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Abstract
<p>This document presents the first report on the work done on Work Package 5 during the first 12 months of the project.</p> <p>The procedures described in this deliverable are aligned with the information already provided in the Description of Action for INLANE (as per Grant Agreement number 687458).</p>

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Abbreviations and Acronyms

Acronym	Definition
GNSS	Global Navigation Satellite System
H2020	Horizon 2020
HD	High Definition
HMI	Human-Machine Interface
WP	Work Package

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1. Executive Summary

This document is the public deliverable D5.1 of the H2020 project entitled *Low Cost GNSS and Computer Vision Fusion for Accurate Lane Level Navigation and Enhanced Automatic Map Generation*, denoted by INLANE. This document reflects the work done during the first year of the project in the Work Package 5 (WP5), entitled *Lane Level Guidance Pilot – User Trials*. More specifically, in tasks T5.1 *Methodology and implementation for user trials*, T5.2 *Site system integration*, and T5.3 *Test & demonstrations with end-users*.

First, this document introduces its purpose, the motivation of end user involvement, the intended audience and the related documentation. Section 3 describes the strategy for user involvement, including planned activities, and details about the informed consent process and the assessment of personal data management. Section 4 reports the activity of the first year inside WP5, which includes field tests with expert users and the design of a user survey. Finally, Section 5 presents the future plans and Section 6 concludes the document.

2. Introduction

2.1 Purpose of Document

The main aim of this deliverable is to describe the progress and outcomes of WP5 during the first year of the project. It also serves as a reference document to know the strategy of INLANE regarding the involvement of users in the project.

This document is also devised to be a working document that gets refined and updated during the lifetime of the project. The final version will be reported in D5.2 (Report on User Trials v2) in the 30th month of the project.

2.2 Motivation of user involvement

A successful product cannot be designed without taking into account the user needs. Several design methodologies have emerged to guide development teams putting the end user in the centre of whole product development cycle. In these user-centred methodologies, once the stakeholders have been identified and an investigation of their needs have been conducted, designers develop new solutions to be evaluated by the users. This process is normally run iteratively until a final solution is found. This approach is also followed in INLANE with the aim of obtaining the following benefits:

- Users can positively influence the design of the solution providing their opinion or insight about the use and acceptance of the proposed technologies.
- User involvement is the guaranty of realistic experimentation conditions. Involving users that are not participating in the project is the only way of assuring an objective feedback when evaluating functional requirements.
- End users can complement the technical evaluation of the system from a different perspective pointing out errors or issues that were ignored by the developers.
- The involvement of users can provide external ideas for refining the setup of experiments.
- The involvement of users can help on understanding the potential impacts of proposed technologies and their perception at societal level. It can also help to detect ethical and privacy issues that could arise from the use of the proposed technologies.
- The involvement of users in the testing can give feedback to the exploitation plan identifying the most promising exploitations.

2.3 Intended Audience

This document is intended to be a reference to all partners involved in WP5. The dissemination level of this deliverable is public. The procedures explained here can also be useful for User Experience practitioners.

2.4 Related documentation

WP5 is directly fed by the outputs of WP1 (functional requirements and use cases) and WP4 (prototypes). It is therefore suggested reading the deliverables generated in WP1 (D1.1) and WP4 (D4.1) before reading this one.

3. Strategy for user involvement

3.1 General strategy

User trials are key elements for testing the final users and validating the development as well as for demonstrating and carrying out dissemination and pre-commercial actions. The main objective of the WP5 is to test and evaluate with large and real pilots the INLANE solution in real conditions and to assess user satisfaction. Breaking down this objective into measurable demonstrations the aim is:

- To have validated the complete system in real test facilities using real platforms, such as the sensor-equipped research platform car available at Honda-RI.
- To have implemented demonstrations on two pilot sites: Barcelona city (Spain) and on DITCM, the test site located between the cities of Helmond and Eindhoven (Netherlands)
- And to have validated the INLANE lane level navigation and enhance map generation in terms of technical performances, reliability, cost effectiveness and service availability.

During the first development cycle, technical expert users recorded several datasets in the DITCM test scenario to test the modules of the first prototype. The Prototype 1 is a high performance platform usable in the car for research but which does not comply with automotive standards. For this prototype, PC like components that are already available within the project team are used. These existing platforms are used for first tests of the developed algorithms. The final results of these tests were obtained in the same month of delivery of this document, so the INLANE consortium is now starting to analyse them to generate the commented methodology that will be ready before starting with the end-user trials. Considering the actual objectives related the evolution of the prototype on its first phase, the use cases that affects and are of interest to the end users for its daily use is limited, due to the technical development.

The methodology followed for this test is explained in **Section 4.1**.

3.2 Planned activities

Beside these are the foreseen planned activities:

USER SURVEY / First quarter of 2017: In order to involve the user point of view in an early stage of the project a survey has been designed and planned to execute during the following months. This survey will feed the development of the INLANE process prior its real test with users. The design process and the questionnaire of this survey are explained in **Section 4.2**. The results will be processed to give a useful feedback to WP1 activities during the first half of 2017.

PHASE TEST 2 / End of 2017: phase 2 test using prototype 2 of INLANE solution. **Prototype 2** will unify the commonalities of the available platforms into one platform and further required components will be added. This will be done probably in DITCM with expert users, and if it is possible in Barcelona with end users. The level of integration reached by this prototype and therefore its capacity to be user-friendly enough for the real users will determine that.

PHASE TEST 3 / First half of 2018. Phase 3 test with end users using prototype 3 of INLANE solution in the city of Barcelona. **Prototype 3** – the result of the INLANE project – will be close to an embedded system and usable in different cars. In version 3, realistic hardware will be used in order to demonstrate that algorithms can run on one embedded platform. No product will be created within project lifetime but a roadmap from INLANE to an automotive product.

A defined sample of end users will be recruited through ACASA-RACC members. The prototype will therefore directly be tested by all these users in the Barcelona-Catalonia area. An ex-ante and post evaluation assessment will be carried out in order to obtain feedback from these users.

The municipality of Barcelona will support this test, in early conversation with the municipality it has been discussed that the following “special scenarios” could be tested in order to leverage the INLANE solution::

- **Ring roads**
 - Checking and guidance in junction/bifurcation lanes
 - Especially nodes that communications roads arrive/departures
 - Checking congestion points
 - In standard working day, weekend
 - Especial event (match football, etc...)
- **Internally, inside city, neighbourhood**
 - Streets temporally closed for specific works (Glòries) or events (football match)
 - Near to school, critical hours

3.3 Informed consent process

Informed consent to the users that will participate in the user trials is one of the key notions of personal data protection. Several General principles must then be taken into account when dealing with personal data:

- The right to access and to rectify collected data.
- The protection of the rights of individuals, and
- The control and protection of these data by an independent national authority.

The following informed consent documents will be produced to ensure a correct procedure:

- Information sheet: Before collecting the consent, the participants must understand the nature of the research and the risks and benefits involved if they are to make an informed decision about their participation. To do so, the document given out to describe the study must be simple and understandable by any subject.
- Letter of consent: Once the participants have been aware of the nature of the study and the risks and benefits involved, a formal consent in the participation to the experiment is required. A specific form will be produced to ensure that the participant has fully understood the specificities of the experiments and agrees to take part in the study. This form also will provide information on the withdrawal procedure; the data collected and encourages the participants to ask further questions to the researcher.
- Withdrawal procedure: As detailed in the informed consent forms, the participant has all the rights to decide at any time during the research that he/she no longer wish to participate in the study, and that he/she can notify the researchers involved and withdraw from it immediately without giving any reason. A specific form will be provided with these purposes.
- Complaint procedure documents: In addition to the feedback collection that will take place during the experiment, the participant will be given the possibility to file a formal complaint on their participation to the study. A complaint procedure information document and a complain form will be provided to the participants:

These documents will be further detailed in the next deliverable.

3.4 Assessment of personal data management

One of the challenges of the project involvement of participants in the user trials is to correctly

understand and assess the type of data that are collected by the experiments, how they are treated, stored, used, communicated and eventually destroyed.

This is important to understand and detect rapidly any potential privacy impact in case personal data would be collected, and any other potential security and ethical issues related to data protection.

To ensure that, the INLANE consortium will follow the following principles

- Informed consent of the concerned persons will be gathered.
- Rights to access, rectify and delete collected data will be provided.
- Rights of the individuals will be protected.
- Data granularity will be limited to what is required.
- Data will be processed locally and unnecessary transmission will be avoided.
- Unnecessary data storage will be avoided.
- Collecting data that would enable the identification of people will be avoided.

In the following deliverable the assessment of personal data management will be further developed.

4. First year activity report

4.1 Tests with expert users

The current status of the in-vehicle system is that all data is recorded using RTMAPS (see D4.1 for more detail) and then processed off-line. Limited on-line experiments have been performed with existing pre-commercial technology (i.e. the basis for the technology developed in INLANE). The conclusion is that additional map info is required to achieve a product-viable lane-based navigation concept (see D3.1 for more detail on the enhanced maps that contain the additional data).



Figure 1: HMI of lane advice functionality.

The current expert workflow consists of several steps that are detailed below.

- Creation of enhanced map database, i.e. TomTom HD maps
 - Based on Mobile Mapping (MoMa) van data.
 - Partly automated processing to obtain HD maps from MoMa data.
 - Currently, requiring expert user inputs.
- Recording experimental data
 - Use in-vehicle setup and RTMAPS to record data.
- Processing experimental data off-line
 - Process experimental in-vehicle data (visual odometry, 3D stereo reconstruction, lane detector).
 - Correlate visual data with HD maps (i.e. with the RoadDNA layer).
 - Obtain lane-accurate positions.
- Simulate the lane advice HMI, see figure 1.
 - Set a reference lane-accurate track manually.
 - Play the estimate lane-accurate track (obtained from in-vehicle data).
 - Display lane advice information

4.2 User survey

In order to involve the user point of view in an early stage of the project a survey has been designed and planned to execute during the following months. This survey will feed the development of the INLANE process prior its real test with users.

The survey has been designed together among the user experience experts of TomTom, VicomTech and ACASA. To carry out this survey an online questionnaire will be used. This questionnaire has the main objective to understand the barriers and the level of acceptance of the future INLANE solution among potential users. Besides the questionnaire also pursue to understand the knowledge of the

user of the GNSS systems.

The questionnaire will be online and will be disseminated through the channel of communication (website, social media, press release) of the RACC the biggest automotive club of Spain using specific designed banners. Therefore a big impact it is expected among its members. Fellow blogs (automotive sector) will be used as well to disseminate the survey. Other consortium partners such as the network ERTICO will be used as well to disseminate the survey.

In order to attract more participants a simple gamification process will be used: one or two TomTom personal navigation device (EG: TomTom GO 520) will be raffled among the participants.

The option of using other automotive clubs of Europe in order to disseminate the target to other European countries will be studied as well.

Survey questionnaire

To fulfil these objectives, the questionnaire has been divided in 4 different clusters.

- A USER PROFILE / DEMOGRAPHICS
- B USE OF NAVIGATION SYSTEMS
- C ACCEPTANCE OF A LANE LEVEL NAVIGATION SYSTEM
- D KNOWLEDGE OF GALILEO AND OTHER GNSS

In order to set the background for the user the following introduction will be used:

We all know the advantages of the vehicle navigation systems, they provide us with reliable guidance, reducing last minute braking or lane changing which avoids accidents and traffic jams and at the end of the day they make drivers being more relaxed. However, there is not available in the market a technology offering the user a lane level accuracy but only a road level. Therefore, the current solutions offer a severe simplification of the road description, implying that the information is not based on vehicle's real position. INLANE project is developing a low cost accurate lane level navigation system and we are asking you to help us designing it.

Below the different questions and possible answers (in brackets) are described:

B USE OF NAVIGATION SYSTEMS

- 1 years of experience using navigation systems
(Absolut value)
- 2 type of navigation systems used
(integrated in car, navigation device (Tom Tom), smartphone application, ...)
- 3 preferences among types
(integrated in car, navigation device (Tom Tom), smartphone application, ...)
- 4 I rely on voice commands when using navigation device
(I strongly disagree, I disagree, neutral, I agree, I strongly agree) 5 scales possible.
- 5 I rely on visual cues when using navigation device
(I strongly disagree, I disagree, neutral, I agree, I strongly agree) 5 scales possible.
- 6 periodicity of use (multiple choice, only choose one)
(every day, few times per week, few times per month, few times per year, ...)
- 7 amount of usage in familiar areas
(always, often, sometimes, seldom, never)
- 8 intensity of usage in familiar areas
(actively rely on device, rely slightly more on device, neutral, rely slightly more on road,

actively rely on road)

- 9 amount of usage in unfamiliar areas
(always, often, sometimes, seldom, never)
- 10 intensity of usage in unfamiliar areas
(actively rely on device, rely slightly more on device, neutral, rely slightly more on road, actively rely on road)
- 11 In familiar areas I focus most on information such as...
(multiple choice of information, such as traffic, routing, traffic rules such as max. speed, ...)
- 12 In unfamiliar areas I focus most on information such as...
(multiple choice of information, such as traffic, routing, traffic rules such as max. speed, ...)
- 13 In familiar areas I miss information such as...
(Tunnels, Traffic light information, Signs, Traffic Jams, dynamic information, etc.)
- 14 In unfamiliar areas I miss information such as...
(Tunnels, Traffic light information, Signs, Traffic Jams, dynamic information, etc.)
- 15 Main annoyance / frustration with current navigation device?
1-5 scale rate (lost of signal, freedom restriction, overload information, data privacy)

D ACCEPTANCE OF A LANE LEVEL NAVIGATION SYSTEM

For this cluster the user can rate the possible answers with:

(strongly disagree, disagree, neutral, agree, strongly agree, not applicable) from questions 1 to 4
(strongly disagree, disagree, neutral, agree, strongly agree) in the question 5

- 1 When you miss an exit on a highway this is due to ...
... The exit instruction being too late
... The fact that you are not sure whether you are positioned in the right lane
... The fact that you are not sure for which exit the instruction is meant (lack of reference points)
... Some form of distraction / not paying attention
... The instruction not being clear
- 2 When you take a wrong lane in a complex highway situation, this is due to ...
... The exit instruction being too late
... The fact that you are not sure whether you are positioned in the right lane
... The fact that you are not sure for which lane/exit the instruction is meant (lack of reference points)
... Some form of distraction / not paying attention
... The instruction not being clear
- 3 When you are in the wrong lane before a traffic light, this due to ...
... The exit instruction being too late
... The fact that you are not sure whether you are in the right lane
... The fact that you are not sure for which lane the instruction is meant (lack of reference points)
... Some form of distraction / not paying attention
... The instruction not being clear
- 4 When you accidentally drive in a wrong lane (e.g. bus lane, opposite direction, etc.) this is due to ...
... The fact that you are not sure for which lane the instruction is meant (lack of reference points)
... Some form of distraction / not paying attention

... The instruction not being clear

- 5 Do you think lane-accurate navigation will ...
- ... make complex highway situations / intersections more comfortable?
 - ... make complex highway situations / intersections safer?
 - ... make complex highway situations / intersections easier?
 - ... make driving in unfamiliar areas more confident?
 - ... make driving in unfamiliar areas more comfortable?
 - ... make driving in unfamiliar areas safer?
 - ... make driving in unfamiliar areas easier?
 - ... make driving in foggy weather easier?
 - ... make it clearer which turn / exit you have to take?
 - ... make you more confident where you can drive and where it is not allowed (closed lane, bus-lane, etc.)
 - ... make you watch more at the navigation device, to see if you are driving correctly?
 - ... decrease unsafe situations where you have to change lane at the last moment?

C KNOWLEDGE OF GALILEO AND OTHER GNSS

For this cluster the user can choose the following possible answers:

(yes/no) from questions 1 to 7

(from 1 to 5- 1 is " I never heard about it", and 5 is " I perfectly know what is it) in the question 7

- 1 Did you know that Galileo is a Global Navigation Satellite system (similar to GPS)?
- 2 Did you know that Galileo is being developed in the European Union?
- 3 Did you know that GPS was created and is maintained by the US government?
- 4 Did you know that the US government can selectively deny access to GPS system? (For instance, deny access to GPS to a whole country)
- 5 Did you know that GPS has some restrictions on civilian use that affect its accuracy?
- 6 Did you know that Galileo allows users to know their position with greater precision than what is offered by other available systems?
- 7 Rate your previous knowledge of the following GNSS systems
-GLONASS, GPS, BEIDOU, GALILEO

5. Future plans

The activity carried out in WP5 during the first year of the project can be summarised in three main points. First of all, we have defined the strategy that will be followed to involve end users in the project. Then, we have defined the methodology and we have tested INLANE's first prototype by technical expert users. Finally, we have designed a user survey to gather end users' opinion and feed functional requirements and use cases. The plan for the following months is to continue and extend the work done during these first months.

The general strategy will be refined and extended and it will include a detailed methodology for conducting the field test trials with end users. In order to define this methodology, it was necessary to wait for the results of the tests with technical expert users. The final results of these tests were obtained in the same month of delivery of this document, so we are now starting to analyse them to generate the commented methodology that will be ready before starting with the end-user trials.

The user survey is already designed and will be conducted the first quarter of 2017. The results will be processed to give a useful feedback to WP1 activities during the first half of 2017.

Regarding the schedule for user trials, there are two iterations planned:

- End of 2017: phase 2 test using prototype 2 of INLANE solution. This will be done probably in DITCM with expert users, and if it is possible in Barcelona with end users.
- First half of 2018: phase 3 test with end users using prototype 3 of INLANE solution in the city of Barcelona.

6. Conclusions

WP5 started its activity on the 9th month of the project and this deliverable is being submitted on the 12th month. Therefore, this deliverable reports preliminary results as we are still in the first cycle and WP5 is expected to show its most valuable results starting the second cycle of development.

We have presented the strategy for end user involvement. It is important to set as soon as possible this strategy or methodology to have a clear view of what is expected to be done the following months, when end users will have a more important role in the project.

We have also presented the workflow that expert users follow to test the first prototypes. This is important to take into account when designing the future tests for non-technical end users. The expert workflow will be automated and transparent for end users, however, the User Experience experts of WP5 need to study all these points in order to create an efficient and useful test set.

With the idea of involving the user point of view in an early stage of the project, we have designed a user survey that will be conducted the first quarter of 2017. The conclusions obtained for this survey will feed WP1 and will be used to refine the functional requirements and use cases.

As explained in previous sections, WP5 is an important piece of INLANE. If we want to develop products that meet user needs, we need to involve them also in the product design and development. We have presented a first approach that will be refined and extended on the next development cycles.