Cross-Cultural Differences in the Use of In-vehicle Technologies and Vehicle Area Network Services: Austria, USA, and South Korea

Myounghoon Jeon
Michigan Technological University
1400 Townsend Dr Houghton
MI 49931 USA
mjeon@mtu.edu

Andreas Riener
Johannes Kepler University Linz
Altenberger Strasse 69
4040 Linz, Austria
riener@pervasive.jku.at

Ju-Hwan Lee
Korean German Institute of Technology
661 Deungchondong Gangseogu
Seoul, 157-030, South Korea
jhlee@kgit.ac.kr

Jonathan Schuett
Georgia Institute of Technology
654 Cherry Street Atlanta
GA 30332 USA
jschuett6@gatech.edu

Bruce N. Walker
Georgia Institute of Technology
654 Cherry Street Atlanta
GA 30332 USA
bruce.walker@psych.gatech.edu

ABSTRACT
Vehicle area network (VAN) communications and related services are getting more pervasive [1]. However, even though user-centered design has been emphasized, VAN services have often been developed through a technology-driven approach. This paper presents cross-cultural survey results on VAN services in three different countries: Austria, USA, and South Korea. The current research compared the state-of-the-art of drivers' current in-vehicle technology use and investigated their needs and wants for plausible new services in the near future. Further, we validated our next generation in-vehicle interface concepts stemming from our previous participatory design process [2]. Results showed clear differences between Austrians vs. Americans and Koreans. Even though Koreans and Americans in our survey were older than Austrians, they seemed more open-minded to VAN services (e.g., social networks in car, V2V services, in-vehicle agent, etc) in general and rated them more positively. Through these cross-cultural needs analyses of end users, designers and practitioners are expected to gain insights into developing a standardized service across cultures as well as culturally tuned in-vehicle interfaces. Moreover, we hope that this initial international collaboration can serve as a good test bed for future research and hope to expand our consortium with more colleagues in the AutomotiveUI community for further cross-cultural studies.

Categories and Subject Descriptors
H.1.2 [**Models and Principles**] User/Machine Systems – Human factors.

H.5.2. **[Information Interfaces and Presentation (e.g., HCI)]**: User Interfaces – Benchmarking, Interaction Styles (e.g., commands, menus, forms, direct manipulation), User-Centered Design

General Terms
Design, Human Factors

Keywords
Cross-cultural differences; in-vehicle agents; next generation in-vehicle interfaces; social network services; VAN (vehicle area network)

1. INTRODUCTION
Two decades ago, Mark Weiser coined a new concept, "ubiquitous computing" [3] for the shape of future computing beyond a desktop, and now we are living in the real ubiquitous computing era. Thanks to the rapid advance of technologies, ubiquitous computing has become pervasive even in the dynamic environment (e.g., in-car or in-plane) as well as the static environment (e.g., smart home or smart display in stores). This change was accelerated with the introduction of smart phones. However, in-vehicle technologies may be even more powerful and could also leverage the use of smart phones, giving drivers great potential to augment their lives even further. Specifically, in-vehicle technologies are able to (1) provide location-based services, by reflecting speedy movement, (2) store, process, and retrieve bigger, complex data just as desktops do, and (3) afford a more private office – on – the – move [4] that the mobile phones alone are not able to provide.

Networking has enabled all of those seamless services.

Telematics systems are connected to the central server and navigation devices now get real-time traffic information. Research has shown that people can remotely control functions of the vehicle by means of Bluetooth or cellular services [5] and various car issues can be monitored through wireless networks [6]. A case study of the concept car has also shown a possibility of the connection between the in-vehicle interface and home networks [7]. Given that in-vehicle technologies are getting more complex and complicated, two different approaches are needed. On the one hand, a holistic, systems approach is required in terms of integration and arrangement of all of the services in a full usage flow. On the other hand, an analytic approach is also required in terms of personalization and specialization of all of the interfaces according to user characteristics such as cultural differences. In this light, considerable research on the standardization or personalization of mobile phones based on different cultures has been conducted [e.g., 8, 9]. However, research on cultural differences in the driving domain has focused only on perceptual or motor driving skills [e.g., 10, 11], but little research on interface or service issues has been conducted.

To bridge this gap, the present study surveyed drivers' current usage patterns of in-vehicle technologies, and their needs and preferences about near future vehicle area network services across three countries: Austria in Western Europe, the USA in North America, and Korea in Eastern Asia.

2. BACKGROUND

2.1 ENGIN Project

This research is a part of the ENGIN (Exploring Next Generation IN-vehicle Interfaces) [2] project, which was launched to systematically explore the integration of new features in cars. In the first phase of the project, in order to create a blueprint for the next generation of in-vehicle user interfaces, we adopted an iterative participatory design process: brainstorming, drawing affinity diagrams, conducting focus groups, and hosting expert panel sessions. Through these multifaceted sessions, we obtained balanced data about technology trends and feasibility, young drivers' wants and needs, and Human Factors/HCI experts' guidelines and considerations. However, these sessions were conducted only in the USA and might not be generalized across countries. Therefore, in the current stage of the project, we constituted an international consortium across three countries and extended our user populations with a focus on vehicle area network services. Three institutes participated in this effort: Johannes Kepler University Linz in Austria, Georgia Institute of Technology in the USA, and the Korean-German Institute of Technology in Korea.

2.2 VAN Service Concepts

In addition to the results of those iterative participatory studies in the ENGIN project, through more discussions within our new research consortium, we polished up the VAN service concepts and scenarios that were used in the current survey Part 3 (see Table 1). Most of the addressed concepts and technologies were based on research prototypes, but some of them have since appeared on the market. VAN service concepts could largely be classified into four categories: V2I: Vehicle-to-Infrastructure, V2V: Vehicle-to-Vehicle, V2B: Vehicle-to-Business, and IV: Intelligent Vehicle [1].

Table 1. Vehicle Area Networks Service Concept Scenarios

Concept 1 (V2I) Intelligent Traffic Guide: In-car system uses the GPS and telemetry to provide periodic information about the road and traffic signs and warns the driver of any possible violations or danger.
Concept 2 (V2V) Awareness of Others & Their Intentions: Drivers can share navigation information with the other vehicles around them, such as changes in routes or upcoming turns. This would alert drivers of potential sudden changes in surrounding traffic. This leads to better prediction of other drivers' behavior.
Concept 3 (V2I) Free Parking Slot/ Parked Car Finder: Drivers can get a map from the server for the location of vacant slots and navigate to the location. Every parking slot has sensors and signals to the server whether it is occupied or not. Also, the system can guide drivers to their parking slot later.
Concept 4 (IV&V2I) Sensory Bubble: Car sensors sense and alert external conditions such as temperature, ice, or wet roads; and proximity of objects or other cars.
Concept 5 (V2B) Drive-by-Payments: Drivers can get simply approved payments for fast food, meter parking, gas, and more through their vehicle's interface.
Concept 6 (IV&V2B) In-Vehicle Driver Status Monitor: In-car system detects a driver's heart rate (e.g., using steering wheel), fatigue, or emotional state (camera and speech recognition), and mitigate those effects and/or send data to their doctor on a regular basis.
Concept 7 (IV) Route Buddy: The in-vehicle system learns drivers' route preferences and warns drivers about previous mistakes (speeding tickets received, potholes hit etc.).
Concept 8 (V2B) Home Networking: Drivers can control, reserve, and monitor home appliances with standardized, optimized user interfaces in car.
Concept 9 (V2V & V2B) Entertainment on Demand: Drivers can be free with their stacks of DVDs, download and resume audio/video files from their HDD or home server.
Concept 10 (V2B) Nomadic Workstation: Business professionals can access work information on the move. They can connect their office PC, smart phone, in-vehicle system, and any web-based work data in their car.
Concept 11 (V2V) Drivers' Networking: Drivers can give and take various information such as POI, movies, and music files.
Concept 12 (IV) Collaborative Driving: Passengers or an in-vehicle agent can share the control of in-vehicle system, navigate together, and share their views and information with others.
Concept 13 (V2I) Ambient Awareness Ads: Drivers can get direct custom infomercial (information + commercial) intended to suit their situations. Targeted promotions/services will be flown into a driver's car directly from nearby stores. The driver can also order foods in advance, make a reservation for hotels, and check availability in inventory on the way.
Concept 14 (V2B) Broadcast Your Driving Environment: Drivers can realtime-broadcast their environment so that other drivers can avoid routes where accident, construction, unexpected traffic jam occurred. Or they can publish a realtime-recorded scenic view using outer cameras to public (e.g., website or SNS).
Concept 15 (IV) Green Speedometer: Visual speedometer or auditory display can indicate driver's economical driving. Peripheral auditory display of traffic: Drivers can listen to the trend or pattern of traffic around them with aesthetical sound.
Concept 16 (IV) Driver-Vehicle Confluence: The human operator and the technical system vehicle are increasingly merging into a single unit. The car implicitly recognizes the behavior and condition of the driver (e.g., movement, stress levels, fatigue, communication behavior, stored history, etc.), infers what the driver wants, and reacts accordingly (e.g., adjust air-conditioning system, control car stereo, increase/decrease volume, turn off the phone). All this is done proactively, without involving the driver or asking for explicit actions from him/her. If the system detects deviations in the driven route, the vehicle could intervene (apply brakes, change the lane) or warn the driver.

3. SURVEY PROCEDURE

3.1 Participants

Across three countries, volunteer participants were recruited by word of mouth sample. In total, 205 participants answered the full (3 parts) survey (139 Austrians, 1 Hungarian; 29 Americans; 36 Koreans). Most of the participants were graduate or undergraduate students in three technological universities and their majors were related to information technology, media, or computer science. In addition, some of their family members participated. All of the participants were assured of anonymity and confidentiality of their responses.

3.2 Survey Instrument

The survey had three subparts: demographic and driving information (Part 1), current in-vehicle technology use (Part 2), and VAN service concept evaluations (Part 3). We hypothesized that current driving style or usage of in-vehicle technologies would predict preferences about near-future in-vehicle technologies.

The English version was created, reviewed, and iteratively updated by all of the consortium members, who are all authors of the current paper. Then, the survey was translated into German and Korean by a researcher in each country. After several pilots using a test URL, we finalized our website, http://www.pervasive.jku.at/VAN-Survey/, which provided an introduction to the project and served as a gateway to the three different language versions. Answering the survey took less than 30 minutes on average.

3.2.1 Part 1: Demographic & Driving Information

Part 1 consisted of 18 questions about country of origin, age, gender, years of driving experience and type of driving experience, annual driving mileage, vehicle ownership, types of transmission and engine, main purpose of the use of car, driving environment (time and location), car pooling, and attitudes about different driving situations.

3.2.2 Part 2: Current Use of In-vehicle Technologies

Part 2 consisted of 20 questions about current in-car usage of mobile devices and social network services (SNS), preferred interface type and in-vehicle controllers, desired apps, in-vehicle agents, and attitudes and concerns about vehicle-to-vehicle communications.

3.2.3 Part 3: VAN Service Concept Ratings

Part 3 collected participants' ratings on the 16 new VAN service concepts stemming from our previous research with 5 point Likert type scales (see Table 1).

4. SURVEY RESULTS & DISCUSSION

4.1 Demographic & Driving Information

Basic demographics are presented in Table 2. There were more Austrian respondents (A: 68%) than the other two countries (U: 14%, K: 18%). There were more male respondents than female respondents in Austria (85%:15%) and Korea (66.6%:33.3%), but more females in the USA (31%:69%). On average, Austrian (25) participants were much younger than Americans (37) or Koreans (35). Americans' years of driving (21.9) were much longer than the other two (A: 6.8, K: 9). This difference may be because in the USA, drivers may start at around 16 years of age.

The majority of participants labeled themselves as an experienced driver (A: 67.6%, U: 96.6%, K: 50%), but interestingly, 26.6% of Austrians categorized themselves as an expert driver and 33% of Korean categorized themselves as a novice driver. The distribution in their responses to yearly driving miles showed that even though Koreans have more years of driving experience on average, the largest portion of them had lower average miles than Austrians (see Figure 1). This may be because there is a good public transportation system in Korea.

Table 2. Demographic and basic driving information

	Austria	USA	Korea
N	140	29	36
Gender	M 118 F 21	M 9 F 20	M 24 F 12
Age (*Mean*±SD)	25 (19-42) ± 3.8	37 (22-63) ± 14	35 (23-53) ± 8
Driving Experience (*Mean*±SD)	6.8±3.6	21.9±14.5	9±8
Driving Hours/ Week (*Mean*±SD)	4.9±4.8	6.6±3.9	6±6

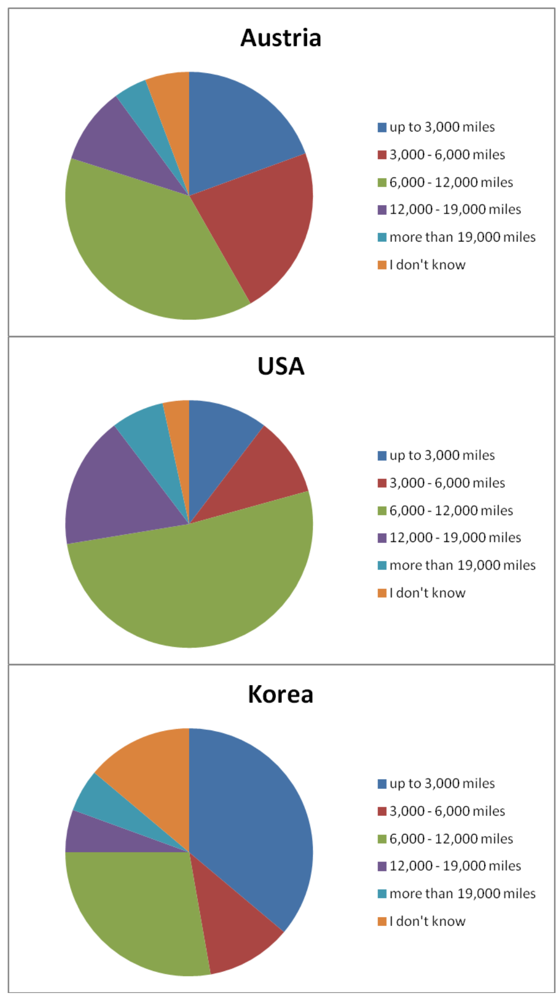

Figure 1. Miles per yearly driving

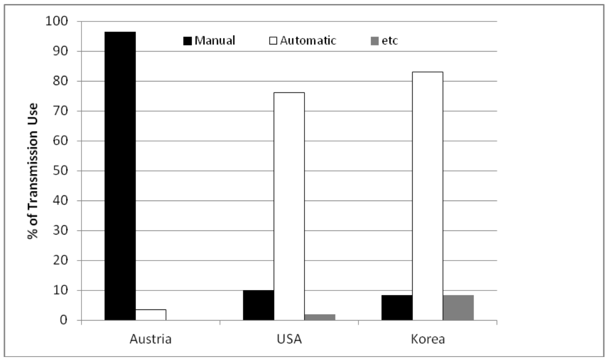

Figure 2. Transmission Type

Regarding the ownership of the car, the portion of 'own car' was largest (A: 65%, U: 82.8%, K: 50%) and Americans showed the highest number among them, followed by 'family car' (A: 31.7%, U: 6.9%, K: 36%).

One of the most salient differences among countries came from the type of transmission (see Figure 2). 96 % of Austrians used manual, whereas 75.9 % of Americans and 83% of Koreans used automatic transmission. Although this specific finding itself is not unexpected, the implication it has on the driving style might affect their current and future use (or perception) of in-vehicle technologies. The engine type was also different across countries. In Austria, 53% used diesel and 45% used gasoline. In the USA, 93% used gasoline, but no diesel. In Korea, 58% used gasoline, 19% diesel, and 14% natural gas. Across countries, there was no response for hybrid or electric car except that two Americans used a hybrid car. The difference of the engine type may come from driver's personality or lifestyle rather than cultural differences. Hybrids or electric cars are relatively new, making them more expensive and less likely to be owned by college aged drivers. However, note that regarding this question, we found that there might be some translation issues.

For the main purpose of using a car, the top response was 'to commute' (A: 54.7%, U: 48%, K: 36%). Second, Austrians (26.6%) and Koreans (27.8%) answered 'leisure or vacation', whereas Americans (27.6%) answered 'shopping'. The third answer of Austrians and Koreans was also 'shopping' and the third answer of Americans was 'leisure or vacation'. Therefore, across countries, in-vehicle services could commonly aim at these three main purposes of the car use. Depending on a driver's goal, their needs and wants may be different. For example, their psychological states such as cognitive resources or emotions might be different in each condition. The needed services can also be affected by their driving location or time. The location might vary more than cultural effects and for driving time, the majority of the respondents reported 'no specific time' (A: 74%, U: 51.7%, K: 58%).

Additionally, drivers' capacity and conditions depend heavily on the presence of passenger(s). Passengers can collaborate on a driving task or a secondary task, reduce a driver's workload, or mitigate a driver's affective states. The majority of the respondents answered that they 'sometimes' have one or more passenger(s) (A: 53%, U: 75.9%, K: 44%). Specifically, only a few participants answered 'always' (A: N=1, U: N=0, K: N=2), which tells us that a car is a often private space and thus, the in-vehicle technologies may need to be personalized in terms of not only physical fit, but also entertainment files, navigation setup, phonebook list, etc., just like for smart phones.

Then, how do participants in different countries think about driving with an unfamiliar passenger or car pool? 44.8% of Americans answered that it is good, but they have no experience and 38% of them had an actual experience. Similarly, 55.6% of Koreans thought it is good and 30.6% of them had the experience. In contrast, 66% of Austrians answered that it is good, but only 18% of them had an actual experience of car pool. Given that V2V services include relation to unknown others, this distinction may be a critical predictor for the acceptance rate of V2V services. Interestingly, around 10% of the participants in each country answered that car pool is not desirable.

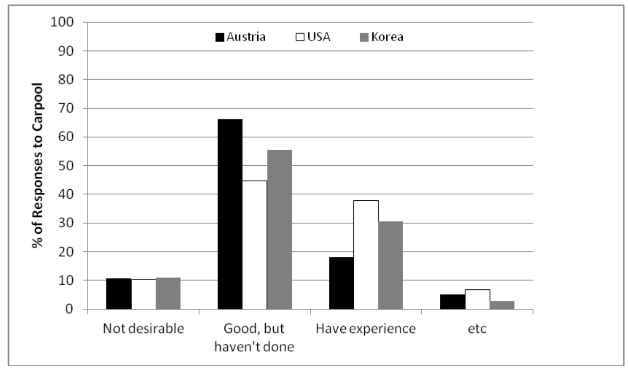

Figure 3. Experience of car pool.

Next, we asked why they do not want to car pool. 85% of Austrians and 52.8% of Koreans answered simply because it is a troublesome duty. There were very rare answers about safety, security, or privacy issues. Surprisingly, Americans mainly answered that it is hard to do because of timing or opportunity issues. From the perspective of VAN services, an easy solution can be provided with a community-based car pool app [e.g., 12].

To investigate cultural differences in relation to others, we asked a couple of questions in the end of Part 1. The first one was a type of Good Samaritan question and the other successive questions were about responses to aggressive driving behavior:

Q17. "What would you most likely do in the following situation? After a long workday, you are driving home alone on a rural road. It is already dark with very little traffic on the road and you see a car at a distance, beside the road, lying upside down. It seems that there are some people in the car."

Austrians and Americans showed similar response patterns to this question. 73% of Austrians answered that they would stop and try to help and 12% of them would call police and wait in the car. 55% of Americans would stop and try to help and 20.7% of them would call police and wait in the car. In contrast, 50% of Koreans answered that they would call police and wait in the car, but only 25% of them answered that they would stop and try to help. This contrast could stem from different social norms or implications. Another plausible cause of the difference might be more in line with legal implications. For example, if the driver got out and tried to help someone but made the situation worse, such as pulling them out of the car if they already had a spinal injury, the helper could receive a lawsuit from either the person he or she tried to help or their insurance company.

Question 18 yielded more similar answers from the three countries. If a car is approaching from behind at a higher speed and wants to pass when they are in the far left lane of the highway, most of the respondents answered that they would change the lane to the right (A: 79%, U: 89.7, K:86%). The last question asked about the opposite case where respondents need to go fast and the car in front of them was moving slowly. 70.5% of Austrians answered that they would not care and slow down. Only 8.6% answered that they would overtake on the right lane. 55% of Americans and 44% of Koreans also answered that they would not care and slow down. However, 34% of Americans and 44% of Koreans answered that they would overtake on the right lane. Based on this, we can cautiously infer that more active communication services may be needed or applied to Americans and Koreans for road safety.

4.2 Current Use of In-vehicle Technologies

The second part of the questionnaire asked people about their current use of in-vehicle technologies and mobile devices as well as their attitude about plausible VAN services.

Mobile Devices and Interfaces: The majority of respondents had their own smart phone (A: 76%, U: 72%, K: 100%). iPhone was the most used across the three countries (Table 3), followed by Nokia (A) or Android (U & K). The use of hands-free devices also showed a similar pattern to the use of smart phones (A: 39%. U: 34%, K: 44%) and Koreans showed a slightly higher portion of hands-free use.

Table 3. Most popular smart phone brands

Austria	iPhone (15.7%)	Nokia (9.3%)	others
USA	iPhone (51.7%)	Android (13.7%)	others
Korea	iPhone (33.3%)	Android (33.3%)	others

Commonly, more participants used navigation devices than hands-free devices. Again, Koreans (75%) showed a slightly higher portion than Austrians (60%) or Americans (62%). The popular navigation brands agreed with the traditional market research. In Europe, TomTom was more popular than other brands, and in the USA, Garmin dominated. Interestingly, 30% of Austrians answered that they use Google Maps as their navigation system. In contrast to Austrians or Americans, Korean people used their own brands (Table 4). This is of particular interest because Korean people used similar brands in smart phones or SNS services to others. Specifically, they chose to use their local brands regarding navigation devices. Regardless of whether it is because of the market preoccupancy or localized services, car manufacturers or aftermarket providers may need to take special care when they try to enter the Korean market. They might want to collaborate with local brands or at least, need to carefully analyze local ones first.

Table 4. Most popular navigation device brands

Austria	TomTom (13%)	Garmin (7%)	others
USA	Garmin (50%)	TomTom (11%)	others
Korea	iNavi (22%)	Gini (22%)	others

The current use of a mobile device connected to the car strongly predicted participants' preference about future VAN service concepts. 39% of Koreans were using their mobile devices connected to the car, but only 20% of Austrians were currently using them in that way. Americans (31%) were in the middle of the two. Across the three countries, iPods or iPhones were the most frequently used mobile devices connected to their car (Table 5).

Table 5. Mobile devices connected to car

Austria	iPods/ iPhones (35.7%)	Other smart phones (39%)	MP3 players (10.7%)
USA	iPods/ iPhones (66.6%)	MP3 players (22%)	others
Korea	iPods/ iPhones (28.5%)	MP3 players (35.7%)	Other smart phones (21%)

Even though drivers use the same iPods or iPhones connected to their car, drivers' preference or choice of the *interface* might be different. When asked about their preference for the use of interfaces, the answers were very different from each other (see Table 6). Austrians preferred using the interfaces of the mobile devices hooked up to in-vehicle systems (52%), whereas Koreans (50%) preferred using in-vehicle systems (not hooked up to mobile devices). Meanwhile, the preference portion was evenly distributed in Americans.

Table 6. Choice of interfaces used in car

Choice of Interfaces	Austria	USA	Korea
Use mobile devices	16.7%	27. 6	8%
Use in-vehicle systems	18%	27.6	**50%**
Use interfaces of the mobile devices hooked up to in-vehicle systems	**52%**	10	19 %
Use interfaces of the in-vehicle systems hooked up to your mobile devices	8%	27. 6	19 %
others	5%	6. 9	2.7%

Social Network Services (SNS): 85% of Americans and 83% of Koreans used social network services (SNS), whereas a slightly lower portion of Austrians (61%) used SNS. Most of the participants used multiple SNS services and Facebook was the most popular SNS services across the three countries (Table 7).

Table 7. Most popular Social Network Services (SNS)

Austria	Facebook (93%)	Google + (20%)	Xing (18%)	Twitter (12%)
USA	Facebook (100%)	Twitter (33%)	Linkedin (8%)	others
Korea	Facebook (93%)	Twitter (40%)	others	

Currently, 26% of Americans used SNS in car, 17% of Koreans also did so, but only 4.6% of Austrians. As an activity regarding SNS in the car, the first answer was passively 'just read and see' (A: 36%, U: 63.6%, K, 47.8%). Given that doing such a secondary task is very dangerous, this answer is not surprising. However, several participants answered that they 'tweet' some traffic updates, which is a type of V2B. One remarkable report was that 34.7% of Koreans answered that they write comments on SNS as well in car. Taken together that Koreans prefer using in-vehicle interfaces and they are likely to do a secondary task such as SNS in car, how to design the in-vehicle user interfaces intuitively and make interaction more safe seems to be particularly critical in the Korean market.

Worst Experiences in a Car: Every in-vehicle service is provided to enhance user (drivers and passengers) experience in a car regardless of whether it is related to networks or not. As a basis for that purpose, we asked about their worst experiences in a car. The top two answers were 'car out of order' (A: 38%, U: 38%, K: 41.7%) and 'driving destination not found' (A: 28%, 31%, K: 47%). If the car status could periodically be checked and updated information could automatically be sent to a database, it would prevent drivers the frustration of a sudden breakdown [7]. For destination finding, much has been improved. The most recent trend in navigation systems includes the live-view GPS navigation (LVN) that adopts context-aware technologies and augmented reality systems [13]. Because the LVN system integrates navigation information and live video onto the same screen, it can merge users' navigation map and cognitive map and thus, help drivers find their destination. As expected, 'locked with key inside' (A: 9%, U: 34%., K: 19%) or 'lost in the parking garage' (A: 8%, U: 10%, K: 16.7%) were also frequently answered options. These problems can also be solved by VAN services. It is certainly possible to remotely start engines as well as unlock and open the car using smart phones through wireless [5]. As can be seen in our VAN service concept 3, we suggested not only a parking lot finder but also a parked car finder.

Technology Use in a Car: Currently, the most pervasive use of technologies in the car involved listening to music, using phones, and navigating (Table 8). Use of technologies mainly focused on secondary tasks (navigation) or tertiary tasks (music or phone), rather than driving tasks. Note that 36% of Koreans answered that they watch video or TV in the car. In fact, watching TV or DMB (Digital Multimedia Broadcasting) in the car is very popular in Korea and most vendors provide that functionality in PNDs or telematics systems (e.g., Hyundai Motors, http://worldwide.hyundai.com/WW/Main/ index.html or iNavi, http://www.inavi.com/). Interestingly, 20.7% of Americans answered that they play a game in the car. People do not yet seem to do office work in the car that much. It is not clear whether this is mainly because people do not want to do office work or the task is inconvenient to do in car, or other reasons.

Table 8. Technology use in a car

Technology Use in Car	Austria	USA	Korea
Listen to music	36.8%	100%	86%
Use phone	40%	86%	55.6%
Navigate with PND or Phone	24%	76%	72%
Watch video/TV	1.7%	3.4%	36%
Play a game	0.86%	20.7%	11%
Office work on laptop	4.3%	3.4%	2.7%
others	0.57%	3.4%	2.7%

When they were asked about an app wish list with an open question, 27.9% of Austrians answered a 'speed trap' and 17.3% answered a 'black box' (i.e., data recorder), 9.3% answered a 'traffic jam warning system', and another 9.3% wanted an 'autopilot'. Other interesting answers included 'head up display' (HUD) (4.7%) and 'tactile feedback in the steering wheel' (3.9%). 20.7% of Americans wanted to have a 'speed trap' and 17% of them wanted to have 'road conditions or traffic information'. 61% of Koreans wanted to have a 'black box' and 13.8% of them wanted to have 'navigation-related apps'.

Driving Controllers: With respect to controllers for driving, most participants turned out to be conservative and wanted to stick to using the traditional ones, pedals, steering wheel, and gearshift (A: 66.7%, U: 65.5%, K: 30.5%). Given that driving is deeply related to the automatized skill set and some people actually enjoy using the current driving controllers, this could be expected. 15% of Austrians were interested in using brain-computer interfaces and Koreans were also interested in other methods (voice: 19%, joystick: 16.7%). However, few participants were interested in gestures (A: 2%, U: 6.9%, K: 8%). Gestures are one of the frequently adopted control methods for in-vehicle touch screen devices, but it might not be appropriate for the driving task.

In-vehicle Agents: As in-vehicle technologies and services are getting complicated, the driving task has been seen as a collaboration, instead of a driver's independent work [7, 14]. In fact, movies have often depicted the future of integrated in-vehicle agents or robots (e.g., 'i-Robot' (2004) or 'Total Recall' (1990)). A number of issues and considerations in designing agents could be related to VAN services. To illustrate, when communicating with other vehicles, drivers can allow each of their agents to interact while they still concentrate on driving itself. When asked to rate an in-vehicle intelligent agent in general with a five point Likert-type scale (1-5), participants gave a positive rating (A: 3.3, U: 3.6, K: 4). For the gender of the agent, participants commonly preferred humanoid over non-humanoid, and preferred female over male (Table 9). There were also several participants who do not have any preference for the gender of the agent.

Table 9. Gender preference of the in-vehicle agent

Gender Type	Austria	USA	Korea
Female	50.7%	27.6%	55.6%
Male	7%	3%	14%
Prefer to think of it as a machine or system (not a humanoid)	14%	10%	11%
No preference	27.5%	58.6%	19%

V2V Communication Services and Concerns: Participants were also asked to rate their general thoughts about vehicle-to-vehicle communications using the same five point Likert-type scales. The results showed that they were generally positive to V2V communications (A: 3.7, U: 3.3, K: 4). Again, Korean people were the most positive of all. For the updating information methods (automatic update when available: push vs. update only when you want: pull), participants preferred in-between those possibilities, that is, specific customization for case by case (A: 45.7%, U: 48.3%, K: 50%) (Table 10). While Austrians generally were more conservative on other issues, around 30% of them preferred automatic update, which is much higher than the others. Koreans showed higher preference for requiring authentication (36%).

Table 10. Updating information methods

Update Information	Austria	USA	Korea
Automatic update	29.7%	13.8%	13.9%
After authentication	18%	20.7%	36%
Specific customization for case by case	**45.7%**	**48.3%**	**50%**
others	6.5%	17%	0%

The top three wish list of information to be shared via V2V communications included road condition (A: 38%, U: 76%, K:

91.6%), navigation (A: 28%, U: 44.8%, K: 47%), and POI information (A: 16%, U: 44.8%, K: 55.5%). Entertainment showed a relatively small portion (A: 6.5%, U: 10%, K: 11%). Participants seemed to prefer sharing driving-related information rather than non-driving data. Other answers included information about radars/police control, car information (speed, how many persons on board; child/elderly on board…), parking space information, braking info (emergency brake), traffic jams, safety relevant information (Austria); "you forgot to turn off your blinker", "your coat is hanging out under the door", etc, (USA); traffic expectation based on route data, measurement of the distance between cars, lane change (Korea).

Austrians considered ‘privacy’ (29%) and ‘security’ (22%) as the most critical barriers for V2V communications, whereas Americans (62%) and Koreans (47%) considered ‘safety’ as the most important factor (Table 11). These differences in drivers’ concerns could/should be reflected in in-vehicle services and interfaces with a different design focus even with the same functionality. Few participants considered network reliability or information reliability as a critical variable for V2V services.

Table 11. Critical concerns regarding V2V communications

Critical Concerns	Austria	USA	Korea
Safety (while control, setup, engage in communications with other cars, driving safety might be reduced)	16.7%	**62%**	**47%**
Security (while communicating with other cars, your key password or ignition information has been leaked)	**22%**	17%	25%
Privacy (while communicating with other cars, your personal picture or phone number has been leaked)	**29%**	17%	8.3%
Network reliability (while communicating with other cars, network is often disconnected)	10.9%	0%	8.3%
Information reliability (navigation, restaurant, etc. information got from other cars is not that accurate to trust or use)	10.9%	0%	11%
others	10%	1%	0%

4.3 Service Concept Ratings

As shown in Table 12, only two service concepts obtained average scores greater than 4, across countries: Concept 1 (V2I) Intelligent Traffic Guide (4.38) and Concept 4 (IV&V2I) Sensory Bubble (4.17). These two concepts are deeply related to the primary task, which is driving itself. It corresponds to the information type that they want to share with other drivers. The third one was also related to the primary task, Concept 3 (V2I) Free Parking Slot/ Parked Car Finder. These results clearly show that drivers are still concerned more about the primary task than other services. In other words, drivers in all three countries are still more interested in technologies that will keep them safer, instead of Facebook updates. Moreover, all of the these three services are V2I, which might indicate that drivers consider vehicle-to-infrastructure services as more important and needed concepts compared to other services.

Concepts C2 (V2V other vehicles intent awareness), C6 (V2B in-vehicle driver status monitor; no country difference), and C14 (V2B Broadcast Driving) attained more than 3 out of 5 on the Likert scale.

When it comes to the differences among countries, each separate one-way ANOVA showed a significant difference in many service concepts (C2, C3, C4, C5, C7, C8, C9, C10, C11, C13, C14, C15, & C16) among the three countries. In particular, Korean drivers generally tended to respond more positively than the other two countries. Overall, it seems that Koreans are open to new in-vehicle services, whereas Austrians are more conservative (or sensitive) to privacy and security issues of in-vehicle technologies. Americans seem to lie between them depending on the case.

Table 12. Mean rating scores with a 5 point Likert scale about VAN service concepts (ANOVA results: * $p < .05$, ** $p < .001$).

Service Concept	Country	Mean	Std. Dev
C1 Intelligent Traffic Guide	Austria	4.34	.94
	USA	4.57	.57
	Korea	4.36	.83
	Total	**4.38**	.88
C2 Awareness of Others & Their Intentions *	Austria	3.21	1.27
	USA	3.75	1.08
	Korea	3.81	1.09
	Total	3.39	1.24
C3 Free Parking Slot/ Parked Car Finder *	Austria	3.60	1.37
	USA	3.57	1.20
	Korea	4.31	0.86
	Total	**3.72**	1.29
C4 Sensory Bubble *	Austria	4.04	1.15
	USA	4.50	0.69
	Korea	4.39	0.87
	Total	**4.17**	1.06
C5 Drive-by-Payments **	Austria	2.23	1.38
	USA	2.89	1.40
	Korea	3.64	1.22
	Total	2.57	1.46
C6 In-vehicle Driver Status Monitor	Austria	3.12	1.30
	USA	2.71	1.36
	Korea	3.39	1.23
	Total	3.11	1.29
C7 Route Buddy **	Austria	2.69	1.38
	USA	3.32	1.34
	Korea	3.89	1.14
	Total	2.99	1.41
C8 Home Networking **	Austria	2.16	1.40
	USA	2.68	1.22
	Korea	3.33	1.20
	Total	2.43	1.41
C9 Entertainment on Demand **	Austria	2.40	1.44
	USA	2.75	1.32
	Korea	4.14	1.07
	Total	2.75	1.51
C10 Nomadic Workstation **	Austria	2.35	1.34
	USA	2.68	1.19
	Korea	3.47	1.30
	Total	2.60	1.37
C11 Drivers’ Networking **	Austria	2.64	1.29
	USA	2.25	1.24
	Korea	3.44	0.94
	Total	2.73	1.28
C12 Collaborative Driving	Austria	2.65	1.35
	USA	2.36	1.34
	Korea	3.03	1.06
	Total	2.69	1.31
C13 Ambient Awareness Ads *	Austria	2.14	1.15
	USA	2.00	1.05
	Korea	2.67	1.20
	Total	2.21	1.16

C14 Broadcast Your Driving Environment *	Austria	3.04	1.37
	USA	3.57	1.35
	Korea	3.86	0.99
	Total	3.26	1.34
C15 Green Speedometer *	Austria	2.96	1.31
	USA	3.25	1.27
	Korea	3.56	1.11
	Total	3.10	1.29
C16 Driver-Vehicle Confluence *	Austria	2.88	1.37
	USA	2.64	1.57
	Korea	3.50	1.21
	Total	2.96	1.39

5. CONCLUSION & FUTURE WORKS

This study hypothesized that the use of in-vehicle technologies and their needs for the use of VAN services in the near future could be different based on their culture or nationality. Research has shown that there might be cultural differences responsible for traffic accidents [16]. This also coincides with the study [15] which provided evidence that some factors such as aggressive violations are sensitive to the social context. The results of their study indicated that each country has its own problems in its traffic culture in addition to global problems like speeding. Therefore, pan-cultural regulations should also take into account the “local” characteristics and requirements.

As a result of our survey, we found some interesting differences. Austrians were more conservative to the use of in-vehicle technologies and were more concerned about their privacy, whereas Americans or Koreans seemed to be more progressive to the use of in-vehicle technologies even though there were also some interesting differences between them. Merely asking users may not be the best way to design a good service or interface, but we believe that we could, at least, learn how to avoid the worst scenario. This effort is expected to have substantial implications for designing culturally adapted interfaces as well as a standardized service protocol, or even a car itself that works for all.

Despite the successful initial attempt, there were some limitations inherent in the current research. The number of participants in each country was quite different and may not be sufficient to draw a firm conclusion. We are still under data collection and the present paper is a type of summary of initial findings. In addition, the participant groups were mostly graduate or undergraduate students and thus, very homogenous and not representative of all the populations. Therefore, it might be difficult to discover clear differences between cultures. Our next step includes recruiting larger samples with multiple generations and more balanced gender in each country and hopefully, extending our consortium to more diverse cultures and countries.

6. REFERENCES

[1] Faezipour, M., Nourani, M., Safed, A. and Addepalli, S. Progress and challenges in intelligent vehicle area networks. *Communications of the ACM, 55*, 2 (2012), 90–100.

[2] Jeon, M., Schuett, J., Yim, J.-B., Raman, P. and Walker, B. N. ENGIN (Exploring Next Generation IN-vehicle INterfaces): Drawing a new conceptual framework through iterative participatory processes. *Adjunct Proceedings of the 3rd International Conference on Automotive User Interfaces and Vehicular Applications (AutomotiveUI'11)* (2011).

[3] Weiser, M. The computer for the twenty-first century. *Scientific American*, September (1991), 94-104.

[4] Sodhi, M., Cohen, J. and Kirschenbaum, S. Multi-modal vehicle display design and analysis, University of Rhode Island Transportation Center, Kingston, RI, USA, A study conducted in cooperation with US DOT. <http://www.uritc.uri.edu/media/finalreportspdf/536103.pdf> (2004).

[5] Wright, A. Hacking cars. *Communications of the ACM, 54*, 11 (2011), 18-19.

[6] Rouf, I. et al. Security and privacy vulnerabilities of in-car wireless networks: A tire pressure monitoring system case study. *Proceedings of the 19th USENIX Security Symposium* (2010).

[7] Jeon, M. "i-PASSION": A concept car user interface case study from the perspective of user experience design. *Proceedings of the 2nd International Conference on Automotive User Interfaces and Vehicular Applications (AutomotiveUI'10)* (2010).

[8] Kim, J. H. and Lee, J. P. Culturally adapted mobile phone interface design: Correlation between categorization style and menu structure. *Proceedings of the 9th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI'07)* (2007).

[9] Dai, H. and Palvi, P. C. Mobile commerce adoption in China and the United States: A cross-cultural study. *The Database for Advances in Information Systems, 40*, 4 (2009), 43-61.

[10] Lajunen, T., Corry, A., Summala, H. and Hartley, L. Cross-cultural diffferences in drivers' self-assessments of their perceptual-motor and safety skills: Australians and finns. *Person. individ. Diff., 24*, 4 (1998), 539-550.

[11] Özkan, T., Lajunen, T., Chilaoutakis, J. E., Parker, D. and Summala, H. Cross-cultural differences in driving skills: A comparison of six countries. *Accident Analysis and Prevention, 38* (2006), 1011-1018.

[12] Carticipate for iPhone, iPod touch, and iPad on the iTunes App Store. Retrieved April 15, 2011, from:http://itunes.apple.com/us/app/carticipate/id285818837?mt=8 (2011).

[13] Huang, J. Y., Tsai, C. H. and Huang, S. T. The next generation of GPS Navigation Systems. *Communications of the ACM, 55*, 3 (2012), 84-93.

[14] Forlizzi, J., Barley, W. C. and Seder, T. Where should I turn? Moving from individual to collaborative navigation strategies to inform the interaction design of future navigation systems. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'10)* (2010), 1261-1270.

[15] Özkan, T. Lajunen, T. Chliaoutakis, J.E., Parker, D. and Summala. H. Cross-cultural differences in driving behaviours: A comparison of six countries, *Transportation Research Part F 9* (2006) 227–242.

[16] Cale. M.H. Cultural Differences and Traffic Accidents, *Presented at the UNECE*, Geneva, September (2011).