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Augmented Reality Framework (ARF)
Industrial use cases for AR applications and services

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Reference

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group Augmented Reality Framework (ISG ARF).

The ISG ARF shares the following understanding for Augmented Reality: Augmented Reality (AR) is the ability to mix in real-time spatially-registered digital content with the real world. The present document describes the most relevant use cases identified via a survey conducted with the help of an online questionnaire.

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Executive summary

The present document summarizes the results of a questionnaire issued by the Industry Specification Group Augmented Reality Framework (ISG ARF) on industrial use cases and reviews of two workshops held by the ISG ARF, where a number of use cases were presented. These results are presented in categories such as:

- most relevant use cases;
- challenges of AR;
- scale of operation;
- accuracy for the positioning of augmentation;
- data sources for augmentation data;
- data security;
- data sharing;

- mode of operation;
- environmental conditions; etc.

Based on this analysis it is possible to identify the most relevant parameters and operational conditions for Augmented Reality in the industry and thus elaborate a requirements document for industrial use cases.

Introduction

The Industry Specification Group Augmented Reality Framework (ISG ARF) has been established to synchronize efforts and identify key use cases and scenarios for developing an Augmented Reality (AR) framework with relevant components and interfaces and to provide technical requirements for AR specifications in order to ensure interoperable implementations that will benefit both technology providers and end-users. The first step of the work of the ISG ARF was to collect the most relevant use cases in the industrial sector and to identify the required operational conditions for these use cases.

1 Scope

The present document presents and classifies industrial use cases for AR applications and services. It forms the basis for the requirements document to be drafted ETSI GS ARF 004 [i.2].

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GR ARF 001: "Augmented Reality Framework (ARF); AR standards landscape".

[i.2] ETSI GS ARF 004: "Augmented Reality Framework (ARF) Interoperability Requirements for AR components, systems and services".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

digital twin: virtual representation of a physical product or process, used to understand and predict the physical counterpart's performance characteristics

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

2D	2-dimensional
3D	3-dimensional
AG	Aktien Gesellschaft
AR	Augmented Reality
ARF	Augmented Reality Framework
ATEX	ATmosphères EXplosibles
CAD	Computer Aided Design
CBRN	Chemical, Biological, Radiological and Nuclear

DCC	Digital Content Creation
FoV	Field of View
HAZMAT	HAZardous MATerials
HHI	Fraunhofer Heinrich Hertz Institute
HMD	Head Mounted Display
IEM	Fraunhofer-Institut für Entwurfstechnik Mechatronik
IFF	Fraunhofer-Institut für Fabrikbetrieb und -automatisierung
IoT	Internet of Things
ISG	Industry Specification Group
IT	Information Technology
LIST	Luxembourg Institute of Science and Technology
OS	Operating System
QR	Quick Response
SLAM	Simultaneous Localization And Mapping
TM	Trade Mark
TV	Television
WIFI™	Wireless Ethernet

4 Overview of industrial Use Case analysis

The following overview is the result of a survey based on an online questionnaire (see Annex A) carried out in the period between February 28th and May 1st 2018 and a review of contributions to the two ARF workshops in Berlin and Paris (see Annex B).

Altogether 77 persons from 16 countries responded to the questionnaire. The distribution of countries was as follows:

- 43 % from Germany
- 24 % from France
- 5 % from Canada
- 5 % from USA
- 5 % from Spain
- 5 % from Italy
- 13 % from other countries

Most responses came from the general "Technology" sector (21 %) followed by Academic Research (18 %) and IT (15 %). Other distinct sectors were automotive (6 %), basic industries (6 %), consumer services (4,5 %), education (4,5 %). The remainder (around 25 %) of the responses was distributed over other sectors (e.g. energy, finances, aerospace, telecommunication, media). Among the occupations of the participants "Research" clearly dominate (32 %), followed by "Architecture and Engineering" (17 %), "Computer and Mathematical" (12 %) and "Management" (12 %). 57 % of the participants defined themselves as "Technology Providers" and 35 % as "Technology Users". The expected benefits of AR technologies showed a rather homogenous distribution over the different areas, with a slightly higher ranking of "Better Training Methods" (50 %).

The following benefits of AR technologies are expected:

- Better training methods (50 %)
- Increasing sales (31 %)
- Better productivity (31 %)
- Better quality of products (27 %)
- Better traceability of operations (23 %)
- Better security for workers (19 %)

- Other (31 %)

Other specifically mentioned benefits were:

- better information delivery;
- visualization of sensor data through digital twins and IoT sensors;
- new research possibilities;
- remote diagnostics;
- help in diagnostics;
- process acceleration;
- higher level of information for decision making;
- easier documentation;
- faster reaction for remote assistance;
- buying decision information;
- faster and better service;

which however in most cases could also be assigned to the categories listed above. Answers illustrate the holistic nature of AR.

The participants were also asked, what their level of maturity with respect to AR usage is. The answers showed a rather homogeneous distribution with values between 9 % and 18 % over the seven categories ranging from "we never heard from AR" to "we already deployed an operational solution". Almost 60 % already work on AR solutions, either by conducting some pilot studies (14 %), proof-of-concept studies (17 %), deploying operational solutions (9 %) or already running operational solutions (18 %).

The most relevant Use Cases are shown in Figure 1.

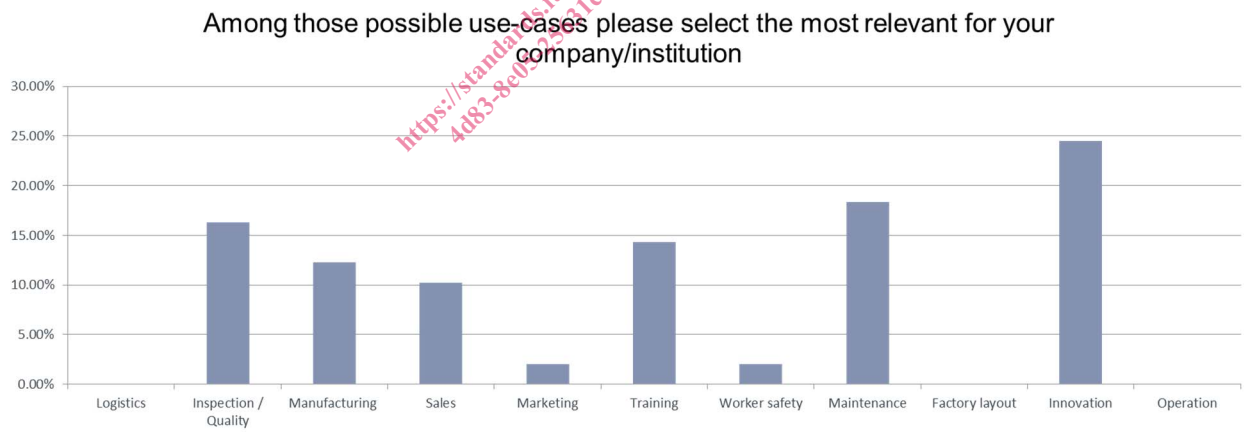

Figure 1: Most relevant Use Cases mentioned in the questionnaire

Surprisingly, sales & marketing does not hit the top three use-cases among the participants of the survey and logistics, worker safety and factory layout planning were not identified among the priorities. This may be attributed to the limited number of answers to the questionnaire and imbalanced profiles of the participants over all business sectors.

As far as operating systems for AR devices are concerned, Android™ is the dominant OS (43 %) followed by Windows™ (25 %) and iOS™ (23 %).

The main challenges identified in the questionnaire are summarized in Figure 2.

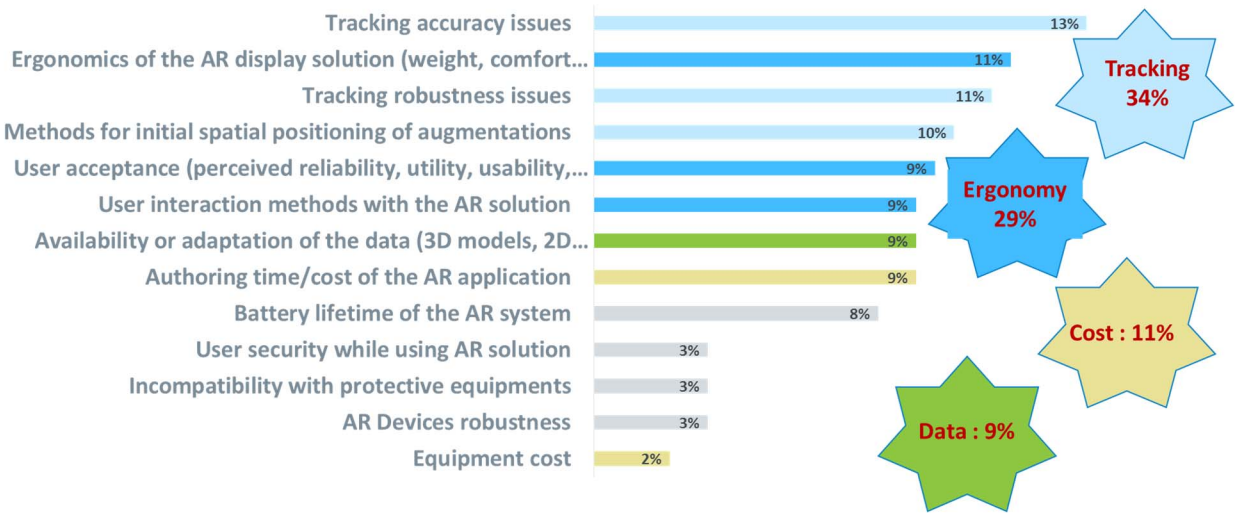

Figure 2: Today's challenges for AR

Tracking accuracy and robustness, initial positioning (34 %) and ergonomics of AR devices resulting in limited user acceptance (29 %) are the dominating challenges. Availability or adaptation of data and authoring time/costs are other important challenges as well as battery life time.

In spite of these challenges participants declared a stronger AR demand and a higher acceptance of AR during the last two years.

Additional information on industrial use cases could be gathered during the two workshops held by ISG ARF in Berlin (1.2.2018) and in Paris (23.5.2018). There were a number of presentations on use cases from various fields. An overview of these presentations can be found in Annex B. The structure of Annex B is the same as in the questionnaire, however there is not always information available for every category, therefore it is difficult to get quantitative results from this overview. However, this overview supports the general outcome of the questionnaire.

5 Usage conditions

5.1 Overview

This clause describes the usage conditions of AR technologies regardless of the use cases as expressed in the responses to the online questionnaire (see Annex A). It is subdivided into "Usage environments", "Operating conditions" and "Augmentation data sources".

5.2 Usage environments

The scales of usage vary from "Letter Scale (A4 letter size)" to "World Scale (~1 000 m^2)", while "Room Scale (~10 m^2)" is dominating (39 %). The given values are depicted in Figure 3.

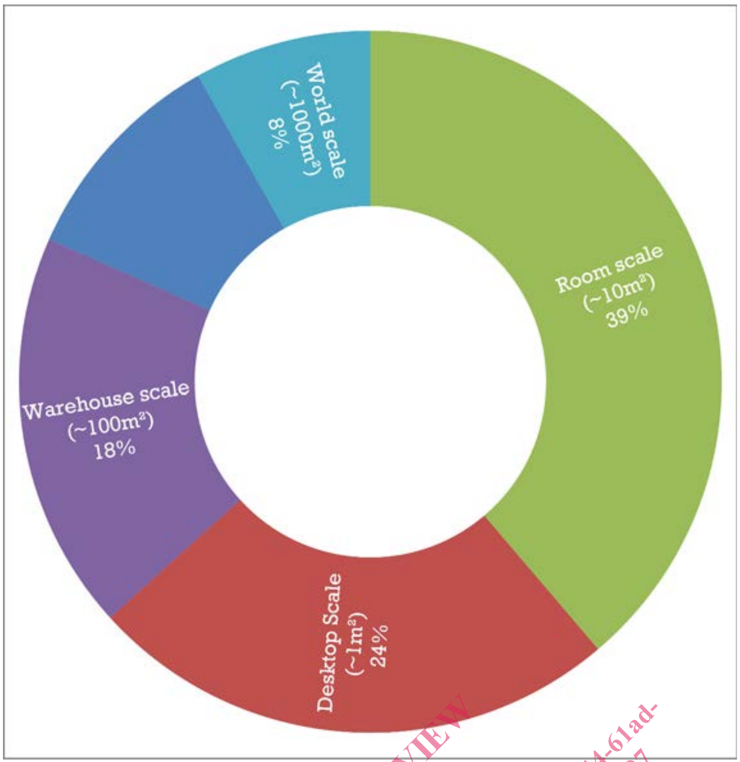

Figure 3: Room scales for AR applications

In addition, in 43 % of the responses there are user friendly or office conditions, in 47 % the conditions are medium difficult, which may include dust or water projection, mid temperatures and small vibrations. Only 10 % are extremely hard conditions, e.g. direct rain exposure, high temperatures, a lot of dust and high vibrations.

5.3 Operating conditions

65 % of the participants want the AR user to have his hands-free while using the solution. 85 % of the respondents want the augmentations to be precisely located relatively to a real equipment or object. 73 % of contributors expect an accuracy of a few millimetres or under. In 88 % of the cases a viewing distance of less than 5 meters to the object (44 % close to hand) is required. 41 % expect the augmentation to be shared among several users, which has significant implications for the use of head-mounted displays.

In 57 % of the cases there is a model evolving over time (e.g. step by step assembly of a mechanical structure), in 43 % it is static.

In 63 % of the cases the scenes to be augmented are mostly static, whereas in 37 % there are moving objects or persons.

5.4 Augmentation data sources

78 % of the participants identified CAD models as source of information for AR application. 52 % of these data have a high level of confidentiality. These data have to be stored on sovereign clouds, internal servers or on the AR devices with an extremely high secure access control.

6 Detailed description of the 4 dominant Use Cases

Besides "Innovation" the most dominant Use Cases identified in the survey are:

- Inspection/quality
- Maintenance

- Training
- Manufacturing

Therefore, these four Use Cases are taken as the basis for a more detailed analysis. They will also be used to identify relevant standards or lacks of and to define the further activities of the ISG. "Innovation" has been disregarded, although it has the highest score in Figure 1, because "Innovation" is not really an industrial use case but rather reflects that many participants in the questionnaire came from universities or research institutes. Therefore, the answers from academia have also been disregarded from the subsequent analysis, although comparison shows that results with or without academic institutions are not significantly different.

Disregarding the answers of academic institutions 55 % of the answers to the questionnaire came from technology providers whereas 38 % came from technology users (see Figure 4).

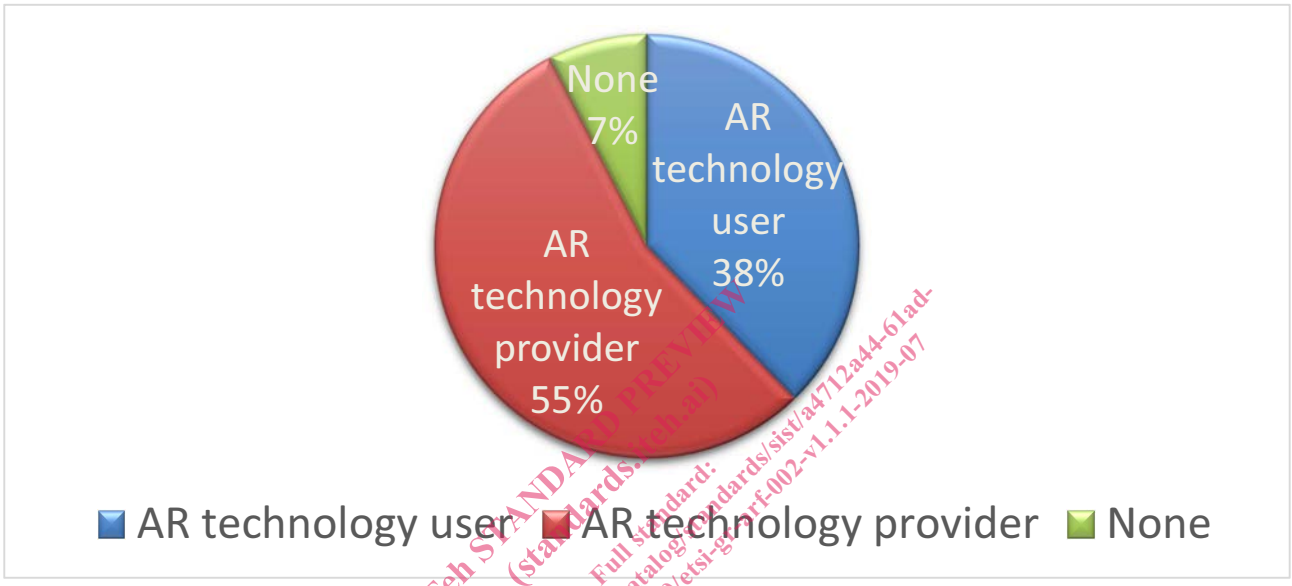

Figure 4: Participant's profile

With respect to augmentation precision, there are different requirements concerning the accuracy in the four main use cases. While inspection and training require accuracies of a few millimetres or even below, maintenance and manufacturing partially accept higher tolerances (see Figure 5).

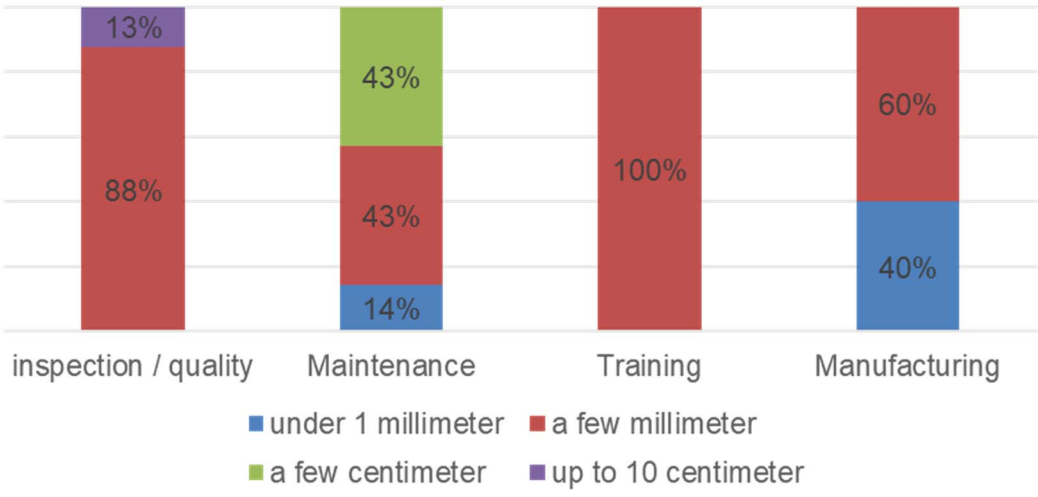

Figure 5: Accuracy of augmentation

73 % of the respondents identify CAD models as a possible source of information for augmentations.