Final Report

July 2018

FIELD TEST OF A NEW MOBILE SYSTEM FOR THE COLLECTION OF CRASH AND CITATION DATA IN NEVADA

SOLARIS Consortium, Tier 1 University Transportation Center

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FINAL REPORT

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ABSTRACT

Collection of accurate and consistent crash data plays a critical role in traffic safety studies for analysis and prevention of motor vehicle crashes. A desirable system for crash data collection needs to meet requirements such as accuracy, consistency, and real-time reporting, as well as minimization of exposure time of law enforcement agents at the crash scene. Software tools currently used for crash data collection suffer from a number of limitations, which decrease the quality of the collected data. This paper describes the development of a state-of-the-art crash and citation data collection system, which takes full advantage of the availability of communication networks and recent developments in software technology to collect data in an easier, faster, and more accurate manner. The proposed system was designed, implemented and field tested in cooperation with law enforcement agencies and data users in order to meet the needs of various stakeholders. The feedback obtained from the field test suggests that the proposed system comprehensively improves the crash and citation data collection process.

EXECUTIVE SUMMARY

Current software tools used by law enforcement officers for crash and citation data collection do not take full advantage of existing state-of-the-art technologies. The most significant consequences of using obsolete tools are location errors, which preclude the correct use and reliability of the data. In addition, the time required for law enforcement agents to arrive at the scene could be lengthy, especially to collect data adequately. Accurately locating crashes is key to geographic analyses of crash statistics and patterns, as well as for the development of safety recommendations for zones with a high risk of crashes. This research project aimed to field test a software product able to deal with limitations of existing technologies by taking advantage of recent developments in software and hardware. The proposed system was developed and field tested in cooperation with several police agencies from the state of Nevada. Multiple tests were performed involving police officers collecting field data using the proposed software system. The field officers provided feedback and acknowledged that the proposed system helps to collect crash data efficiently. They highlighted how the effort and time required to collect crash information is minimized. In addition, administrative staff evaluated the proposed system and agreed that it maximizes the accuracy and consistency of the collected data and is in compliance with state and federal data requirements.

CHAPTER 1 INTRODUCTION

The collection of accurate and consistent crash data plays a critical role on traffic safety studies for analysis and prevention of motor vehicle crashes. There are several challenges related to the process of crash data collection. First, inconsistency or subjectivity may be present in the data, depending on the tools used to collect it. For example, the physical address where the crash occurred can be written in different ways by different police officers. Second, when a crash occurs, it has to be cleared as soon as possible to minimize traffic jams. Third, during the collection process, police officers are exposed to high speed traffic. Therefore, an efficient collection process is required to maximize officers' safety.

Once the data is collected, it needs to be reported in an efficient manner. There are different stakeholders that require crash data to be reported to them. Different types of users require different types of information. For example, on one hand, traffic engineers, traffic planning agencies and research groups require structured and quantitative data, while on the other hand, lawyers, insurance companies and public agencies usually require descriptive and qualitative data.

With the help of various law enforcement agencies in Nevada, the Transportation Research Center at the University of Nevada, Las Vegas developed a system for the efficient and accurate collection of crash data and crash locations. Due to the limitations of the existing hardware and software currently being used by law enforcement agencies, the proposed solution was implemented to eliminate those issues. Taking advantage of many currently existing technologies, the proposed solution has combined them into a cohesive and efficient set of applications to reduce time spent accurately recording crash data. Given the various needs of the law enforcement agencies, and in order for the proposed solution to be as user-friendly as possible several field tests have been conducted *(1)*. The results of this collaboration can be found in the next section titled "Field Test Results."

CHAPTER 2 PROPOSED SOLUTION

The proposed solution illustrated in Figure 1 has three main components: the server application, a web portal, and a mobile application. Law enforcement agents in the field use the mobile application to collect crash and citation data. That data is automatically sent in real time to the database hosted by the server application, which is then made available to the web portal. The proposed solution was built keeping in mind the limitation of existing tools that are currently being used by police departments. Also, it was built considering the requirements of accuracy, consistency, efficiency, and reporting required in a crash data collection tool. The Nevada NCATS Data Dictionary 2010 was used as a data requirement reference *(2)*. These elements are explained in detail below.

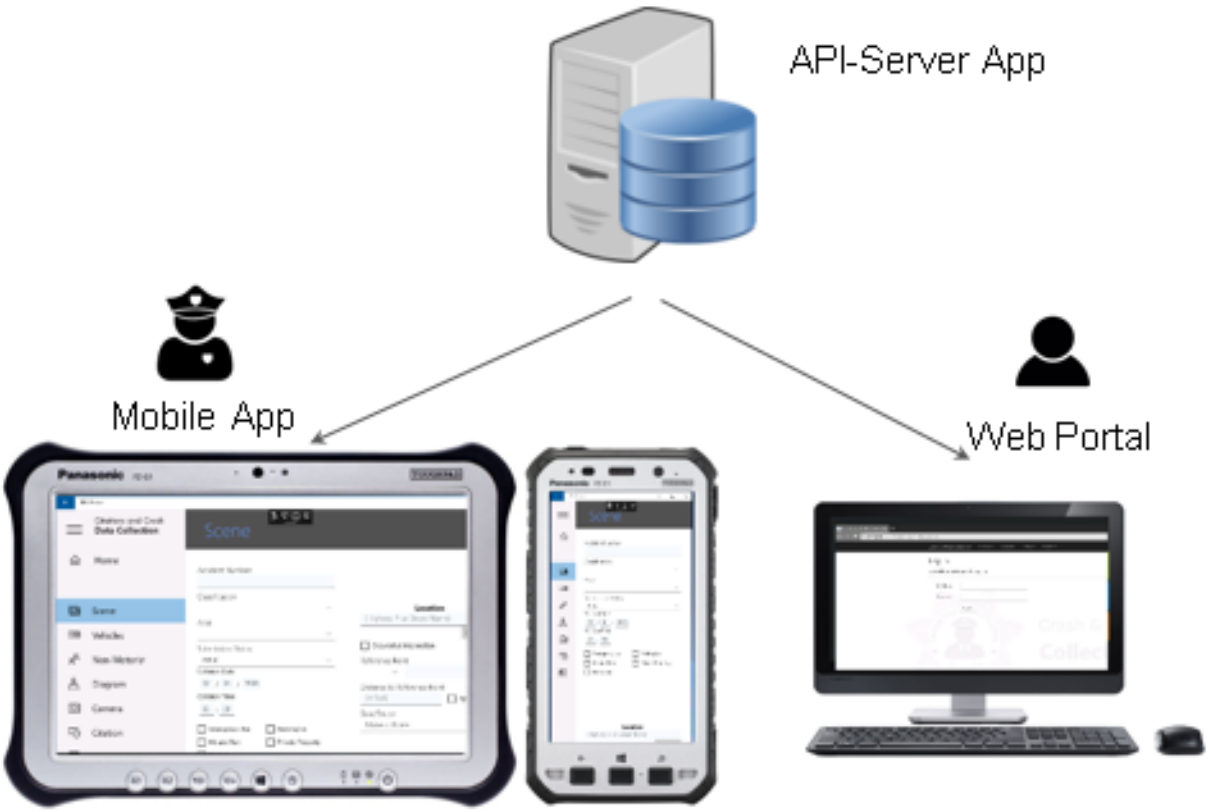

Figure 1. Conceptual Illustration of the Proposed Solution

Data Accuracy

The proposed solution implements several strategies to maximize the accuracy and consistency of the collected data. Since the accuracy of the collected data is important, there are a few ways ensure the location of the scene is as accurate as possible. The general idea is to minimize the "text" user input and replace it by selection lists when possible.

First, as illustrated in Figure 2, the user does not need to manually input the coordinates and physical or street address of the crash. These are captured using the GPS in the device plus a web service that translates the coordinates into physical addresses. This automatic filling of fields for location maximizes consistency since no user input is required.

Second, an important part of the collection of the crash location is the definition of a reference point, and measurement of a distance to such a reference point. The system that police officers currently use requires them to manually describe a reference point and input the distance from the crash. In the field, it is not always feasible to measure distances due to time constrains and high-speed traffic, so officers usually only make a visual estimation of the distance of the crash to the reference point. The proposed system makes this process easier by including a functionality that allows it to use a map and define a reference point. Once the reference point is captured, the distance from the crash to the reference point is automatically measured by the system.

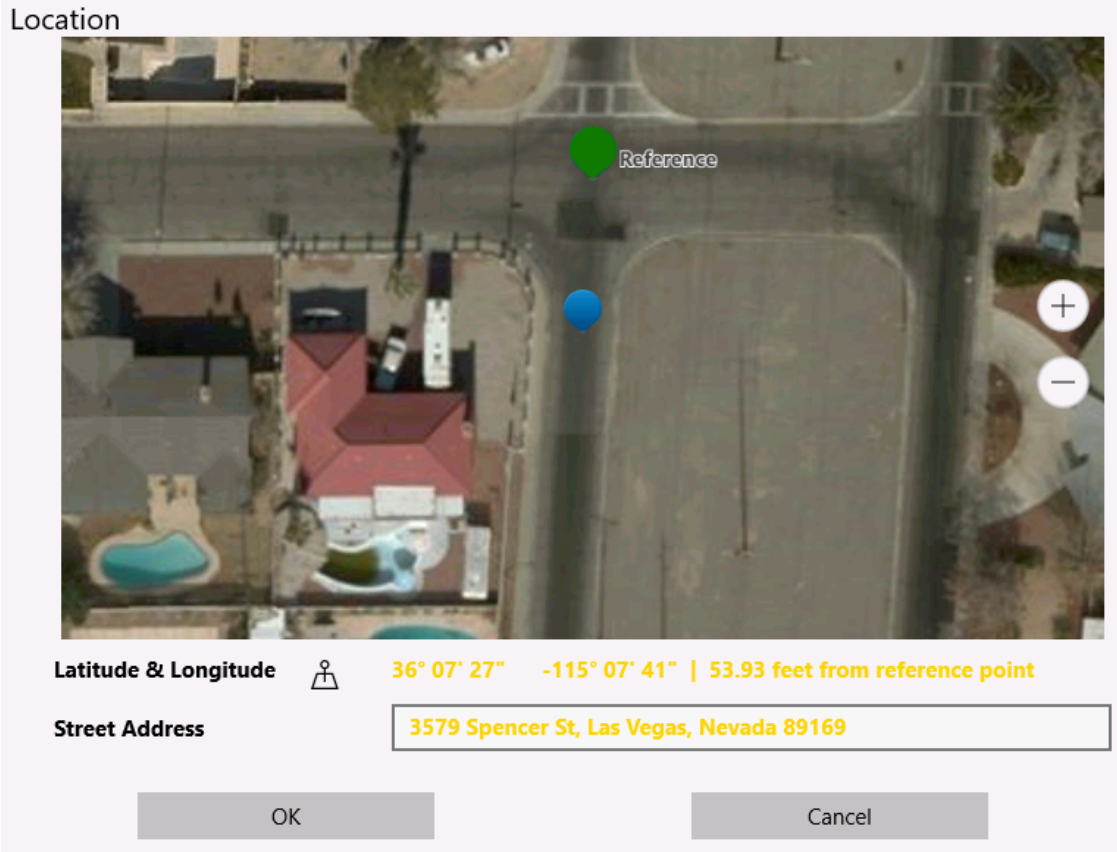

Figure 2. GPS Location with Measure to Reference Point

Third, there are police agencies whose main action field is the highways. Location information on highways has an additional challenge, which is the lack of physical mailing addresses. Currently, the location information on highways is established based on the highway name and the closest crossing street. Filling in this information on existing tools requires a

manual input of both the highway name and the crossing street. As illustrated in Figure 3, the proposed system implements a system of GIS area tagging, which can be used to provide consistent names for locations of crashes on highways. In addition to the location description, the GIS tag contains information about closest cross-street and beat sector, which are automatically filled in. This feature maximizes consistency and minimizes the effort required to input this information.

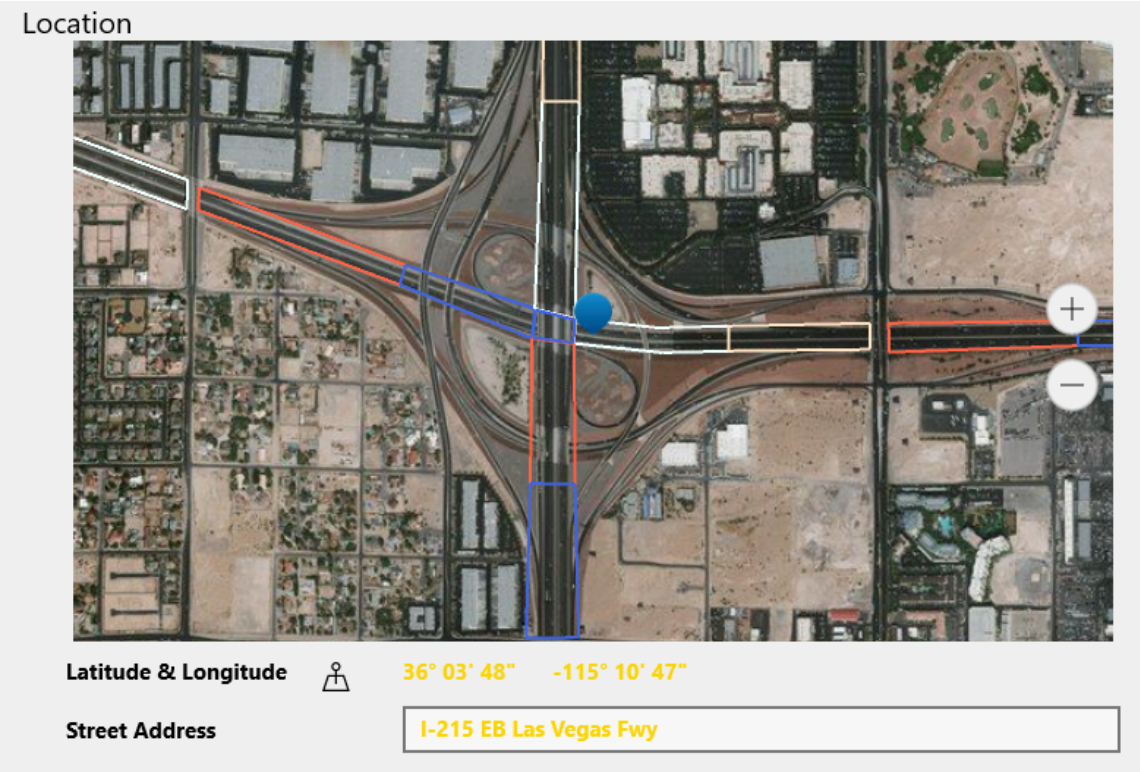

Figure 3. GIS Tagging for Highways

Fast Data Collection

In order to decrease the amount of time it takes to create an accurate report; many features have been introduced to streamline the process. These features have been developed in an effort to minimize the time an agent must be exposed to traffic and potential danger in order to collect accurate data. Should a situation become critical or urgent, an agent will be able to rapidly collect the necessary information with a minimal amount of contact with the mobile application. Once the officers are in less dangerous environments, they can complete the remaining data collection either by continuing to use the mobile application or via web portal.

An adaptive layout has been introduced to the mobile application that is responsive to user input. Whenever more information is required, the layout will dynamically expand to request that information, and it will hide certain information when it is not relevant to the current report or citation. In Figure 4 the user specified that a vehicle was a commercial vehicle, so the mobile application requested additional info.

The barcode reader is capable of scanning driver's licenses and vehicle registration cards from any state with the latest barcode specifications for US driver's licenses. Once scanned, the information is extracted from those documents and it is automatically populated into the corresponding fields. This improves data accuracy, decreases time spent recording relevant information, and allows the users the flexibility of scanning available documents or entering data by hand if necessary. Figure 5 illustrates a two-dimensional barcode commonly used in crash data collection devices.

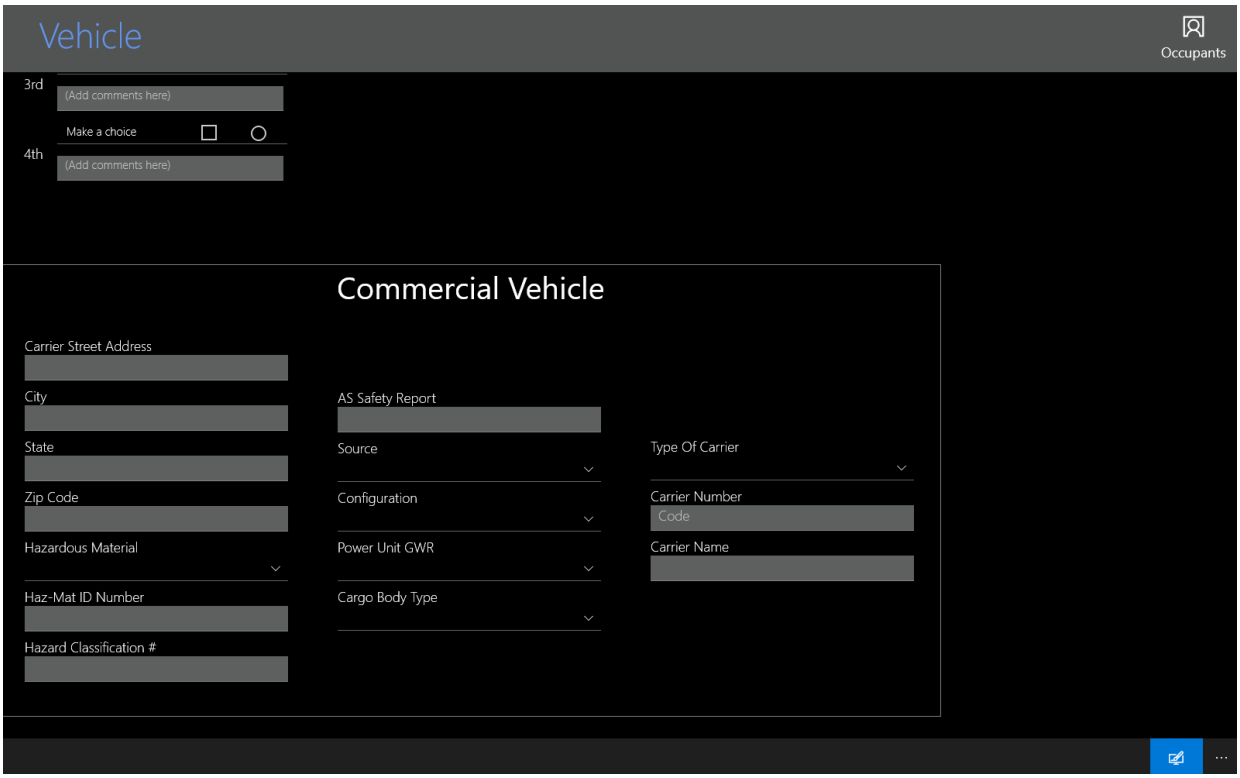

Figure 4: Adaptive Layout.

In addition, when a law enforcement agent needs to create a citation on the scene, the citation will automatically fill in fields that have been previously completed in the associated report. Together these two features reduce the amount of effort an agent must put into creating reports and citations. Several features have also been introduced into the proposed solution to increase the usability of the mobile application. These features include: the ability to print citations on scene; adaptive combo boxes that have frequently used selections filtered to the top of the list; and a barcode reader that allows law enforcement agents to scan relevant documents into the application.

To increase the flexibility of the proposed solution, it is possible to create new reports and citations directly from the web portal. This allows those without access to the mobile application the ability to add information to the database. Those with privileged access to a given report or citation may also edit and make changes to them as needed in order to correct mistakes or update existing information.

Figure 5. Driver's License Barcode Reader

Real Time Data Collection and Reporting

Once the data has become available to the web portal, it will automatically be aggregated into statistics. These statistics can then be reviewed in various formats. Figure 6 shows sample data that has been arranged into pie charts for easy understanding and quick analysis.

In addition to the crash statistics that are generated, each submitted report will be automatically tracked on two maps. Figure 7 illustrates a map with crash locations, with valuable information related to that report available when the point is clicked. This map is color coded to show how new/old each report is and can be filtered if necessary. This allows managers and supervisors to react in real time to incoming data and make decisions based on that information. The web portal also has a web services end-point for external users of the system if required or authorized *(3)(4)*.

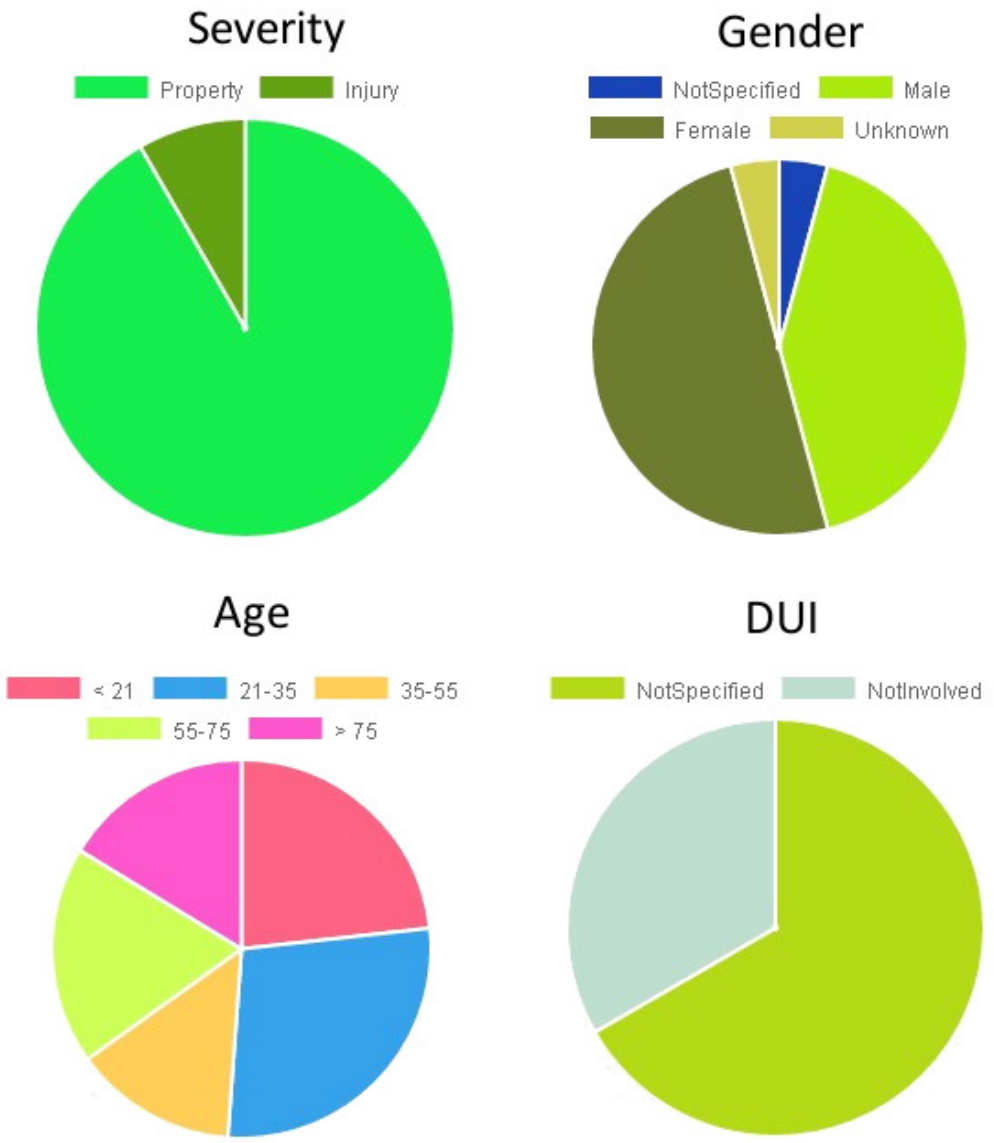

Figure 6. Crash Statistics

The second map the crash details are added to is a heat map that provides users with similar features as the first, but also allows them to analyze crash patterns holistically instead of on an individual basis. Figure 8 shows a heat map of the field test results. The inclusion of the map features on the web portal doesn't require additional effort from mobile application users. Since they are able to easily pinpoint the location of a scene by using the application's built in Global Positioning System (GPS) functionality, all agents must do is confirm the GPS coordinates on the map and the rest is done for them. The application is able to detect the nearest address to the scene and automatically fill in that detail for the user.

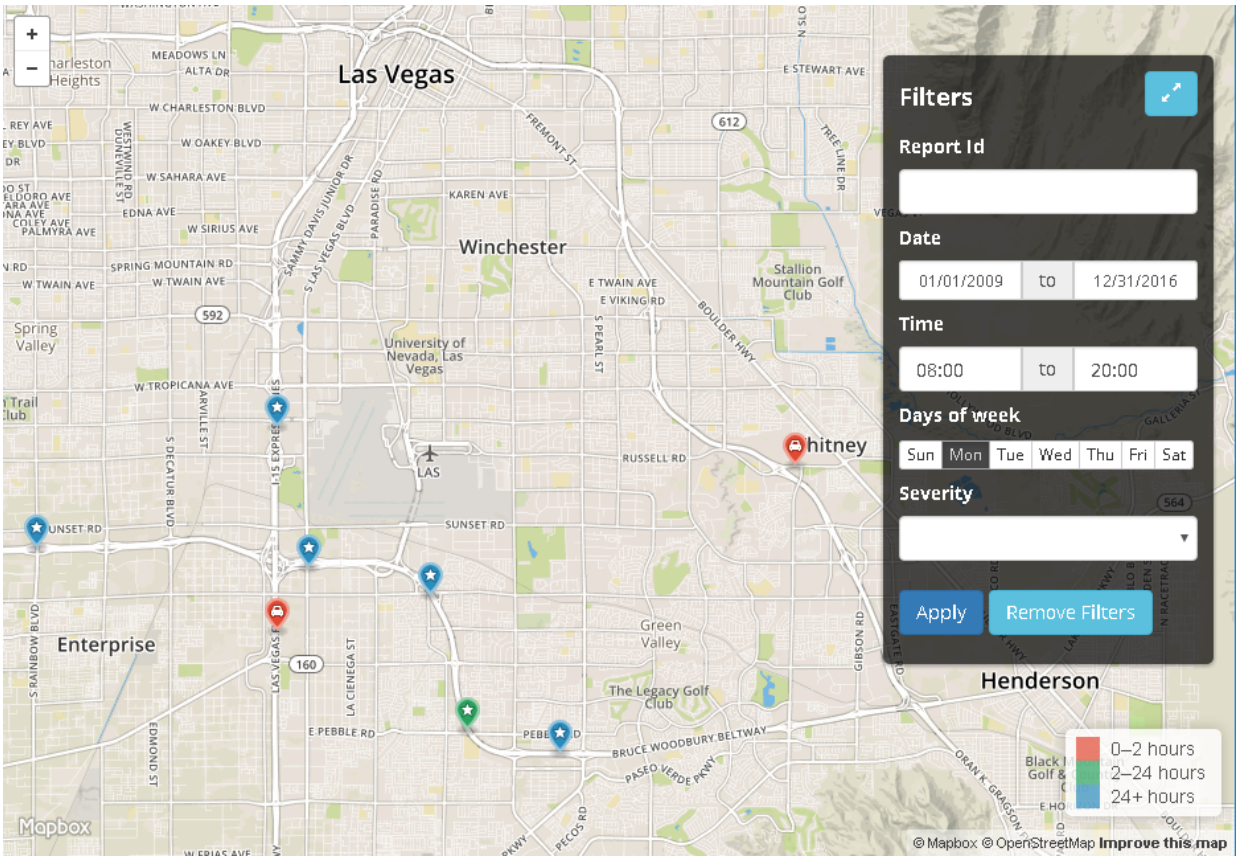

Figure 7. Crash Locations Map

Additional Features

Hand Sketched Scene Diagram

A scene diagram can be created directly on a map of the scene's location. In addition, agents in the field are able to sketch diagrams themselves by hand to be uploaded alongside the map diagram. This feature allows for a graphical representation of the crash scene. This scene diagram is valuable for traffic safety studies and defining countermeasures to prevent future crashes in the same area. Moreover, the scene diagram can help to support of the determination of who is at fault in a crash. Also, this information can be used by insurance companies and judges to get additional information about the crash scene. Figure 9 illustrates an example of a hand sketched scene diagram.

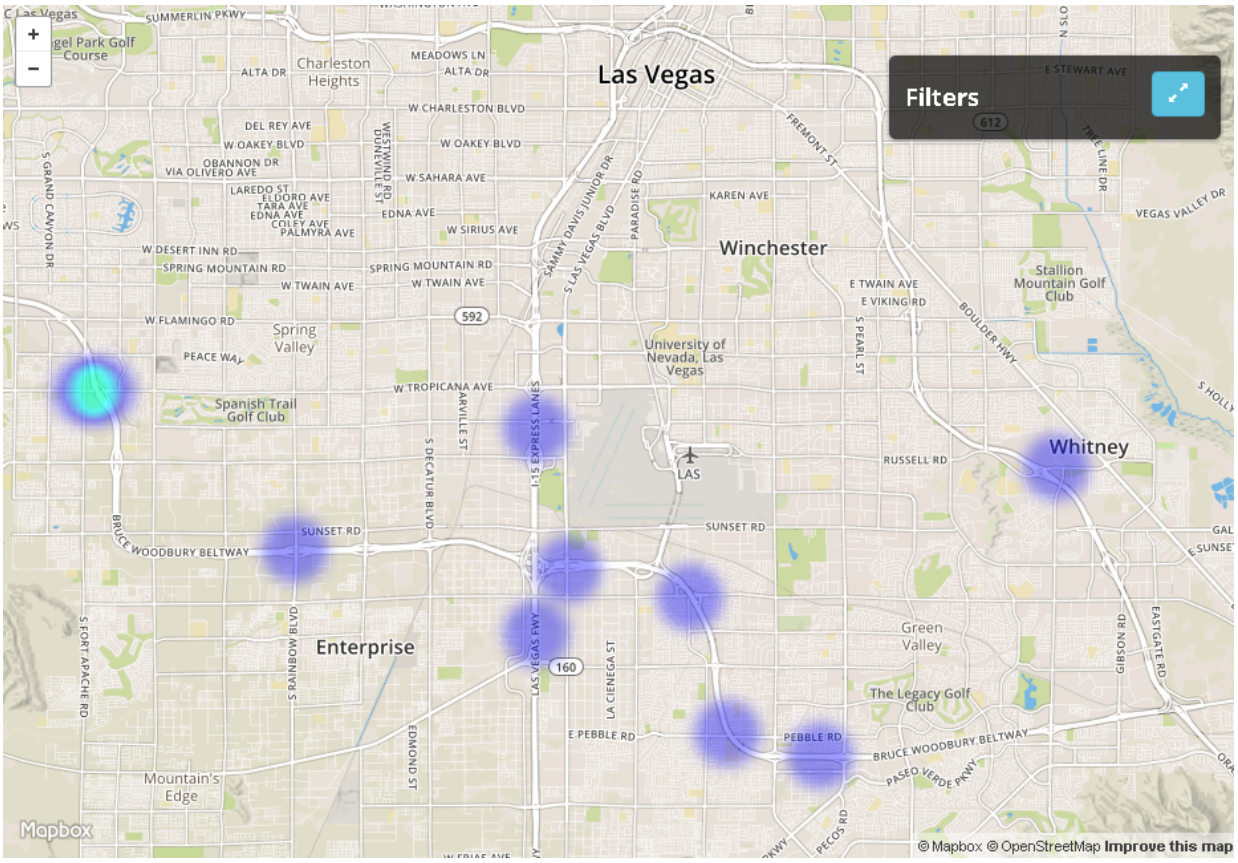

Figure 8. Crash Heatmap

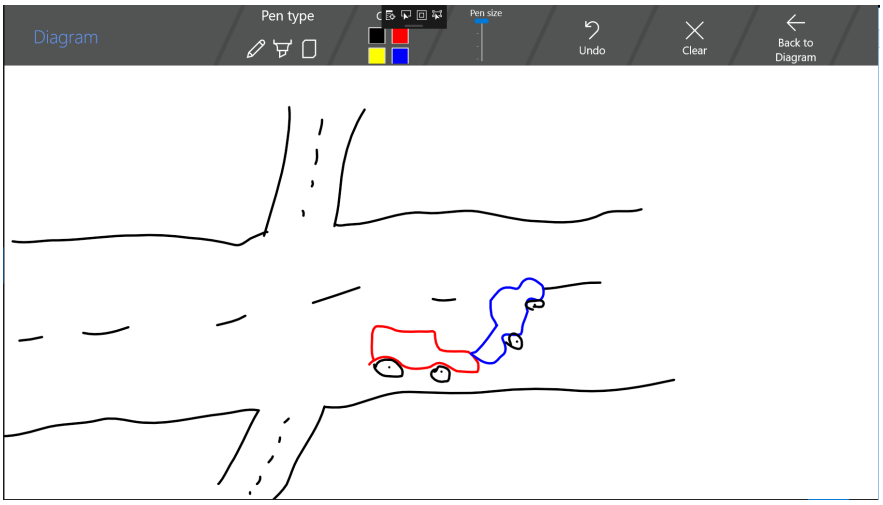

Figure 9. Example of Hand Sketched Scene Diagram

Towing Sheets Filling and Printing

Sometimes, after a crash occurs, a towing service might be required to pick up one or more vehicles involved in the crash. This can also happen when a citation is filed, and the

vehicle has to be impounded due to violations or in cases of arrest. In any case where the vehicle is towed, police officers need to fill out a form called the “towing sheet.” This form contains information about the vehicle, the driver, and the owner. It also contains a vehicle inventory where parts that are visibly broken or in bad states are marked.

Currently, police officers from the Nevada Highway Patrol Southern Command use a physical sheet that is filled in using a pen. This process is time consuming and requires additional effort because the officer needs to manually fill in all of the information in the towing sheet. In order to minimize the required effort, the proposed system implements a towing sheet functionality, which uses the information about the vehicle, driver and owner already present in the crash or citation records. The officer only needs to input the vehicle inventory, which can be easily completed using the touch screen. At the end, the towing sheet is printed including all the information, plus the signatures of the officer and the tow driver.

Responsive design for multiple screen sizes

A large number of police officers use tablet devices with a screen size of 11 inches. These officers work in vehicles with a docking station and a keyboard. Also, there are a number of officers who need smaller devices because they work on motorcycles and it is not possible to have docking stations and keyboards. These multiple types of environments require devices of varied sizes; therefore, the proposed system was implemented considering different screen sizes. The layout of the mobile application was created using the Universal Windows Framework, which provides capabilities to make responsive views. For smaller screen sizes the user only needs to scroll down to continue filling in the information. Figure 10 illustrates an example of the responsive layout working on a mobile device the size of a cellphone.

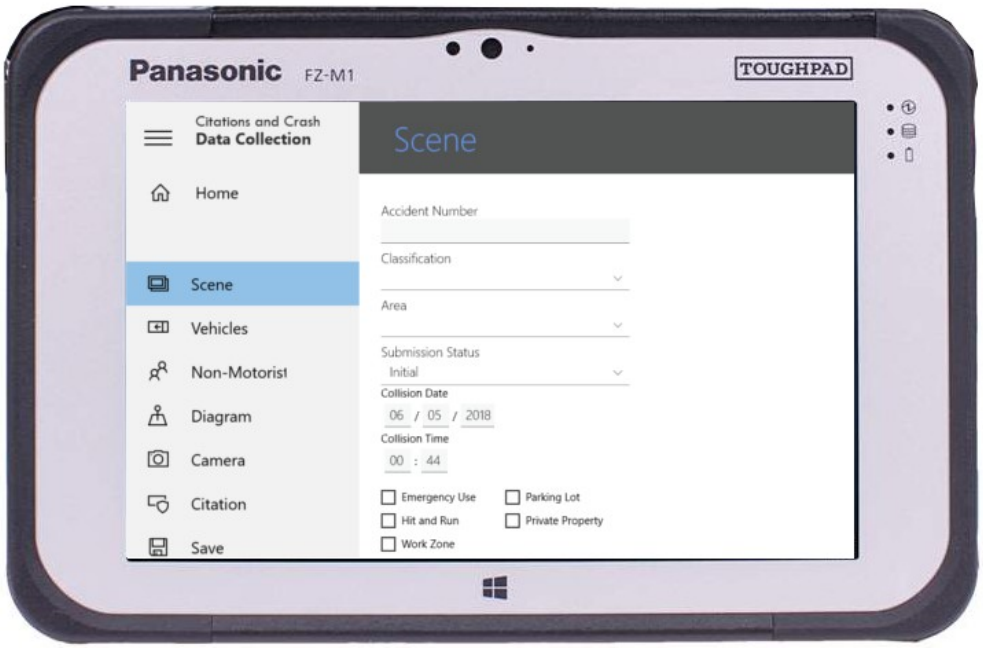

Figure 10. Layout Responsive to Multiple Screen Sizes

CHAPTER 3FIELD TEST

To validate the proposed tool in a real-life environment, a field test with the Nevada Highway Patrol Southern Command was conducted. The field test was designed to collect feedback from four officers with distinct roles in the data collection process. One officer was the system manager and had a high-level knowledge of the technical features of the system. The other three officers were Troopers. Two of them currently collect information with a tablet device and the other one with a handheld device. The requirement was to collect at least three crash reports and three citations with every officer. In total 14 crash reports and 16 citations were collected. In addition, a follow-up session was conducted, in order to evaluate new features that were implemented based on suggestions from sessions of the field test.

Field Test Schedule

Table 1 summarizes the field test schedule.

Table 1. Field Test Schedule

Day	Date	Officer	Start Time	End Time
1	1-Mar-2017	Trp. O'Connor	9:00 a.m.	1:00 p.m.
2	2-Mar-2017	Trp. O'Connor	7:00 a.m.	1:00 p.m.
3	3-Mar-2017	Trp. O'Connor	7:00 a.m.	11:00 a.m.
4	6-Mar-2017	Trp. Pitchford	1:00 p.m.	5:00 p.m.
5	7-Mar-2017	Trp. Pitchford	4:30 p.m.	7:30 p.m.
6	16-Mar-2017	Trp. Stefik	7:00 a.m.	2:00 p.m.
7	21-Mar-2017	Trp. Cholke	10:30 a.m.	3:30 p.m.
8	23-Jun-2018	Trp. Cholke	2:00 p.m.	6:00 p.m.

Feedback

A member of the Transportation Research Center was with the officers during the collection process to provide guidance for the use of the tool and to collect feedback. Table 2 summarizes the collected feedback, and Table 3 aggregates the feedback items by priority and implementation status.

Table 2. Feedback from Field Test

#	Day	Description	Priority	Addressed?	Type
1	1	Zoom for Camera	Low	Future work	Enhancement
2	1	Set reference direction for citations and reports as North Of, South Of, ..., At	High	Yes	Enhancement
3	1	Add Reference and Reference direction fields for Scene	High	Yes	Enhancement
4	1	Add Reference and Reference direction fields for Citations	High	Yes	Enhancement
5	1	Add codes to sequence of events	High	Yes	Enhancement
6	1	Add tags to clarify some fields in scene	High	Yes	Enhancement

#	Day	Description	Priority	Addressed?	Type
7	1	DOB not reading from barcode	High	Yes	Bug
8	1	Mark vehicles as V1, V2, V3...	High	Yes	Enhancement
9	1	Fix minimum date for date fields (Expiration, Initial date, final date)	High	Yes	Bug
10	1	Add No insurance field for vehicle	High	Yes	Enhancement
11	1	Link violations to vehicles and non-motorists	Medium	Future work	Enhancement
12	1	Hide Commercial Vehicle Items until commercial vehicle is selected	Medium	Yes	Enhancement
13	1	Pull Court case from Accident#	High	Yes	Enhancement
14	1	Pull Beat Sector from report to citations	High	Yes	Enhancement
15	1	Make sure that barcode reader can extract all the fields	High	Yes	Bug
16	1	Auto-populate Owner Is defendant for vehicle in citation	High	Yes	Enhancement
17	1	Navigate directly to occupants in the navigation bar	Medium	Yes	Enhancement
18	1	Add button to navigate to current GPS location in Scene View	Medium	Yes	Enhancement
19	1	Create ticket books for citations numbering purposes	Medium	Future work	Enhancement
20	1	Add “in feet” description to distance to reference point	High	Yes	Enhancement
21	1	Fix the UTC time for citations and reports on the website	Medium	Yes	Bug
22	1	Enable creation of citations from the website	Medium	Future work	Enhancement
23	1	Update violations list using the one provided by NHP	High	Yes	Enhancement
24	2	Add hidden fields to be able to pass all the information from barcode reader when populating from crash report	High	Yes	Enhancement
25	2	Add voice recognition to To Wit in offenses	Medium-Low	v	Enhancement
26	2	Add No Court, Warning Only to the list of Courts	High	Yes	Enhancement
27	2	Add Intersection checkbox to Scene and Activate other fields only when intersection enabled	Medium	Yes	Enhancement
28	2	Add search feature to beat sector	Medium-High	Yes	Enhancement
29	2	Add R1, R2, L1, L2 to drop down in Turn Lane	High	Yes	Enhancement
30	2	Fix bug with voice recognition	High	Yes	Bug

#	Day	Description	Priority	Addressed?	Type
31	2	Fix the scene item selected in Navbar when navigating to Scene	High	Yes	Bug
32	2	Fix Address when reading from barcode for Vehicle	High	Yes	Bug
33	3	Include gold in vehicle color list	High	Yes	Enhancement
34	3	Enable Driver Factors only when checkbox driver selected	Medium-High	Yes	Enhancement
35	3	When keyboard connected don't display on screen keyboard	Medium-High	Yes	Bug
36	3	Enable fields for Work Zone only when Work Zone field selected	Medium-High	Yes	Enhancement
37	3	Fix color and display of text for Sequence of events drop down	High	Yes	Enhancement
38	3	Enable Vehicle Towed fields only when vehicle was towed	Medium-High	Yes	Enhancement
39	3	Add Checkbox "Moved" next to Distance After Impact for Vehicle	Medium	Yes	Enhancement
40	3	Only two trailing units for vehicle	Medium-High	Yes	Enhancement
41	3	Mark vehicles as V1 and V2 in scene diagram	Medium-Low	Future work	Enhancement
42	3	Change color of vehicles in scene diagram	Low	Future work	Enhancement
43	3	Violation Time is pulled from Crash Report	High	Yes	Enhancement
44	3	Add Submit Button at the end of offenses view and Submit and New Offense	Medium-High	Future work	Enhancement
45	3	Add Badge number to citation print	Medium-High	Yes	Enhancement
46	3	Delete Button for Camera	Medium-High	Yes	Enhancement
47	3	Remove Report Type for Citation	High	Yes	Enhancement
48	3	Dummy save button at the end of every view	Low	Yes	Enhancement
49	3	Add Radar to citation when speed offense is selected	High	Yes	Enhancement
50	3	Add methods to radar in citation, Radar, Paced, Visual estimate, Stationed	Medium-High	Yes	Enhancement
51	3	Add submit functionality for the website	High	Yes	Enhancement
52	3	Add Submit All button for reports list and citation list in tablet	High	Yes	Enhancement
53	3	Remove Meter#, Device Type, and test type in citations	High	Yes	Enhancement
54	3	Add Pedestrian Safety Zone to citation zone	High	Yes	Enhancement
55	3	If barcode is not able to read,	Medium	Future work	Bug

#	Day	Description	Priority	Addressed?	Type
		should come back automatically to barcode prompt			
56	3	Add Interpreter Needed and Language for Citation	High	Yes	Enhancement
57	3	Add Highway Conditions, Light Conditions and Weather to citations	High	Yes	Enhancement
58	3	Uppercase for beat sector, to wit and narrative	High	Yes	Enhancement
59	3	Replace statute by NRS in offenses selection	High	Yes	Enhancement
60	3	Urban and rural automatically based on court for citations	Medium-High	Yes	Enhancement
61	3	Add printing for contact information of report	Medium-High	Future work	Enhancement
62	3	Change the citation format to NHP format	Medium-High	Future work	Enhancement
63	4	Maximize the inclusion of Other field for items that may need it (Intersection, Roadway Grade, Vehicle Collision Type, Vehicle Action)	Low	Future work	Enhancement
64	4	Add barcode reader for trailing unit	Medium	Future work	Enhancement
65	4	Add autocomplete for vehicle make and type	Medium	Yes	Enhancement
66	4	Zip code auto-populate city and state	Medium	Future work	Enhancement
67	4	Add Straight and Level to roadway type	High	Yes	Enhancement
68	4	Travel lane combined in single field	High	Yes	Enhancement
69	4	Change all the possible fields to drop down	Medium-High	Yes	Enhancement
70	4	Vehicle Action add Lane Change	Medium-High	Yes	Enhancement
71	4	Make Travel Lane dropdown	Medium-High	Yes	Enhancement
72	4	Enable typing date and time	Medium	Yes	Enhancement
73	4	Vehicle action options scroll down gets stuck	Medium-High	Yes	Enhancement
74	4	Add Damaged Areas to Trailing Unit	Discuss	Future work	Enhancement
75	4	Add Child Seat as most common restraint	Medium-High	Yes	Enhancement
76	4	Remove Airbag ON/OFF field	Medium-High	Yes	Enhancement
77	4	Show injuries field only when injury selected	High	Yes	Enhancement
78	4	Show drug involvement fields only when drugs involvement	High	Yes	Enhancement

#	Day	Description	Priority	Addressed?	Type
		selected			
79	4	Don't show driver license information unless the driver is selected	High	Yes	Enhancement
80	4	When populating a defendant in citation, include the vehicle	Medium-High	Yes	Enhancement
81	4	Add Unknown option to race	Medium-High	Yes	Enhancement
82	4	Put Defendant Type at the beginning	Medium-High	Yes	Enhancement
83	4	Check with Brian Drone the fields for Commercial Vehicles	Low	Yes	Enhancement
4	4	Add transported by EMS and add list of EMS in Nevada	Medium	Yes	Enhancement
85	5	When Intersection remove distance and reference, and put Intersection field	High	Yes	Enhancement
86	5	Add Other to Intersection Type	High	Yes	Enhancement
87	5	Implement void for tickets and void approval	Low	Future work	Enhancement
88	5	Implement validation for required fields	Low	Future work	Enhancement
89	5	Delete should be restricted	Low	Future work	Enhancement
90	5	Add supplements for cases of mistakes in the information	Low	Future work	Enhancement
91	5	Add Approximate field for distance to scene	High	Yes	Enhancement
92	5	Add search box to insurance	Medium-High	Yes	Enhancement
93	5	Put the is Driver option first in the view	Medium-High	Yes	Enhancement
94	5	When tab highlight text to improve deletion	Medium	Yes	Enhancement
95	5	Set Straight and Level as common roadway characters	High	Yes	Enhancement
96	5	Change date selector order Month, Day, Year	Medium	Yes	Enhancement
97	5	Traffic Control scroll bar for vehicle gets stuck	Medium-High	Yes	Enhancement
98	6	Panoramic Pictures would be good	Low	Future work	Enhancement
99	6	Improve suggestion system for narratives	Low	Future work	Enhancement
100	6	Put numbers on top of touch keyboard	Medium	Yes	Enhancement
101	6	Add Owner is driver to vehicle	Medium-High	Yes	Enhancement
102	7	Dropdown with autocomplete for Vehicle basic information fields	High	Yes	Enhancement
103	7	Split address for Owner Address	Medium-High	Yes	Enhancement

#	Day	Description	Priority	Addressed?	Type
104	7	Enable Transported By field only when injury	Medium	Yes	Enhancement
105	7	Enable typed date and time	High	Yes	Enhancement
106	7	Combo box does not go backwards	Medium	Yes	Enhancement
107	7	Automatic seating position when Is Driver selected	Medium	Yes	Enhancement
108	7	Event Number instead of court case number should be pulled from a report when populating a citation	High	Yes	Enhancement
109	7	Pull Highway conditions from report when populating a citation	High	Yes	Enhancement
110	7	Enable clone of charges	Medium	Yes	Enhancement
111	7	Add Notes to citation	Medium-High	Yes	Enhancement
112	7	VIN decoder for trailing unit	High	Yes	Enhancement
113	7	Total #occupants in vehicles not displaying properly	Medium	Yes	Enhancement
114	7	When populating defendant from crash report, show Occupants in V1 and V2	High	Yes	Enhancement
115	7	Sequence of events has a selection bug	Medium-High	Yes	Bug
116	7	Implement compliance for diverse types of restrictions and endorsements	High	Future work	Enhancement
117	7	List of colors of cars needs more options, same for the list of items	High	Yes	Enhancement
118	7	Additional fields should appear when work zone is selected	High	Future work	Enhancement
119	7	Enhance transition between fields for people not using touch screen, but keyboard	High	Future work	Enhancement
120	7	Court date should be automatically set	High	Future work	Enhancement
121	7	Provide option to hide street names when selecting crash location	High	Yes	Enhancement

Table 3. Summary of Priority and Implemented Tasks

Priority / Implemented	High	Medium-High	Medium	Medium-Low	Low	Total
Yes	51	26	17	0	2	96
Future work	4	3	7	2	9	25
Total	55	29	24	2	11	121

In total, based on feedback from the field test, 96 changes were implemented: and 25 have been marked as future work. The implementation order was based on the priority of the items; for this reason, the number of implemented items with high priority is large. Finally, out of the 121 feedback items, 10 are bugs and 111 enhancements.

Pictures

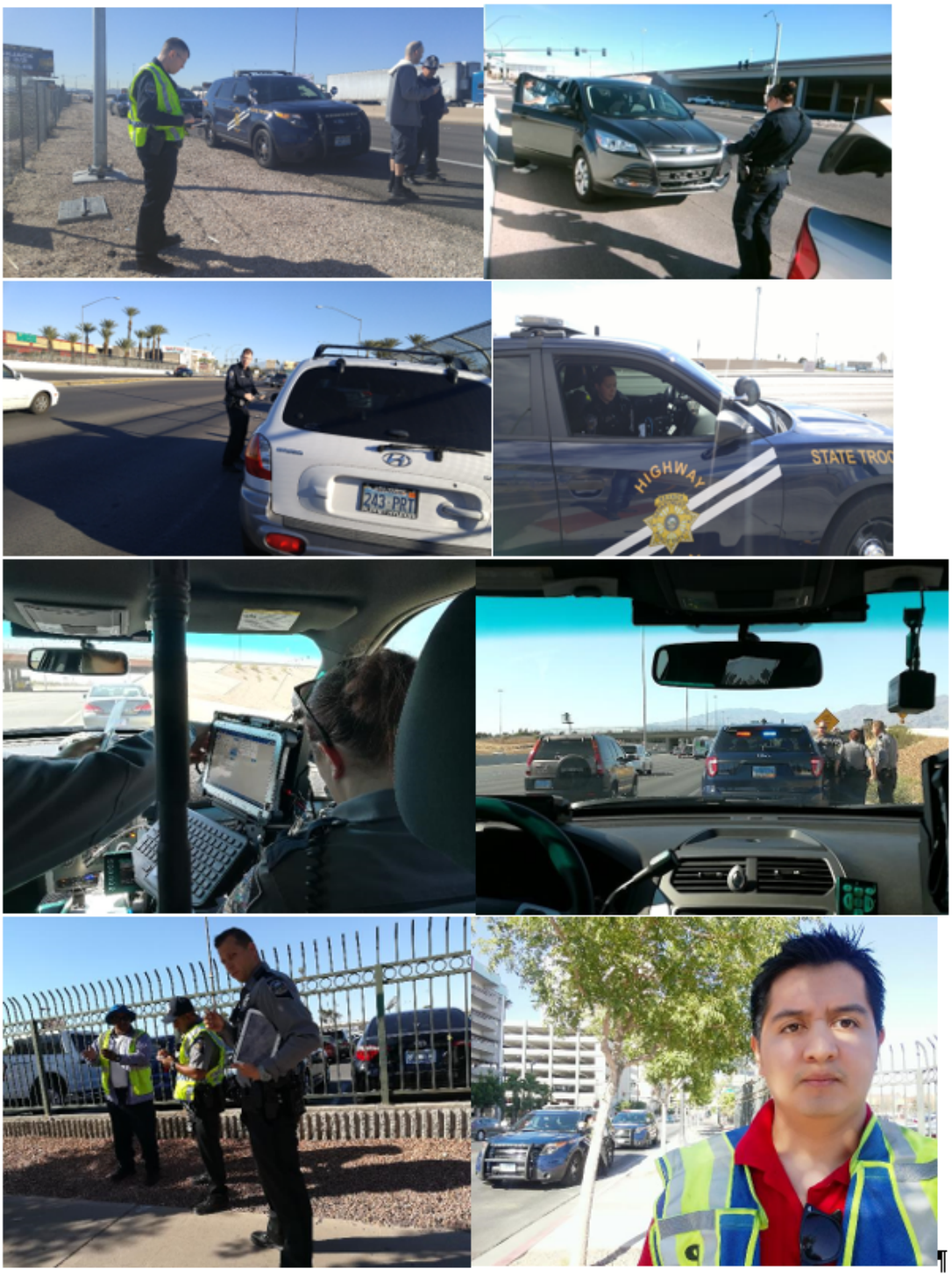

Figure 11. Pictures during Field Test

CHAPTER 4 FUTURE WORK

In addition to the feedback collected from the field test marked as "Future" in Table 1, there are additional requirements that can add value to the proposed system. Some of these items are functionalities already implemented but that can be enhanced. These future items are summarized in Table 4. In addition to the description of the item, an estimated complexity and priority of the requirement is included.

Table 4. Future Work Requirements

#	Requirement Description	Complexity	Priority
1	Two factor authentications for mobile app and website. In general, an authentication web service can be implemented to enhance the existing mechanism.	Medium	High
2	Edition of reports by multiple police officers at the same time.	High	Medium
3	Send social media notifications when a severe crash occurs.	Medium	Low
4	Ability to create lists of common used options by user. For example, many officers commonly use a set of violations for citations.	High	Medium
5	Improve the way that catalogs are updated. Example of catalogs can be insurance companies list, EMS lists, court lists.	Medium	High
6	Create a validation tree that can improve the validation of fields that are not filled in or are not filled in a proper way.	Medium	High

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2. Nevada Highway Traffic Safety Administration. “Nevada NCATS Data Dictionary”. (2010). Available at: http://www.nhtsa.gov/nhtsa/stateCatalog/states/nv/nevada.html (As of April 20,.2018).
3. Carey, M.J., Onose, N. and Petropoulos, M.. “Data services”. *Communications of the ACM*, *55* (6), (2012) pp.86-97.
4. OData. “OData - the Best Way to REST”. (2015) Available at: http://www.odata.org (As of April 20,. 2018).

APPENDIX A. Mobile App User's Manual

Overview

Figure A-1 illustrates the home view of the mobile app. This view has three options. The option "Crash Reports" lists all the reports created in the local device. The option "Citations" lists all the citations available in the device. The option "Arrest Citations" is similar to the "Citations" option, however this option only list citations that are marked with an arrest procedure. The button located on the bottom-left corner allows to change the logged in user. In addition, on this view the user can update his signature and preferences. The icon located in the bottom-right corner allows to change the theme or visual appearance of the application. The application has a dark and a light theme.

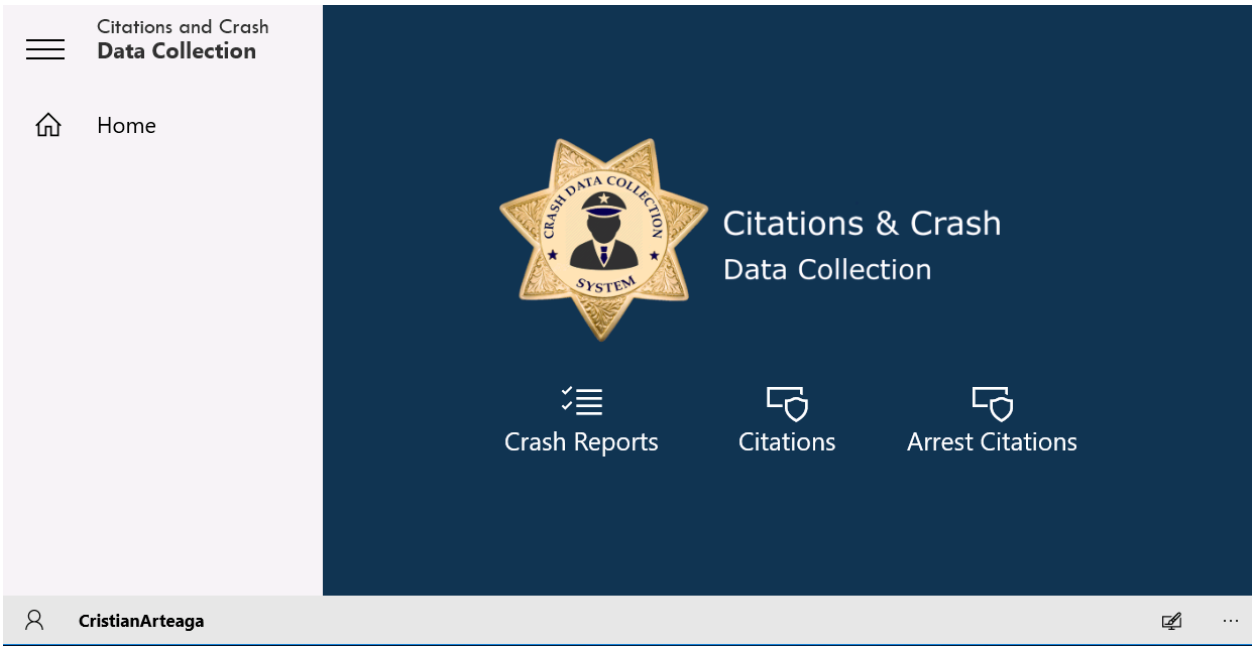

Figure A-1. Home View

Crash Reports

Reports List

Figure A-2 shows the reports list view. This view lists all the reports with basic information about their status. In addition, this view has options to interact with the reports. The option "Sync" is used to save the reports and citations in the remote server. The option "Delete" removes the crash information of the local application. If the deleted information was before saved in the cloud (synchronized), this information can be found there, otherwise the report is completely deleted. The option "Submit" sends the final version of the report to the remote sever. Once submitted, a report cannot be edited anymore and will be available on read mode

only. To edit a report the user only needs to click on the report and the edition view will be displayed.

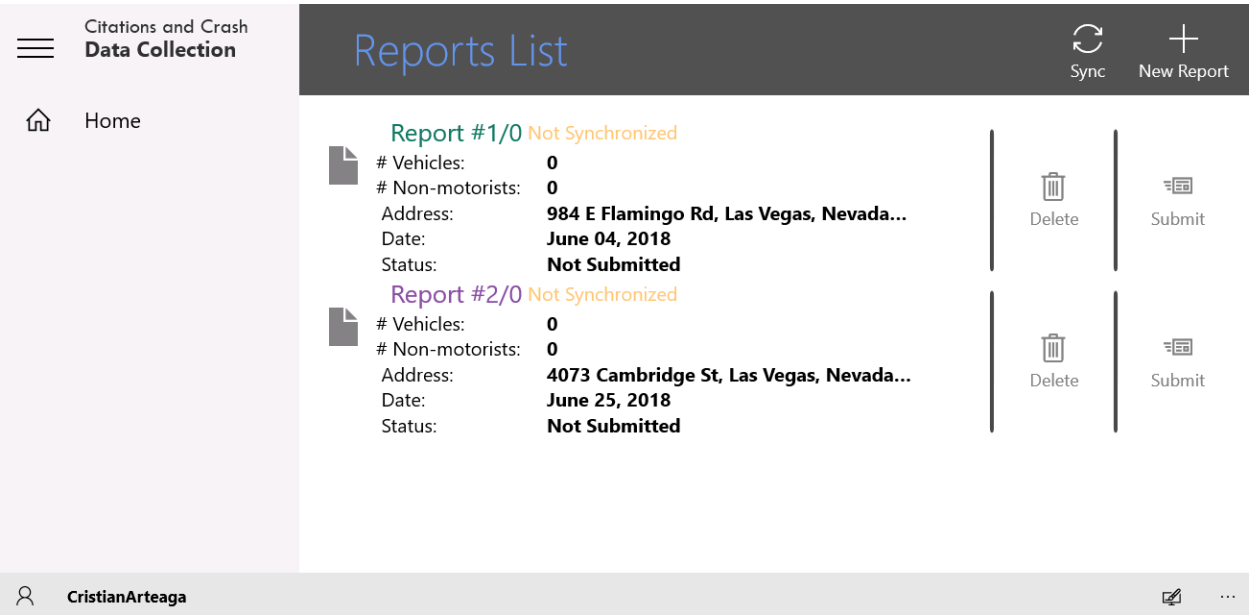

Figure A-2. Reports List View

Scene

Figure A-3 shows the scene view which allows to fill in information about the place where the incident occurred. The option location, allows to open a map and pinpoint the address or reference point that defines an exact crash location.

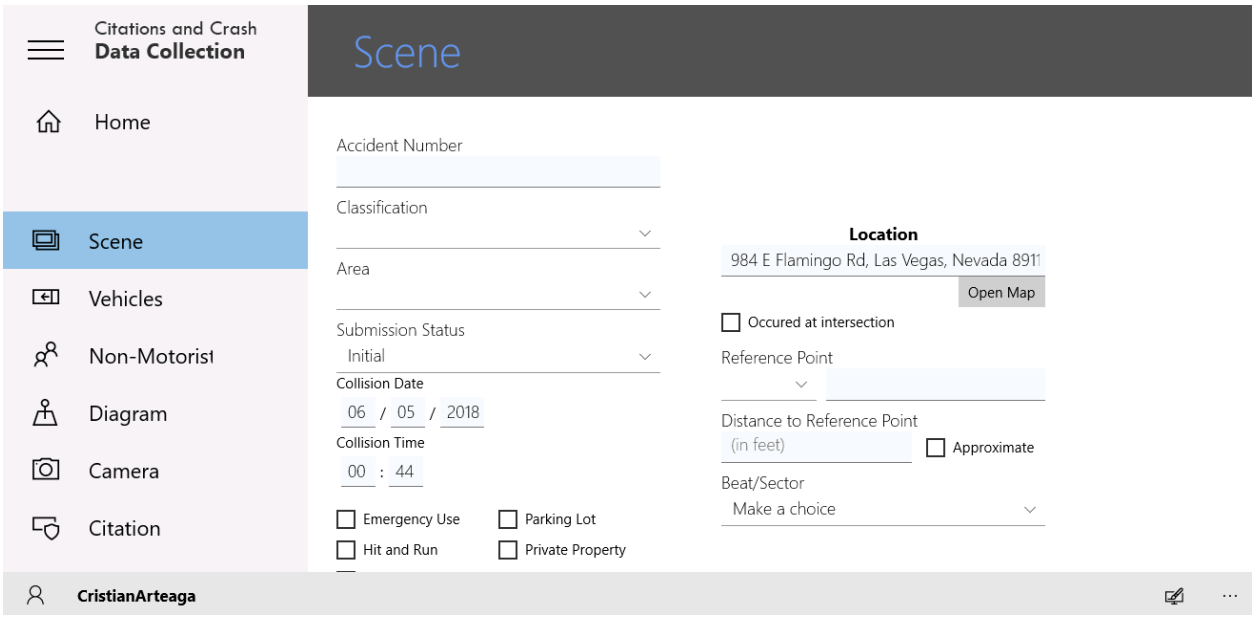

Figure A-3. Scene View

Figure A-3 also illustrates that in addition to Scene, the left ribbon has other five options. These options allow to input information about the vehicles, personal information about the drivers of the vehicles, occupants of the vehicles and additional people involved in the incident.

Vehicles

Figure A-4 illustrates the vehicle list view which allows to see, and edit the vehicles involved in the crash and their occupants. When the "Add Vehicle" button is clicked or when a vehicle is selected, the system will open the "Vehicle Edit View" as illustrated in Figure A-5. In this view, the barcode scanner can be used to scan the vehicle registration and extract the required information. When editing information of a vehicle, depending on the attributes of the vehicle, more or less fields could be requested to be filled in. For example, when a vehicle is marked as "Commercial" the system will ask to fill in addition fields. Another feature available in the vehicle edit view is the ability to print a towing sheet once all the information of the vehicle and driver has been filled in.

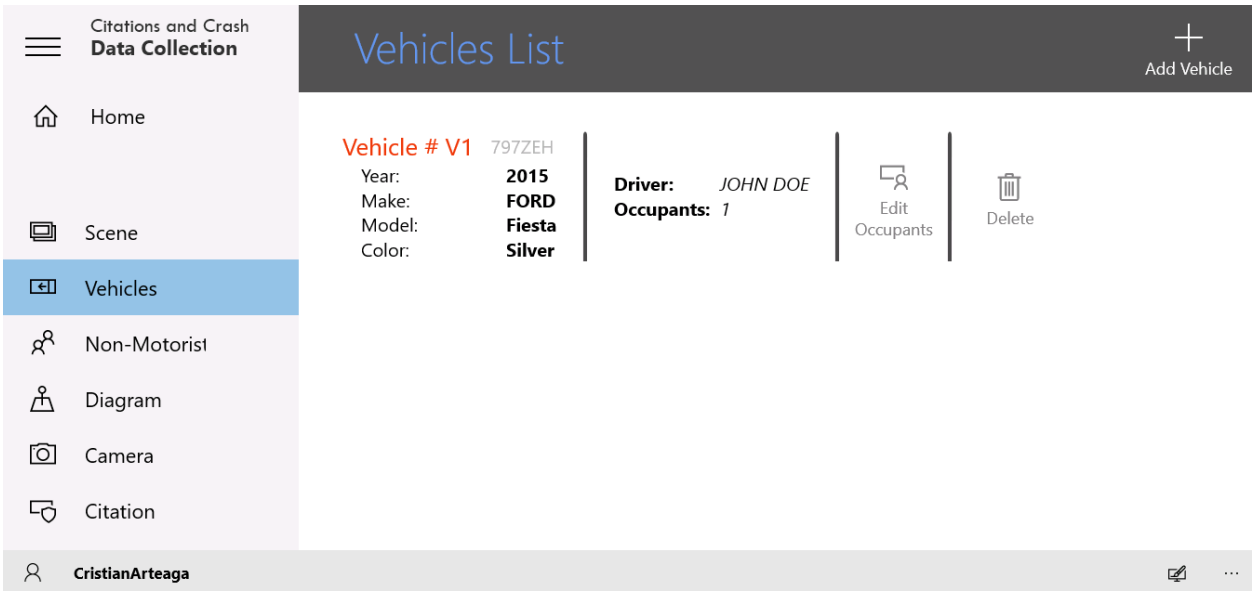

Figure A-4. Vehicle List View

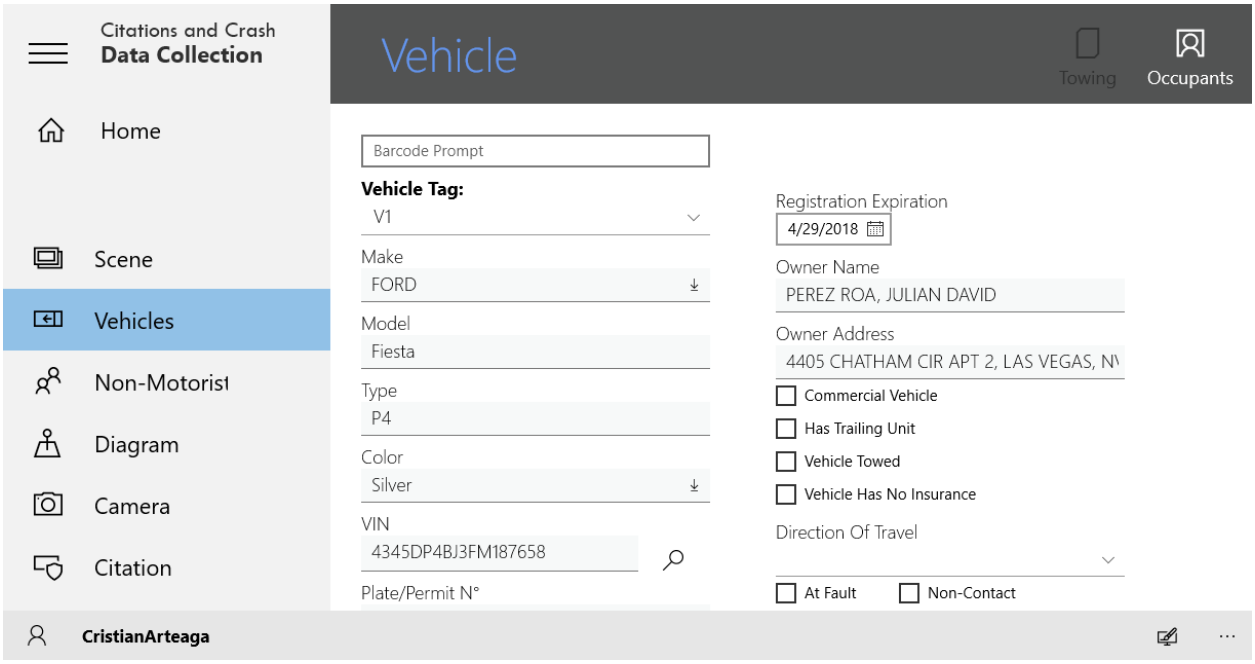

Figure A-5. Vehicle Edit View

Vehicle Occupants

Figure A-6 illustrates the vehicle occupants view. This view shows the list of occupants of the vehicle at the moment of the crash including the driver. When the "Add Occupant" option is clicked or when an occupant is selected a new view will be displayed to fill in information of

the occupant. In this view, the barcode reader can be used to scan a driver license to automatically fill in all the information.

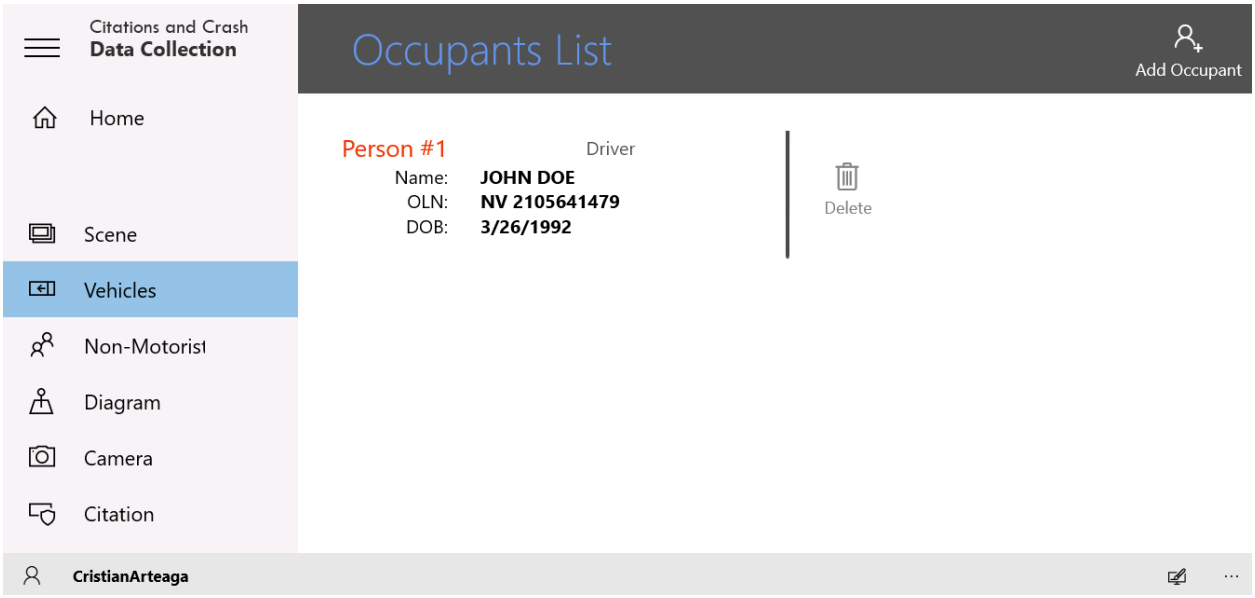

Figure A-6. Vehicle Occupants View

Scene Diagram

Figure A-7 illustrates the scene diagram view. In this view, a diagram of the crash scene is created in order to provide a graphical representation of the crash scene and to have a better understanding of the circumstances and context of the crash. By default, the location of the crash report is set as the center of the diagram. In the right side, there are different objects that can be dragged to the scene. Once in the scene, the objects can be rotated and moved in order to produce a representation of the crash scene the objects that can be added to the scene include different type of vehicles, road signs, movements, events and pedestrians.

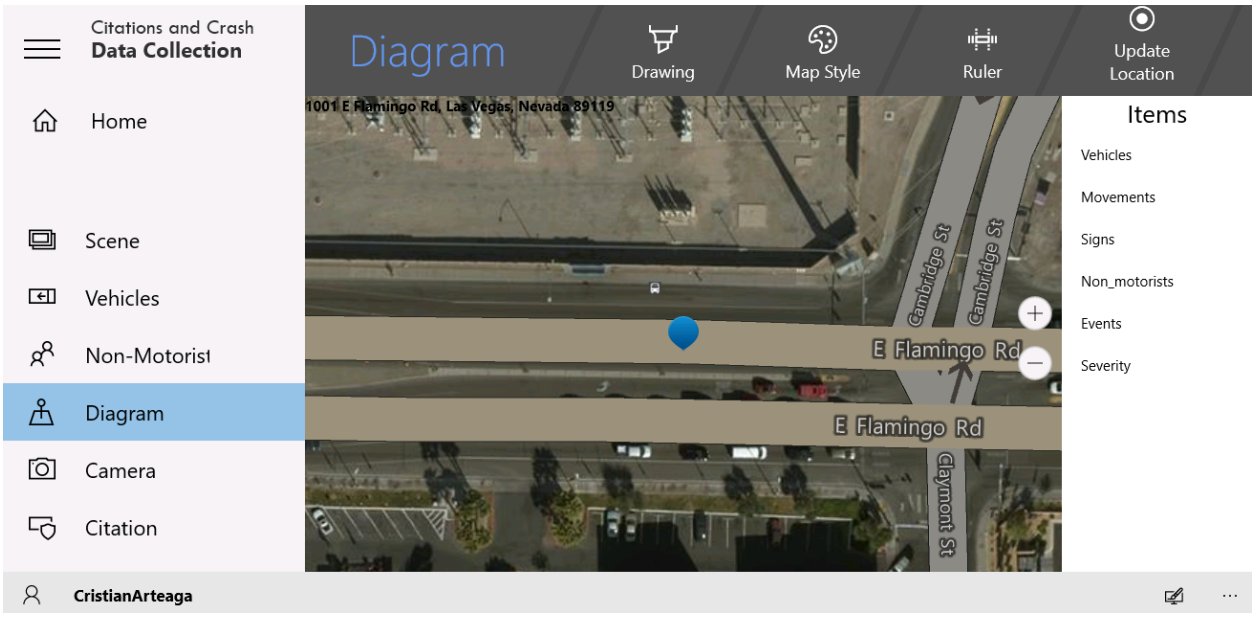

Figure A-7. Scene Diagram View

Citations

Citations List

Figure A-8 shows the citations list view. This view lists all the citations and their basic information. Similar to the reports list view, this view has options to synchronize, submit and delete reports. The behavior of this options is the same as in the reports list view. In addition, given that it might be necessary to duplicate a citation, there is an option to clone a citation and its content. The cloning functionality includes the cloning of the list of offenses, pictures and everything linked to a citation. When the "Add Citation" button is clicked or when one of the citations is selected, a view that allows to fill in information about the defendant and the vehicle.is displayed. Also, if the citation is linked to a crash report, information of vehicles and occupants can be used to auto-populate the citation information.

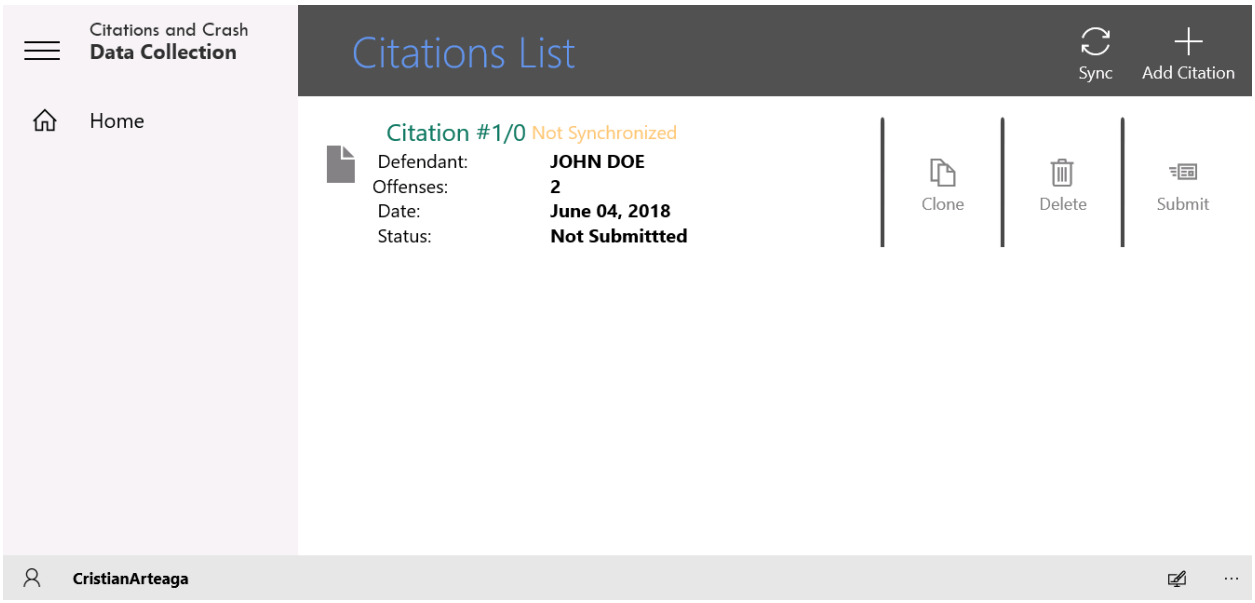

Figure A-8. Citations List View

Offenses List

When a citation is created, there must be a list of offenses supporting the reason to create the citation. One or many offenses can be added to a citation. The information related to an offense include the code and number of the statute or law that was broken and a description of what the police officer witnessed. At least one offense must be added in order for the citation to be valid. Figure A-9 illustrates the offenses list view in the system.

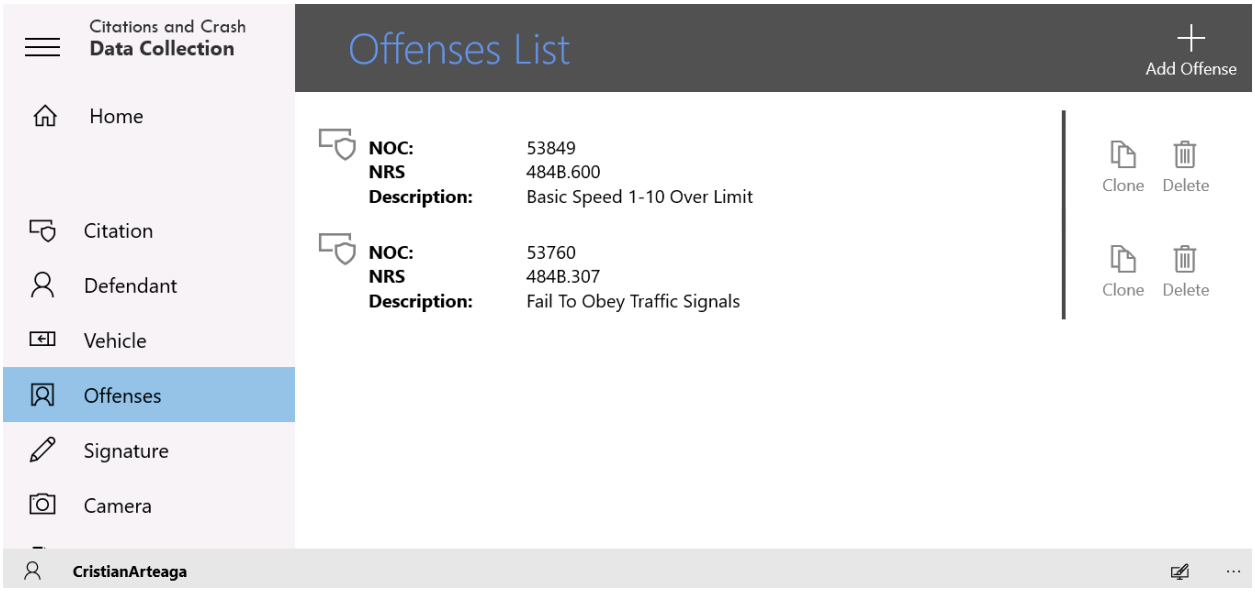

Figure A-9. Offenses List View

Defendant Signature

Once the citation is filled, the defendant must sign the citation in order for it to valid. Figure A-10 illustrates the view that allows to do it in the system.

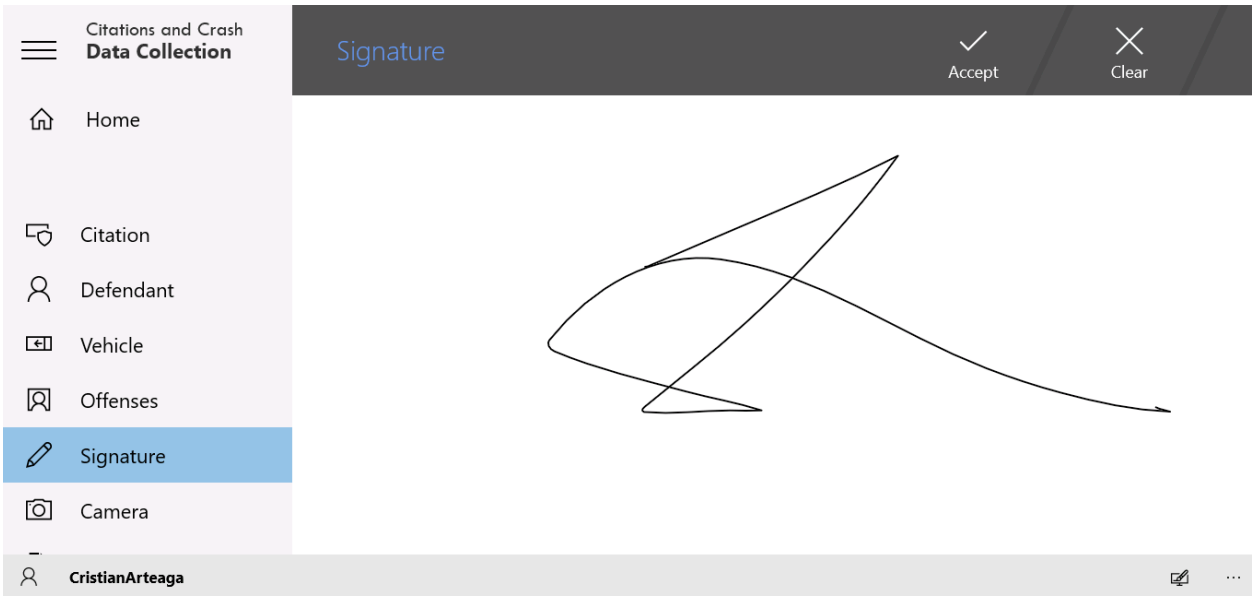

Figure A-10. Defendant Signature for Citation

Print Citation

Figure A-11 shows the citation print view. When the police officer completes the process of filling in the citation, the print button can be used to show a print preview before sending the citation to the printer. The final printable version of the citation includes a summary of the citation basic data, the defendant, the vehicle and the list of offenses. Also, at the end the signature of the defendant and the police officer are included. The print functionality uses the default printer configured in the system. This and other options can be changed from the print preview.

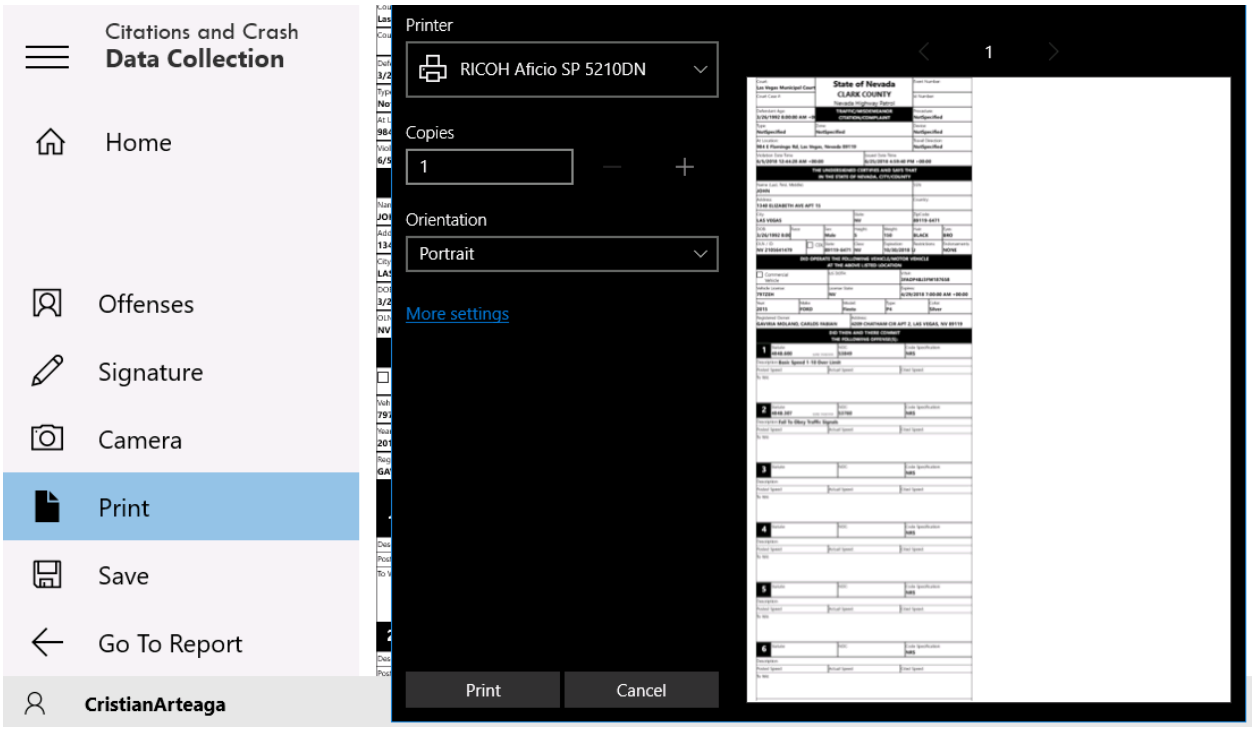

Figure A-11. Citation Print View