Mobile Location-based Augmented Reality Framework

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Mobile Location-based Augmented Reality Framework

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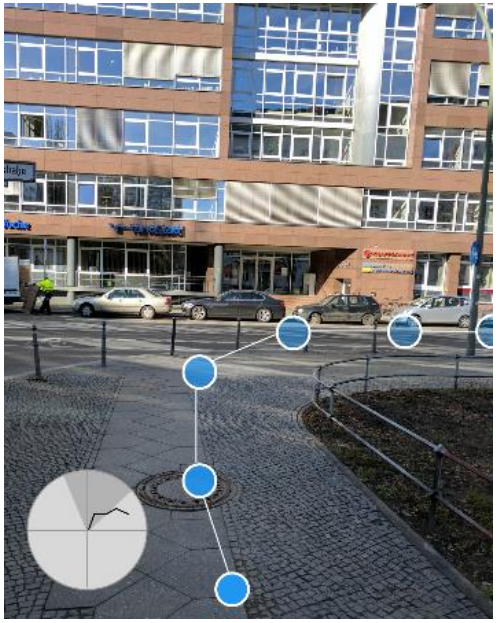
2. Mobile location-based augmented reality
3. Applications of location-based AR
4. SDKs for location-based AR
5. Concept of a mobile location-based AR framework
6. Implementation and usage
7. Summary



1. Introduction

Mobile Location-based AR Framework: motivation and main idea

Motivation:

- Mobile augmented reality (mAR) technology **has great economic potential** and is **suitable for the mass market** (e.g. *Pokemon GO, Snapchat*)
- There are **hardly any SDKs** that can be used to develop **customized geo-based AR applications** as important functionality and customization options are missing

Main idea:

- Concept and implementation of a **framework** (GeoAR SDK) that integrates the core functionality of **location-based mAR applications**
- Target group: **experienced app developers** who do not wish to have to acquire expert knowledge in computer vision and AR

Goals:

- Support of a **wide range of GeoAR use cases**
- **great customizability** of developed applications in terms of functionality and design

2. Mobile location-based augmented reality

Augmented Reality

What is Augmented Reality (AR)?

Human perception of real-world environment is supplemented with digital computer-generated content

→ **AR has already reached our daily lives,** however: Growing interest in AR as enabling technology in the **mobility space**

2. Mobile location-based augmented reality

Mobile augmented Reality

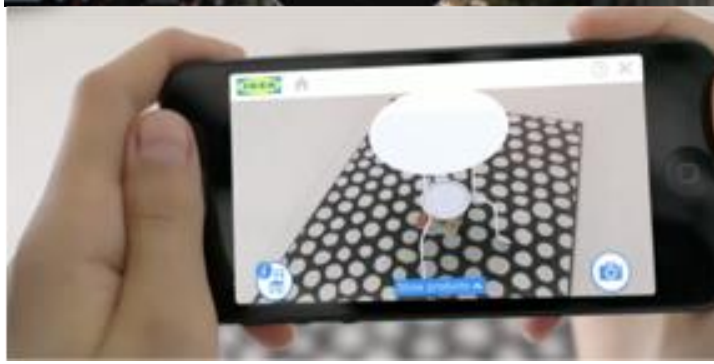
What is mobile Augmented Reality (mAR)?

Overlaying virtual information onto the real world

- using mobile devices
- on the local surroundings

- Smartphones & tablets as **suitable platform** for mAR applications
  - Growing availability and computing power
  - **Integration of sensors** that are necessary to realize mAR (compass, GPS, camera etc.)

- **Fields of applications, e.g.:**
  - Marketing and advertisement (e.g. IKEA app)
  - Tourism (display of points of interests)
  - Games



2. Mobile location-based augmented reality

Location-based AR vs. Image-based AR

Location-based AR (Geo-AR)

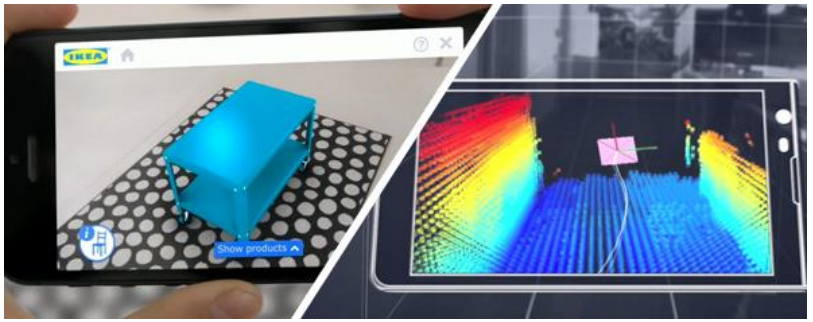
Technical realization:

- **GPS sensor** for determination of position
- **IMU sensors** (compass, accelerometer, gyroscope) for determination of orientation

Pros and cons:

- Robust, modest und fast technology
- Suitable in large-scale environments
- Imprecise

Image-based AR / Model-based AR



Technical realization:

- **Analysis of camera image** for determination of pose & orientation (**feature tracking**)
- Registration within virtual 3D model (**model-based SLAM**)

Pros and cons:

- Very precise and realistic rendering possible
- Complex, error-prone technology (light conditions, moving objects etc.)
- Not suitable in large-scale environments

2. Mobile location-based augmented reality

Location-based AR vs. Image-based AR

Location-based AR (Geo-AR)

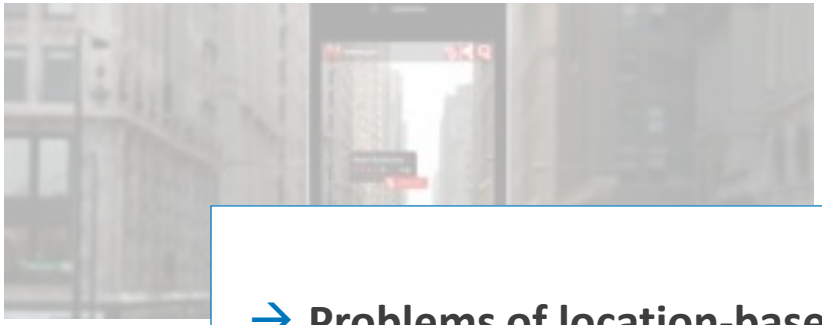


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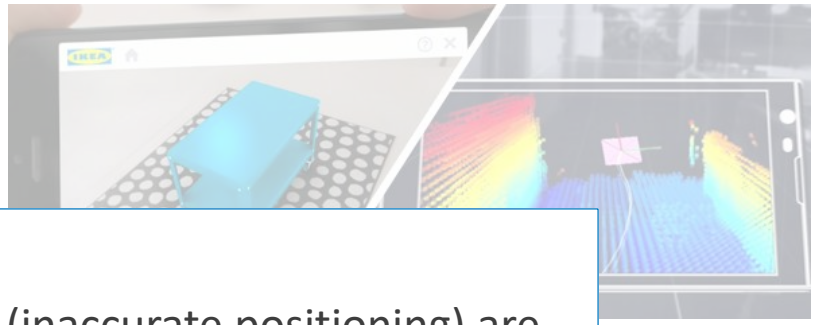
Image-based AR / Model-based AR



- termination of pose & orientation (**image-based feature tracking**)
- Registration within virtual 3D model (**model-based SLAM**, possibly with additional IR sensors)

Pros and cons:

- Very precise and realistic rendering possible
- Complex, error-prone technology (light conditions, moving objects etc.)
- Not suitable in large-scale environments

→ **Problems of location-based AR** (inaccurate positioning) are **acceptable** in several application use cases!

location-based AR applications

3. Applications of geo-based AR

Area information

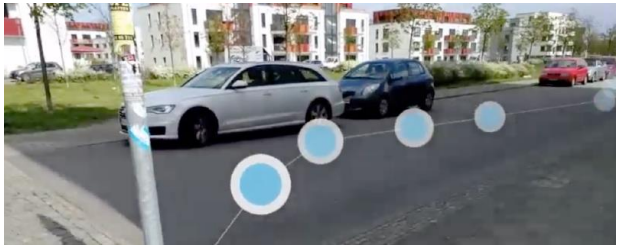
Display of specific information about the user's environment in the camera image (e.g. tourist attractions, rivers etc.)

Object information

Display of specific information on a particular object in the immediate environment (e.g. exhibits in open-air museums)

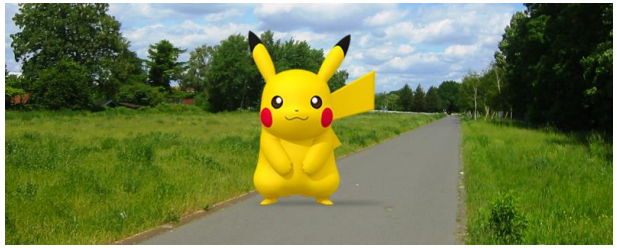
Navigation

Display of georeferenced waypoints (or arrows) in the camera image along a navigation route



Games

Display of game elements on top of the camera image. The real world becomes part of the playing field (e.g. Pokemon Go)



3. Applications of geo-based AR

General functional requirements

- **Presentation of spatial objects** with
  - one geographic reference (POI, 3D model)
  - several geographic references (polyline, polygon)

- **Dynamic creation of adaptable content:**
  - different types of objects depending on user context
  - with different, dynamic properties (size, color), e.g. depending on distance to object

- **User interaction with objects** (e.g. click on object)

- **Camera control and accessible camera image** (e.g. capture photo function)

4. SDKs for location-based AR

Analysis of existing geoAR-SDKs

- **Purpose of analysis:** study of various existing geoAR-SDKs with regard to their functionality and possible applications

- **Examination criteria:**
  - **Non-functional requirements:** e.g. platforms, supported programming languages, available licenses, documentation, current status
  - **Functional requirements:** presentation of AR objects (2D/3D POIs), customization of appearance, access to AR object screen coordinates, radar, object events (e.g. onClick, onFocus), photo capture functionality

4. SDKs for location-based AR

Overview of existing geoAR-SDKs

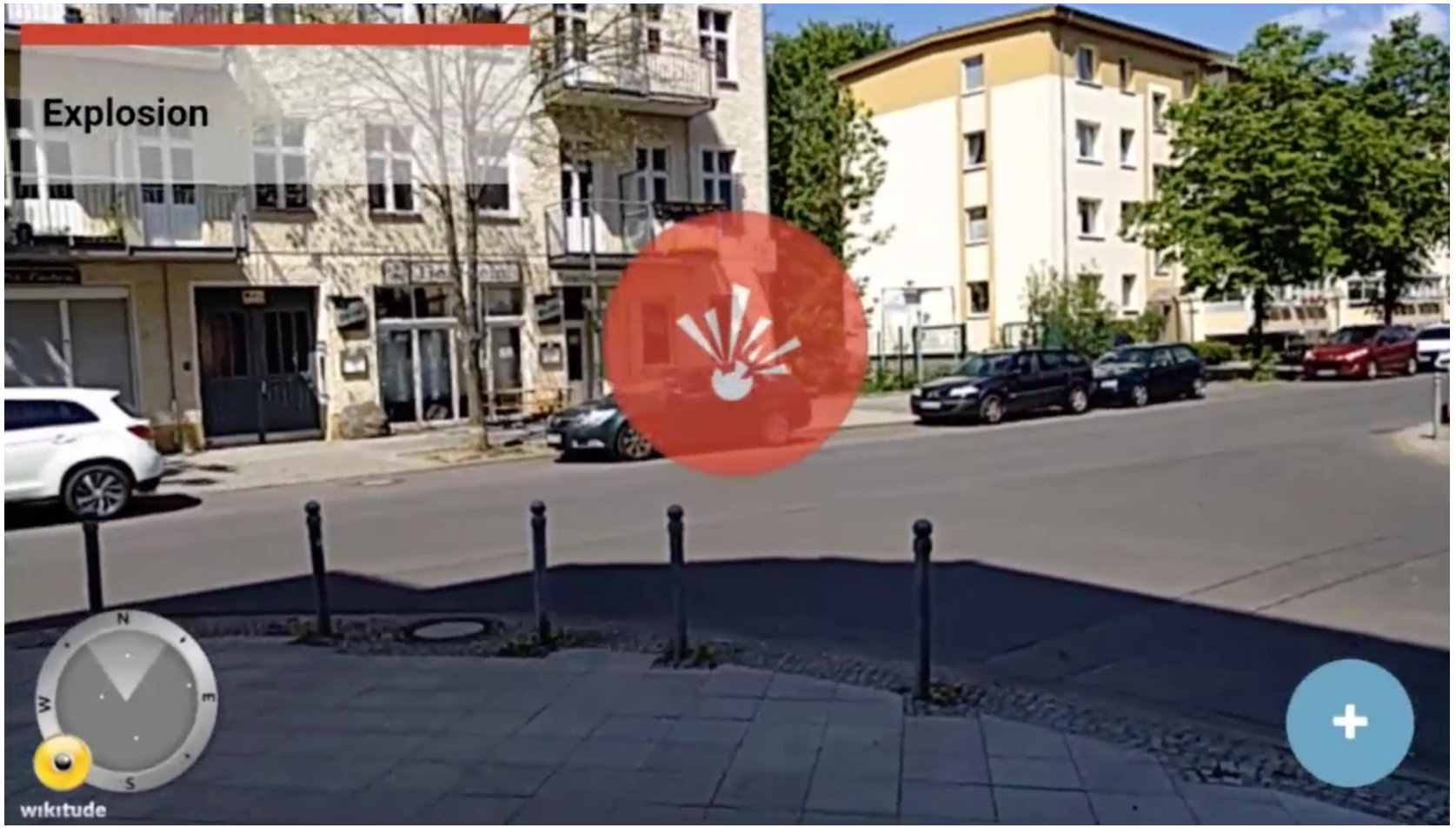
- **Results:** ~40-50 mAR SDKs found
  - ~20 of them identified as geoAR SDKs (however, half of them are outdated/not available)

  → There are **hardly any current SDKs available with working geoAR support**

#	name / provider	licence	last update	comments
1	3DAR	Unkown	2010	not up-to-date / no longer available
2	52 North: GeoAR	Apache 2.0	2013	not up-to-date / no longer available
3	Argon3	Open Source	2015	only iOS / browser-based
4	ARlab	Commercial	2013	not up-to-date / no longer available
5	Inglobe Technologies: ARmedia	Commercial	2016	barely documented; focus on image-based 3D tracking
6	ARPA	Unkown	2014	not up-to-date / no longer available
7	ARToolKit	GPLv3	2016	focus on image-based AR; GPS/IMU integration only on iOS
8	AugView	Commercial	2016	GIS system with AR functionality; no actual SDK
9	aumentia	Custom	2014	focus on image-based AR; geo-location only in iOS
10	Awila (Esri)	Commercial	2014	not up-to-date / no longer available
11	beyondAR	Apache v2	2014	some customization possible (low level); slighty outdated
12	Droidar	GPLv3	2013	some customization possible (low level); outdated; V2 is closed source
13	Hoppala	Unkown	2011	not up-to-date / no longer available
14	Instantreality (Fraunhofer IGD)	Unkown	2016	AR framework not available for mobile AR
15	Kudan	Commercial	2016	GPS integration apparently only on iOS ; focus on SLAM
16	Layar	Commercial	2016	customization possible according to docs; SDK currently not available
17	LibreGeoSocial	Unkown	2010	not up-to-date / no longer available
18	Metaio	Commercial	2015	not up-to-date / no longer available (bought by Apple in 2015)
19	Minvera	GPLv3	2011	not up-to-date / no longer available
20	Mixare	GPLv3	2012	not up-to-date / no longer available
21	PanicAR (Vuframe)	Commercial	2014	some customization possible (low level); free for non-profit projects
22	WearScript	Apache 2.0	2014	supports GPS-based AR; apparently only for Google Glass
23	Wikitude	Commercial	2016	some customization possible with certain limitations (high level)

4. SDKs for location-based AR

Existing geoAR-SDKs – Example: Wikitude SDK



4. SDKs for location-based AR

Weakness of existing SDKs

- **Presentation of spatial objects** with
  - one geographic reference (POI, 3D model) ✓
  - several geographic references (polyline, polygon) ✗
- **Dynamic creation of adaptable content:**
  - different types of objects depending on user context ✗
  - with different, dynamic properties (size, color), e.g. depending on distance to object ✗
- **User interaction with objects** (e.g. click on object) ✗
- **Camera control and accessible camera image** (e.g. capture photo function) ✗

4. SDKs for location-based AR

Weakness of existing SDKs

- **Presentation of spatial objects** with
  - one geographic reference (POI, 2D model)
- **D**
- **User interaction with objects** (e.g. click on object)
- **Camera control and accessible camera image** (e.g. capture photo function)

- **Missing functionality** or **missing customization options** in existing SDKs!

→ **Goal:**
Development of a mAR framework for app developers offering several options to realize various location-based AR applications

5. Concept of a mobile location-based AR framework

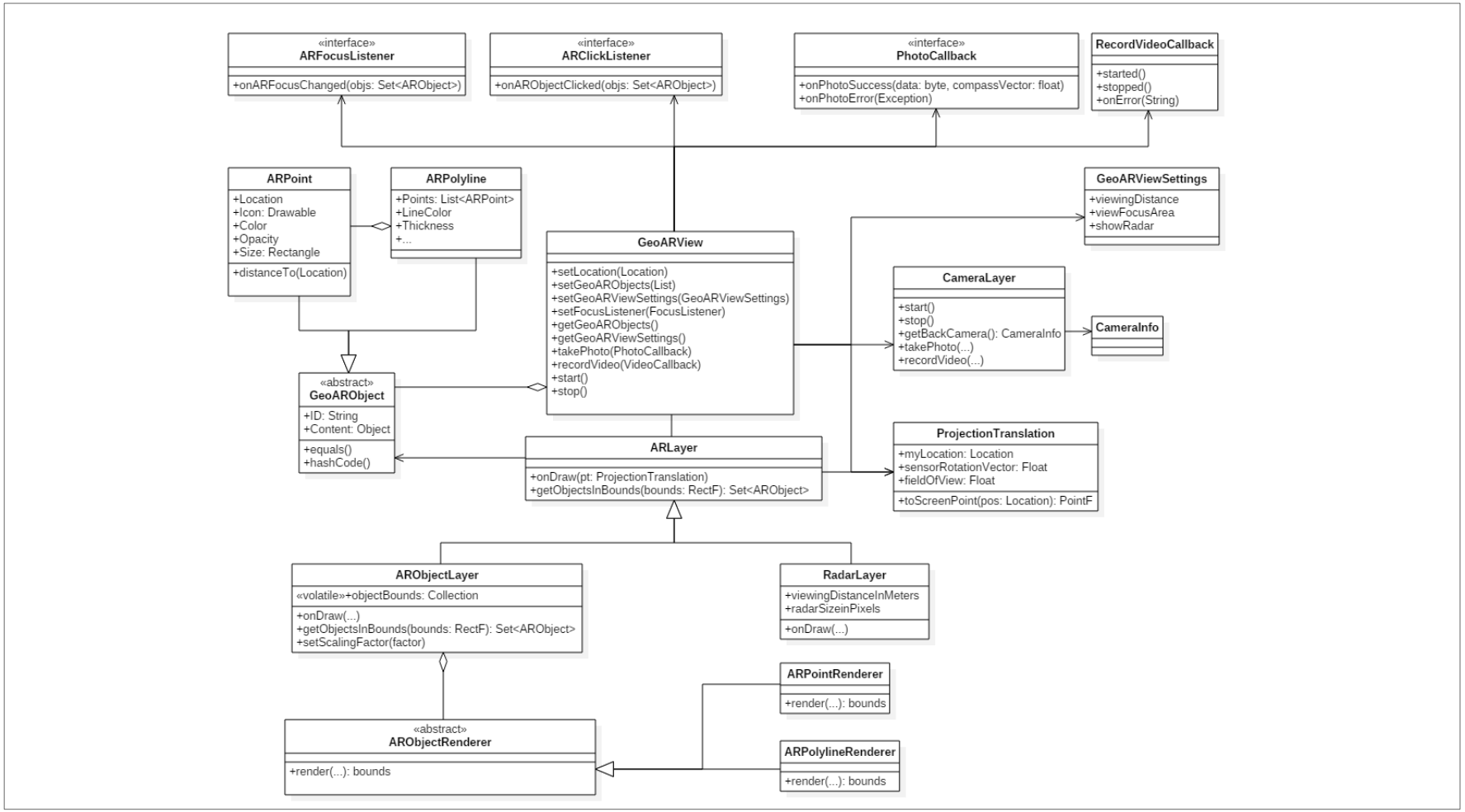
- **ARView** with own lifecycle controlling several layers:
  - Camera image
  - Overlay of GeoAR objects
  - Radar view (optional)

- Internal **camera control** and implementation of core AR functionalities, e.g. **3D-2D projection** of all AR objects based on current device position and orientation

- **GeoARObject**:
  - Single ARPoint (POI) or list of ARPoints (polygon, polyline)
  - Adaptable **appearance** (icon, color, opacity, size, thickness etc.) and **3D position** / **geographic location** (longitude, latitude, altitude)
  - Full access to **2D screen coordinates** of all projected AR objects

- **Interaction via event model**
  - Access to visible AR objects (onFocus/onClick)
  - Access to current camera images (PictureListener)

5. Concept of a mobile location-based AR framework



MoLAR v0.5

- Framework implementation with **Android SDK**

6. Implementation and usage

Sample application: City.Risk

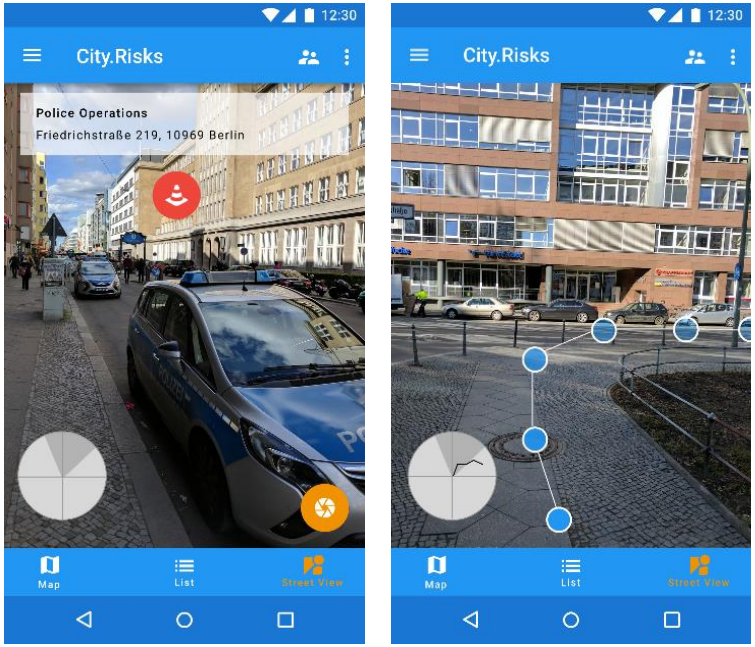
EU project „City.Risks“:

- Idea: IT solutions to prevent and mitigate security risks in cities
- With the aid of smartphones, citizens actively contribute to combatting crime and increasing the sense of security

CITY.RISKS
AVOIDING AND MITIGATING SAFETY RISKS IN URBAN ENVIRONMENTS

Applications with AR integration:

- **Ongoing incidents**: citizens report crimes (e.g. fire, explosion etc.) via smartphones. AR is used to visualize information about ongoing crime incidents in the area
- **Navigation**: user is navigated out of a dangerous area to a safe destination using AR methods



6. Summary: Mobile location-based AR framework

- **Location-based AR is suitable for the mass market**. Disadvantages compared with image-based AR are acceptable for several applications (Example: Pokemon Go).

- **There are hardly any mature and convenient SDKs available** for app developers to realize individual and customized geoAR applications. Existing SDKs usually offer **limited functionality** or **limited customization options.**

- The presented framework is designed as 'low-level' framework for Android:
  - It addresses **app developers** without expert knowledge in computer vision
  - It allows the development of customized geoAR applications and allows the realization of a wide range of geoAR applications

Thank you! Questions?

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