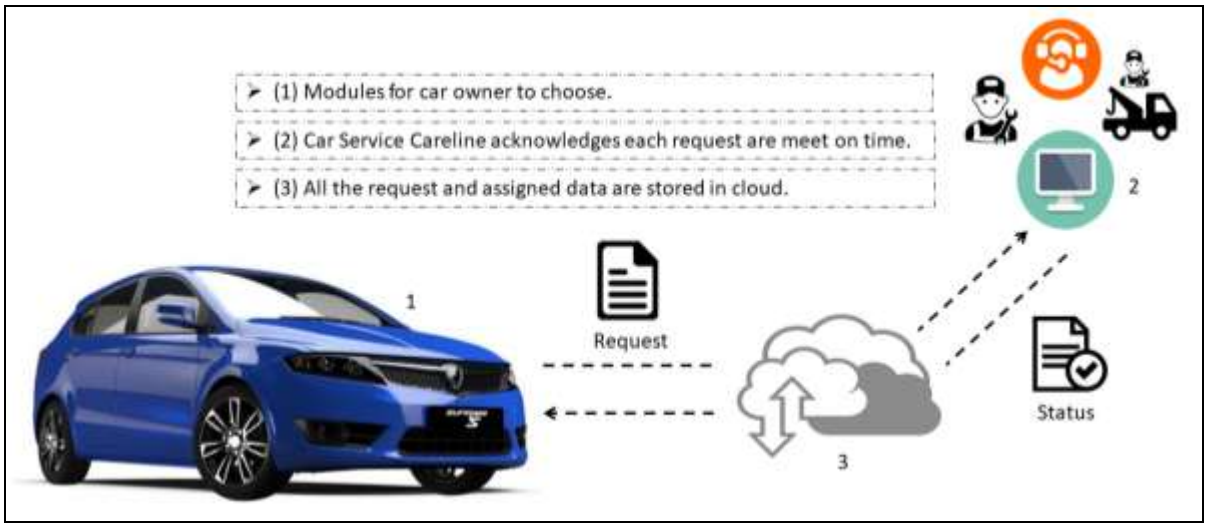

Fig. 1: Process Flow of the Proposed System

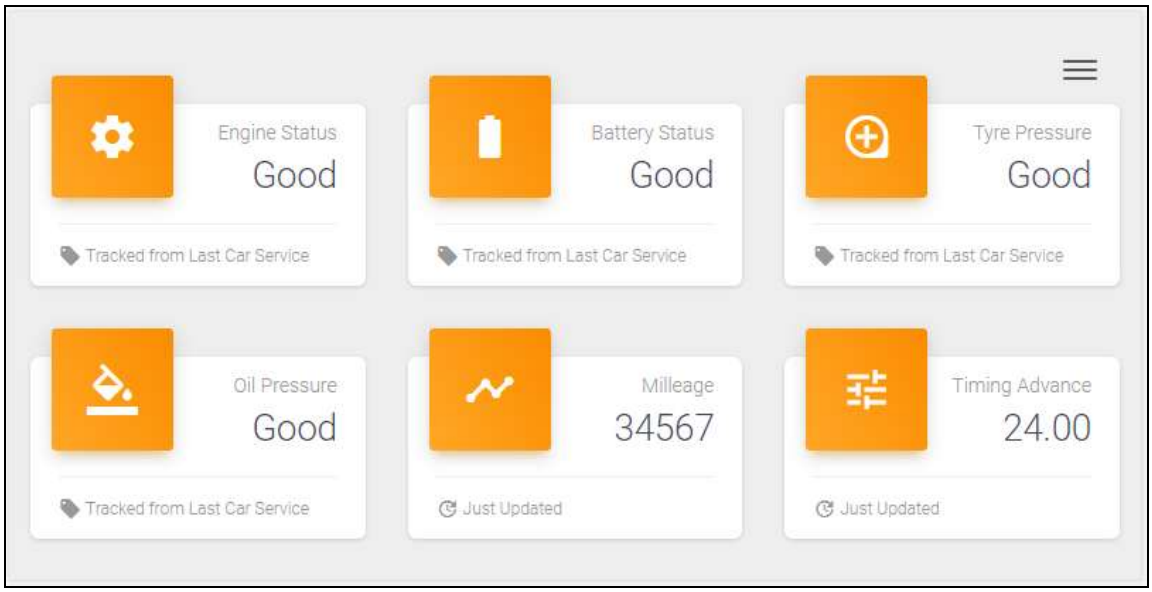

Fig. 2: Dashboard Display (User)

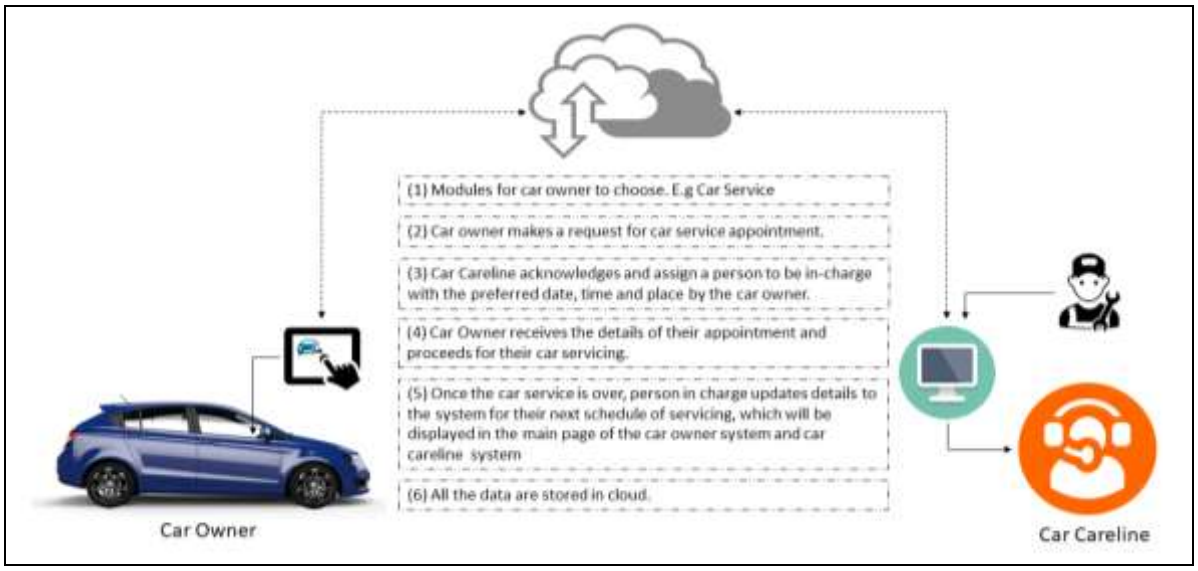

Fig. 3: Process Vehicle Service Request (User)



Fig. 4: Vehicle Service Request Status (User)

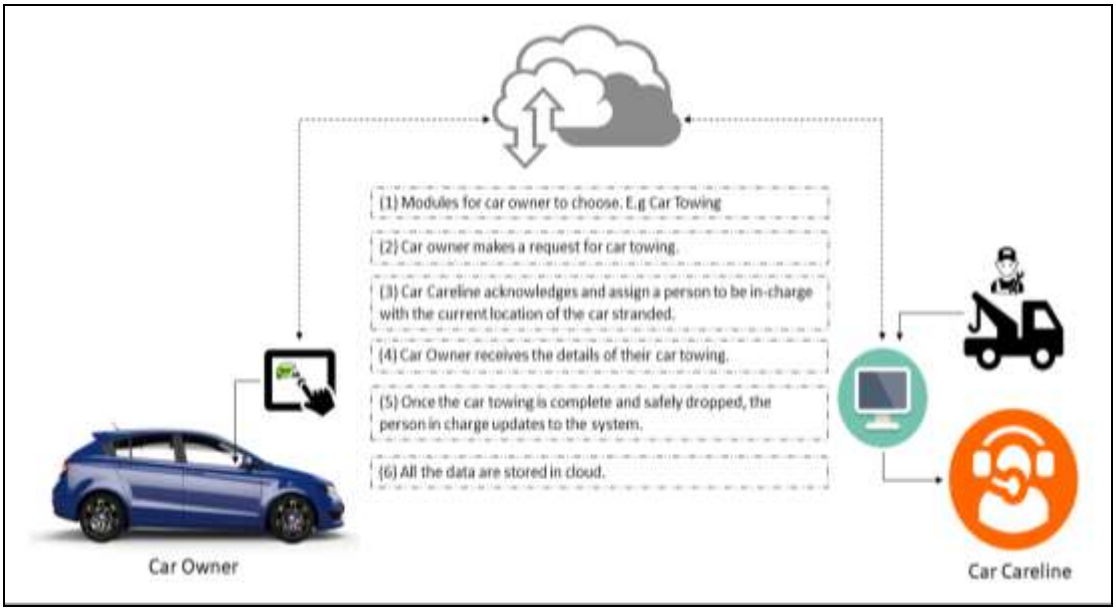

Fig. 5: Process of Vehicle Towing Request (User)

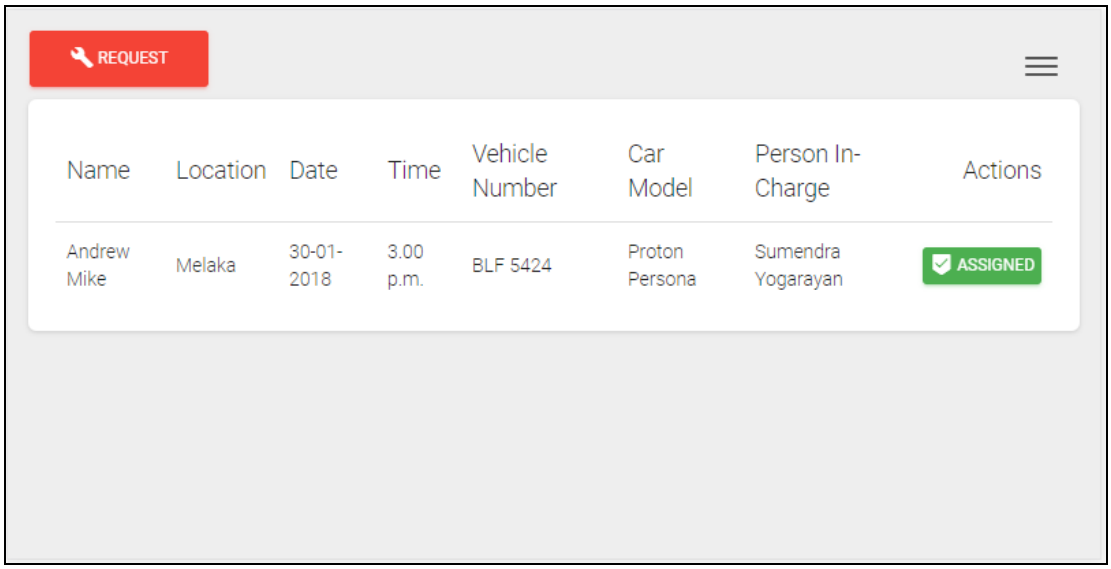

Fig. 6: Vehicle Towing Request Status (User)

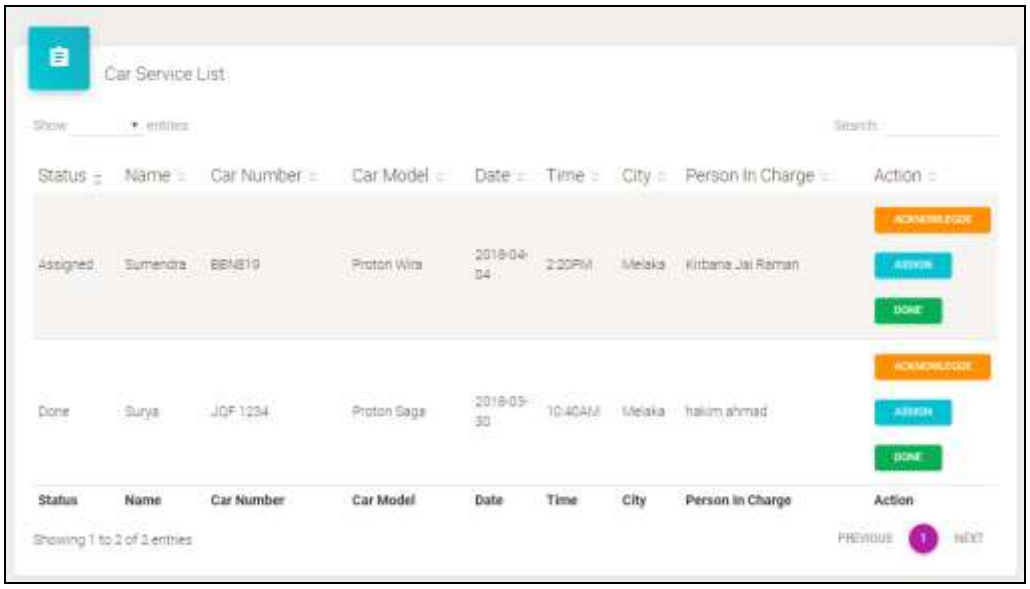

Fig. 7: Vehicle Service Requested List (Admin)

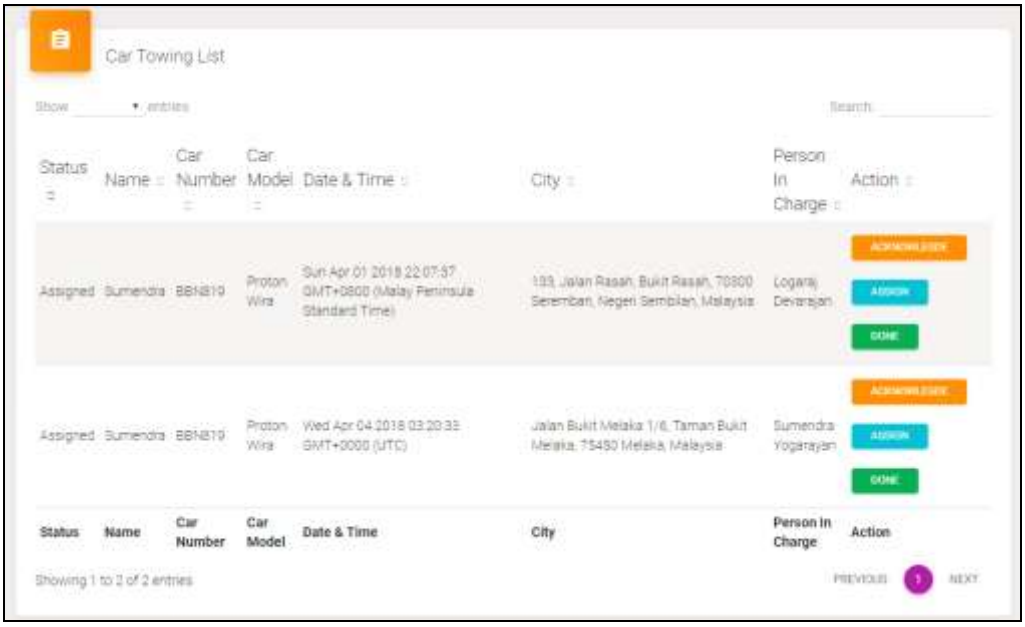

Fig. 8: Vehicle Towing Requested List (Admin)

From the administrative team of car service centre, a list of vehicle requested for service is recorded with the details of owner, car and preferred service time and date. The car service list on the panel display for the administrative team is as shown in Fig. 7.

Car towing list from the administrative team is as shown in Fig. 8. It comprises of the car owner, car details and specific towing location of the stranded car together with person in charge.

4. Conclusion

This paper explains on the integration of car owner, service centre and towing vehicle. With existence of such integrated connection between all these three, it will ease the entire situation when a car is stranded. Besides, it also helps the service centre to track in advance on the request without usage of paper aligned with green technology. On the other hand, there will be no issues on locating the stranded car because location of the car is sent together when requesting for towing service. However, there are also prospect for future work when these can be taken further of getting the predictive techniques involved.

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