SmARt Car*

An application fully adapted and integrated to the car

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ABSTRACT
SmARt Car is an augmented reality application meant to be integrated to a car in order to ease the interaction of the driver with the tools usually found in a car.

It is made of several tools (GPS, tachometer, ...) gathered on the windshield of the car. The utility of *smARt Car* is twofold: providing to the driver an easy natural way to control the tools, getting information from them and understanding them in context, and reducing the amount of attention needed to use these tools.

Therefore, asking for directions and following them, monitoring the speed of the car, controlling music or getting information about the surroundings will become natural and will enhance the experience of the user as a driver, beyond the plain objective of getting from a point to another one.

Categories and Subject Descriptors
H.5.1 [**Information interfaces and presentation**]: Multimedia information systems: Artificial, augmented, and virtual realities; Audio input/output

General Terms
Human Factors

Keywords
Virtual Environments, Car, Transport, GPS, Traffic

1. INTRODUCTION
Nowadays, a lot of tools are present in cars (GPS, dashboard, ...) but the interfaces are independent and thus require the driver to pay less attention to the road in order to use all these systems at a time. Operating these multitude of interfaces while driving a car is not only a hassle but can also be quite dangerous. Furthermore, these tools are not always integrated to the car and dramatic improvements can be done to display information in the most efficient way and interact with these systems.

Thus, *SmARt Car* is an application designed as an augmented reality windscreen to be used in cars. The aim is to display all these interfaces on the windscreen to allow the driver to have an easy access to information while driving without loss of attention. Another important point is that the GPS will display instructions and other information (traffic jam, points of interest, ...) in the real world. The main technologies to achieve this are the head-mounted display, where the user wears a helmet adding virtual elements to its view, or the projector. The application we will present here is a prototype built for iOS, since most people use car-related applications on their mobile phones.

The prime feature of this interface is to overlay the view through the windscreen with a non-obtrusive natural user interface. The information displayed are data like the speed, the route to be taken, music to be played and information about nearby locations. At the same time the cues are as natural as possible to limit any form of distraction to the user. This is why social content like messages or pictures are out of context here. The application focuses on navigation, finding people, finding places and information about these places, without flooding the windscreen with superfluous data.

2. RELATED WORK
Several studies have already been made on car-based interfaces, and more specifically on augmented-reality technologies for drivers.

Last year, Pioneer commercialized a car navigation system working with head-up display projecting augmented reality information on the windscreen. There are several features in addition to navigation, such as informing on traffic or speed limits.[1]

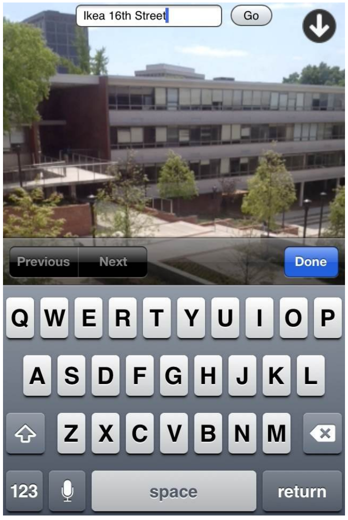

Figure 1: Search for a direction

Works have also been led on the split-attention effect and how it can be used to enhance learning by reducing cognitive load thanks to text and diagrams linking different sources of information.[2]

Since older people have more problems with spatial representation and are more easily distracted, a wind-shield application giving contextual information for navigation like our one was expected to be of great help. Simulations show that errors of navigation and dangerous behaviors have dramatically decreased thanks to the application, and a vast majority of the subjects prefer it to GPS-based navigation, with a slightly more important preference from elders.[4]

A paradigm and a framework to acquire orientation and position data, and to display navigation information in an AR-view have also been developed ten years ago.[5]

One issue in AR systems is the burden involved by a heads-up display for instance. An AR interface integrated to the windshield of a car for ease of use and freedom of movements has already been developed, which is strongly related to our study.[6]

Very recently, DAARIA (Driver Assistance by Augmented Reality for Intelligent Automotive), an augmented reality informing the driver of this behavior and of the hazards on the road, has been developed. Depending on the situation and of the attention of the driver, all information are not displayed.[3]

Also, since controlling the car for activities other than driving is very distracting,a study has shown how to deal with other ways for Human-Machine Interfaces, based on controlling devices with speech and gestures from head and hands, and having feedback with sound. Both tests and surveys prove that these kind of interactions are less distractive and more intuitive than haptic ones.[7]

Quite recently, causes and types of accidents have been analyzed to decide how augmented reality could help with safety. Some solutions are displaying the dashboard on the windscreen, recognizing pedestrians, informing of the distance with another vehicle or indicating its speed.[8]

Last but not least, a simulated AR (augmented reality) personal navigation device (PND) using a heads-up display has been compared with two classical PNDs: one street view-based and one map-based, from the viewpoint of driving performance. Naturally, subjects preferred the AR PND, and results showed that drivers spent really more time watching the road and drove better. Another explanation, in addition to the heads-up display, is that virtual images are harder to analyze than reality.[9]

3. OBJECTIVES

The main objective is to build a GPS displaying instructions in the real world. Therefore, indications have to be located at changes of direction and point towards the road to take. This minimal interface allows drivers to know the route at first sight and reduces the amount of information needed since they do not have to be informed before that they will have to change direction.
All along the route, we want places of interest (historical places, facilities, ...) to be located with a summary and to display detailed information by clicking them.
Also, users have to be informed of bad traffic conditions. All these data must be complete and provide the driver with everything he might need, but with no superfluous information.

In addition of these goals, optional objectives have also been set for this application. They have not been implemented in this prototype but would have to be included in a complete version.
First, speech feedback would be a huge benefit for our system, since it would less distract the driver and help saving place on the windscreen. The speech feedback could concern GPS instructions, but also the places of interest since their description can encumber the view of the user.
Also, a tachometer should be included in the dashboard, which is not relevant here since we do not have a car to

Figure 2: The pointer points towards the next step

test this feature. Music control should also be part of the dashboard since many accidents are caused by this kind of manipulation.
Another additional aim is to display weather warnings. Naturally, usual data like the temperature could be part of the dashboard.
Finally, information about places your friends checked into, ratings and reviews of places would be the next step, but this feature is one of the most delicate to build efficiently since social content is very distractive and is often mighty.

4. SOFTWARE, LANGUAGES & APIS

Our prototype is based on Argon, an augmented reality web browser developed by the Augmented Environments Lab at the Georgia Institute of Technology. One of its very interesting features is to track images to add virtual content to them, but we did not use this feature. Since Argon is a web browser, the languages to use are HTML5, CSS3, JavaScript and KML (Keyhole Markup Language). We mostly worked with JavaScript.

We also use different APIs to retrieve the data needed. The most important one is Google Directions API (`developers.google.com/maps/documentation/directions/`) since it provides us the information for the travel. The places of departure and arrival (coordinates or name of the town) are sent and the instructions as well as their coordinates are retrieved.

Places of interest are given by the GeoNames API (`http://api.geonames.org/`) and especially by the Wikipedia Search service (`www.geonames.org/export/wikipedia-webservice.html#wikipediaSearch`). Once the coordinates, the radius in kilometers and the number of results desired sent, an XML or a JSON file is retrieved (we decided to work with JSON files). For each place of interest, we need its coordinates and a Wikipedia summary.

Finally, in order to give to the user information about the traffic, we use the Microsoft Developer Network Traffic API (`msdn.microsoft.com/en-us/library/hh441725.aspx`). The only parameter we give to the API is the area (two latitudes and two longitudes), the answer is a list of traffic accidents in an XML or a JSON file (we decided to work with JSON files as well). There are optional parameters like the severity of the accident or its type. For each traffic accident, we retrieve its description and the detour proposed if there is one.

5. IMPLEMENTATION

The application we developed leverages the advancements in mobile augmented reality brought to iOS devices by the Argon framework. The application we developed is simply an html page with embedded javascript. The application communicates with the different Argon related tasks via javascript. The application initializes Argon and generates a simple form for the user to enter the destination address into. Once the destination address is obtained a call to Google maps API is made that returns the route to take to the final destination. Behind the scenes Argon uses a javascript framework called Three.js for all the 3D authoring and rendering. We register an arrow shaped 3D object with Three to point to the users next waypoint. This intuitively provides turn by turn navigation to the user without consuming too much screen estate and without extraneous distractions. Further a call is made to the GeoNames API that provides our application with information about places of interest on the userÕs route. These places of interests appear as billboards on the display each billboard being located at the latitude and longitude coordinates of each place. This provides an effective overlay over the natural world allowing the user to obtain more information without any form of input which may be difficult while driving. The application also currently displays detailed information about the nearest place of interest from the user so that they can decide to visit it, should this information peak their interest. At the time of our development Argon was still in Beta making the implementation of this application very frustrating owing to frequent crashes. Some of the initial thought out features had to be dropped because of the current limitations of Argon.

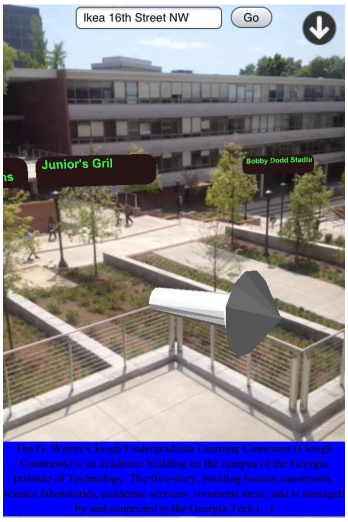

Figure 3: The summary closest point of interest is displayed

6. RESULTS & DISCUSSION

A lot of the initial work revolved around augmenting the road with 3D markers showing the direction the user. Unfortunately, due to lack of sufficient development on that front and since we did not obtain the look and feel we wanted that idea had to be dropped replacing it now with an arrow pointing in the direction to go to. We started with the idea to allow touch interactions with the environment but testing the concept in actual cars showed that such an interaction is difficult to follow through especially while driving.

The choice of Argon for developing this project has turned out to be a blessing as well as a curse. On one hand Argon makes the task of authoring 3D content over the real world quite hassle free, but on the other we lose access to native APIs which could have made the project more suited for daily use. For example one of our goals after the initial setbacks was to allow complete hands-free interaction with our application by using the native speech detection APIs. Unfortunately, this feature is yet to become a part of Argon.

The initial feedback from possible users about the idea and current implementation of the application has been quite encouraging. The application provided information that the users werenÕt aware of in the past and the contextual nature of this information made it easier for the users to follow it if interested or ignore if not. A lot of users made suggestions for future improvement of the application that would make it suitable for practical use. Some of these are mentioned below under Possible Improvements.

7. CONCLUSION

SmARt Car is an application built around the future of having cars with display embedded windscreens. *SmARt Car* is a prototype application that provides navigational directions, augmented information about the environment and facilitates discovery of new and interesting places. The application was developed atop the Argon web browser and leverages Google Maps and GeoNames API for obtaining data about interesting content to display to the user. The application provides the user with turn by turn directions with minimal invasion of sight or hearing. Places of interest are tagged for the user to discover and perhaps visit if details about a place catch the eye of the user. Feedback about the application shows that users can benefit from the context based information and can be used as a means of discovering new places.

8. POSSIBLE IMPROVEMENTS

Since this application is meant to be integrated to a car, several features should be added for the version to be complete. They were not present in our prototype because Argon does not provide facilities for them. Also, *SmARt Car* should be practically deployed and tested with a semi-transparent display since it is built in order to be integrated to a windshield.

First, the driver should have the possibility to have the route drawn on the ground. Indeed, it would help him to stay on the right road and would prevent him from misunderstanding instructions, for instance where two roads are closed. It could also inform the user of the sense of the roads, so that he knows early which ones he can drive on and which he cannot.
Another feature which is very important to us is the speech recognition. Making the user speak to control the system instead of using his hands to click or to write, especially to indicate a destination, would require less of his concentration, making our application safer. For what concerns the interface, it would also be natural and easier to use, which is a non-negligible advantage, especially in virtual environments which one aim is to extend reality in a natural way.
Finally, hand-free phoning will have to be in the complete version. Since phoning requires a lot of attention, dialing on the windscreen and phoning without holding a cellphone is a feature that cannot be missed. The final objective would be to combine speech recognition and hand-free phoning. Therefore, the driver would be allowed to dial, to call someone in his repertory or to send SMS and e-mails simply by speaking. We believe that it would be a huge breakthrough in road safety as well as human-computer interaction.

9. ACKNOWLEDGMENTS

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