



Challenges in the use of indoor navigation and augmented reality in complex space

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Workshop
“Cooperation at Academic Informatics Education across
Balkan Countries and Beyond”

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Agenda



- Background
- Indoor navigation
- Augmented reality
- Results
- Conclusions

Mobile device programming course



- Type: Elective course
- Starts: 8 semester
(of 8 semesters for bachelor studies)
- Class hours: 2+2+1
- Format: Mobile **device** programming **not** Mobile **phone** programming
 - *Midterms 20 (10+10)*
 - *Laboratory 10*
 - *Project 50*
 - *Final 20*
- Topics:
 - Android programming in Java
 - Sensors
 - GUI Patterns

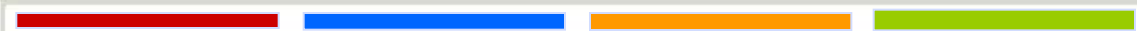
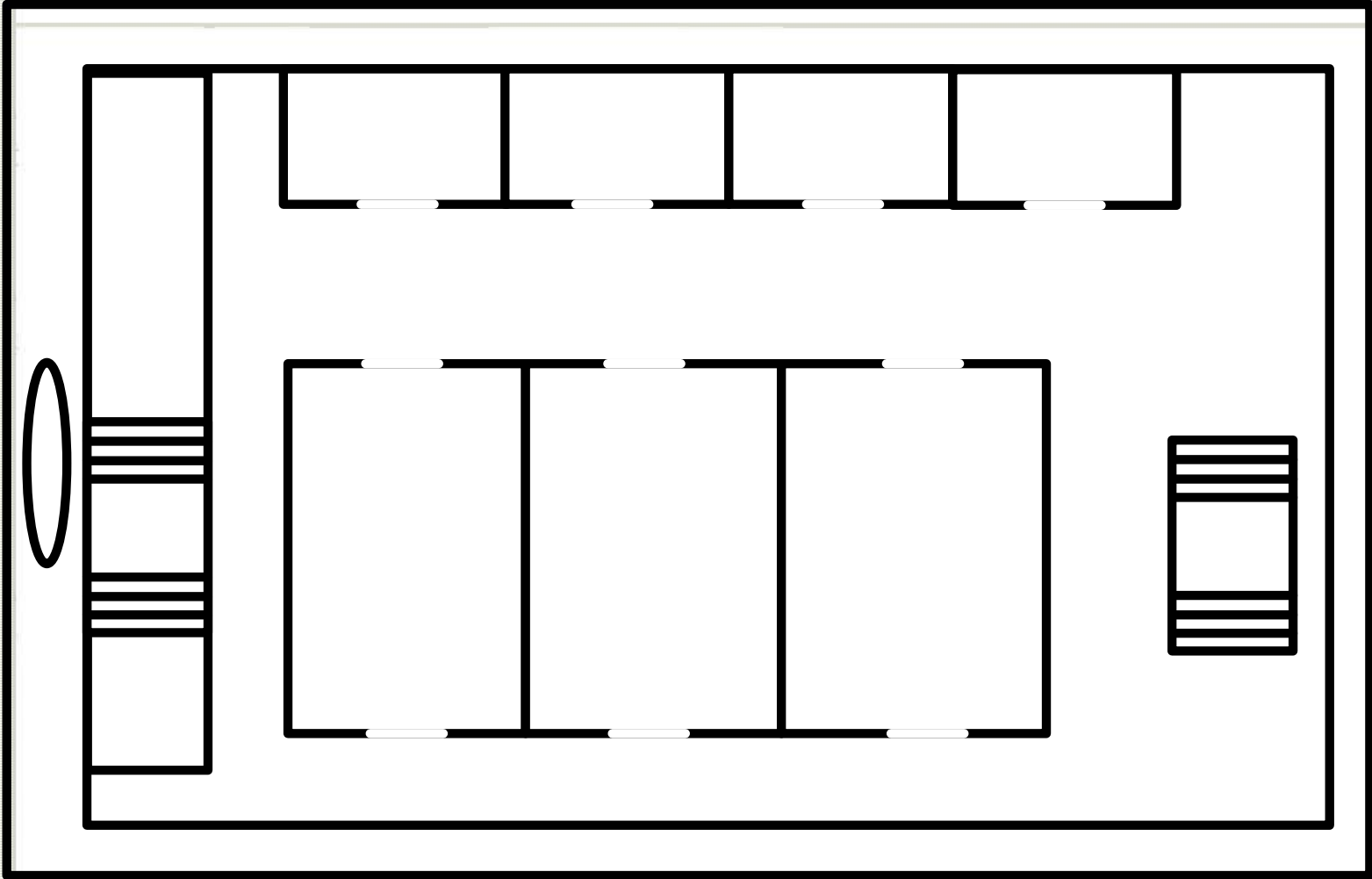
Mobile device



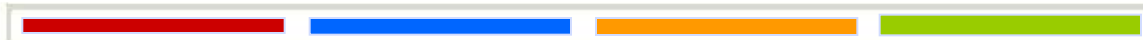
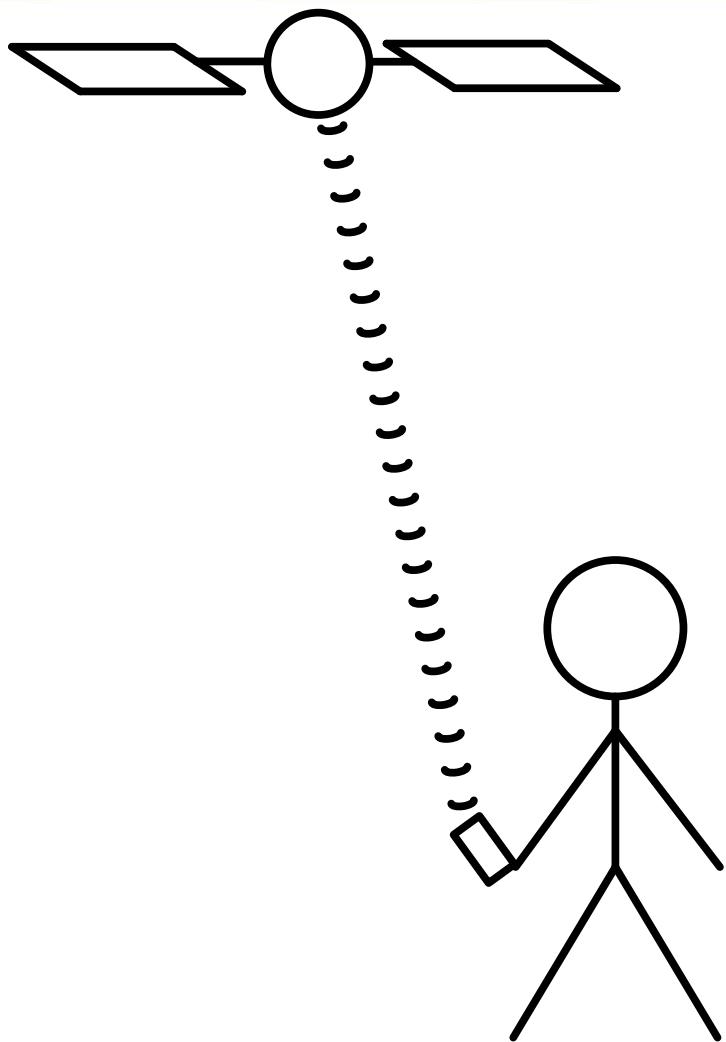
- GPS
 - Gyroscope/Accelerometer
 - Magnetometer/Compass
 - Camera
 - Microphone
 - Electromagnetic receivers (Wi-Fi, NFC, Bluetooth)
- Input
- Speakers
 - Screen
 - Vibrations
- Output



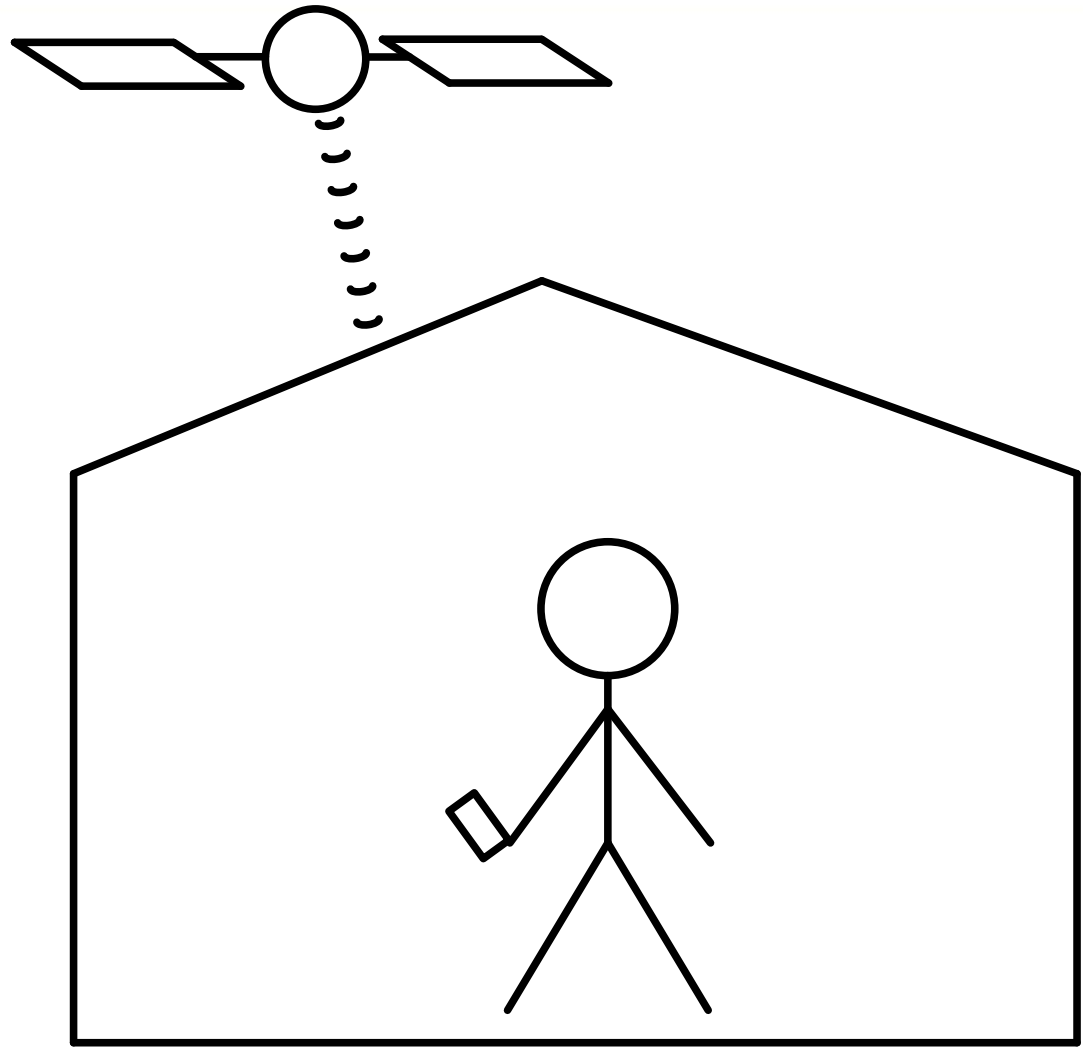
Indoor positioning



Outdoor Positioning



Outdoor Positioning – indoor problems



Can other sensors be used for navigation?



- Gyroscope/Accelerometer
- Magnetometer/Compass
- Camera
- Microphone
- Electromagnetic receivers (Wi-Fi, NFC, Bluetooth)

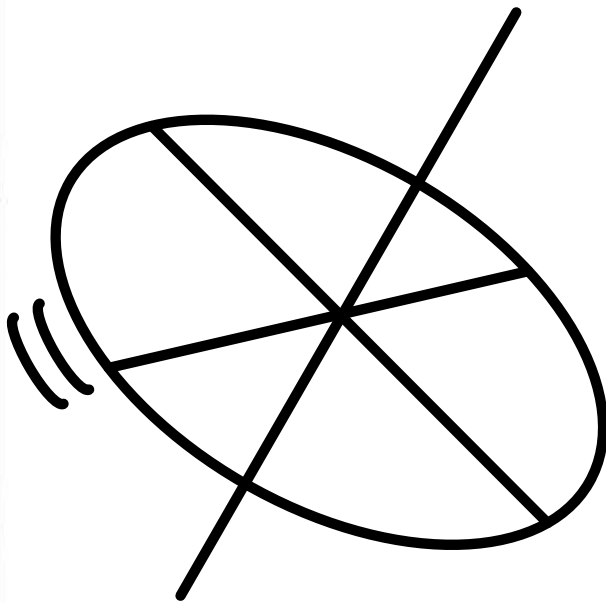


Indoor Positioning – solutions



- Inertial navigation
- Image processing
- Beacon usage
- Combining multiple sensors
- Information regarding space
- ...

Indoor Positioning – Inertial navigation



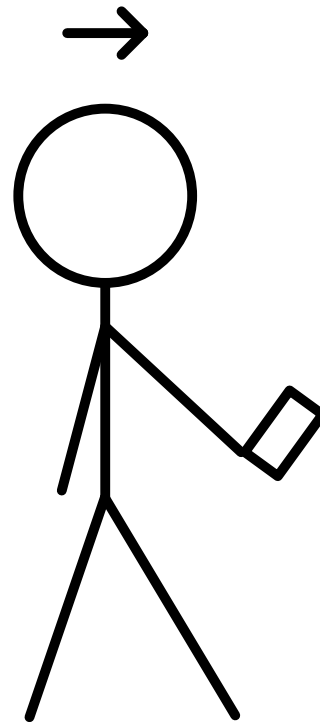
$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$\vec{r} = \vec{r}_0 + \int \left(\vec{v}_0 + \int \vec{a} \right) dt$$

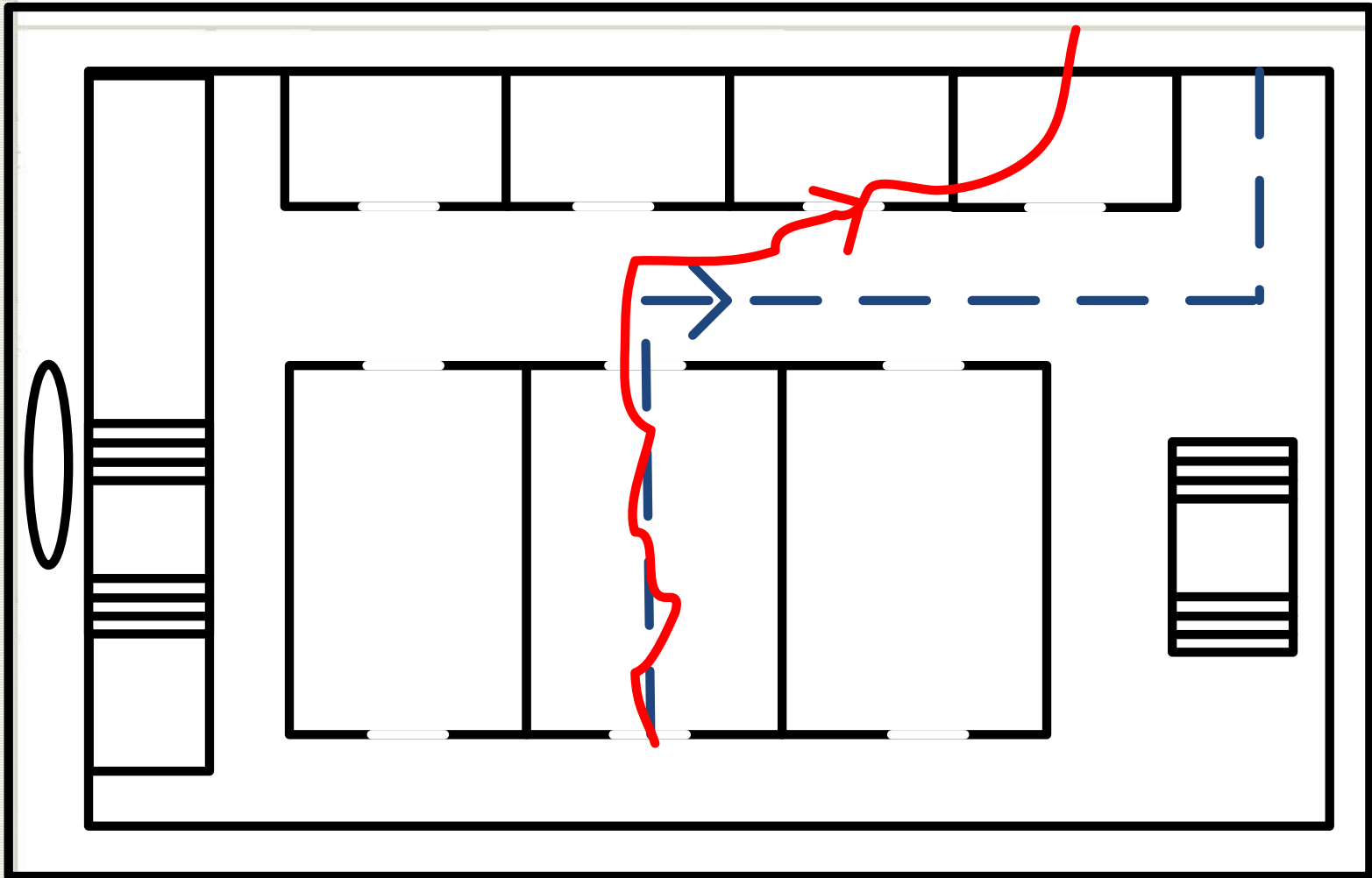
$$\vec{a}_m = \vec{a} + \vec{e}$$

Indoor Positioning – Inertial navigation

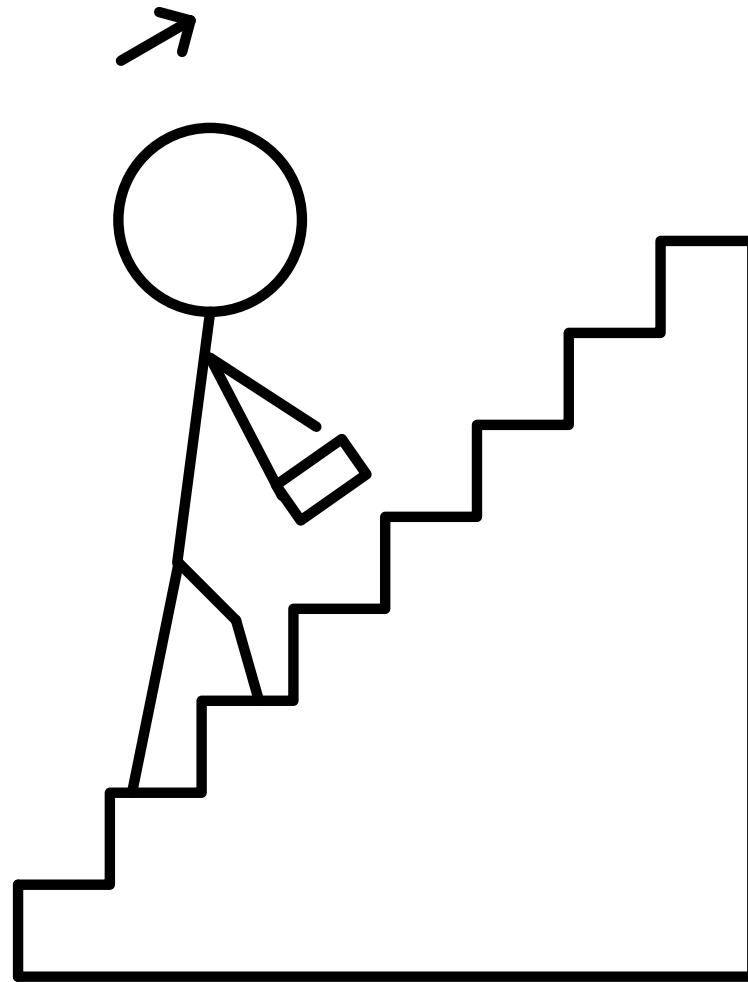


~ results

Indoor Positioning – Inertial navigation

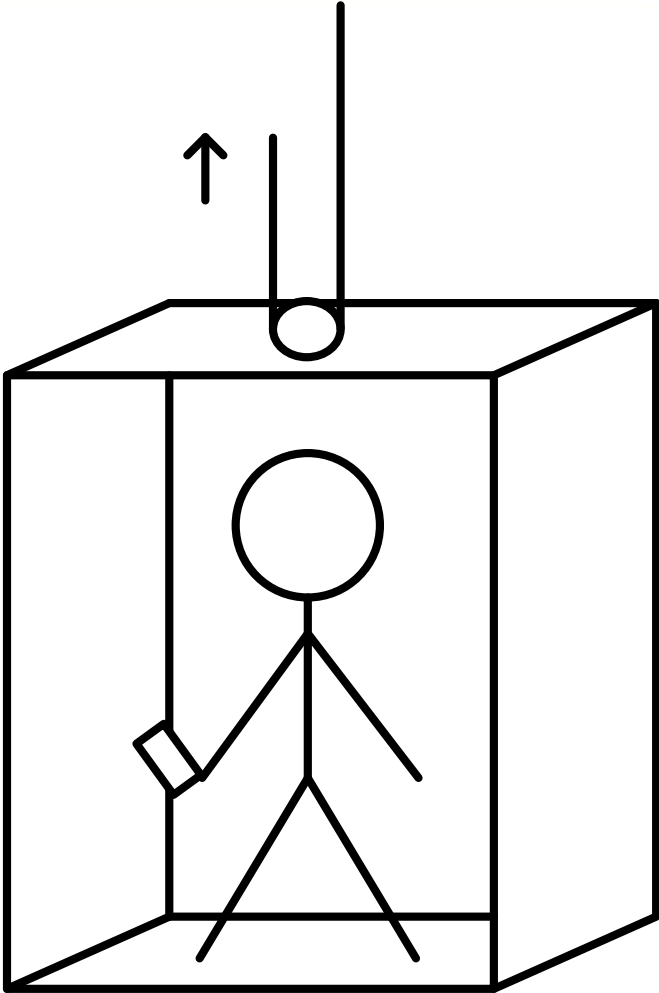


Indoor Positioning – Inertial navigation



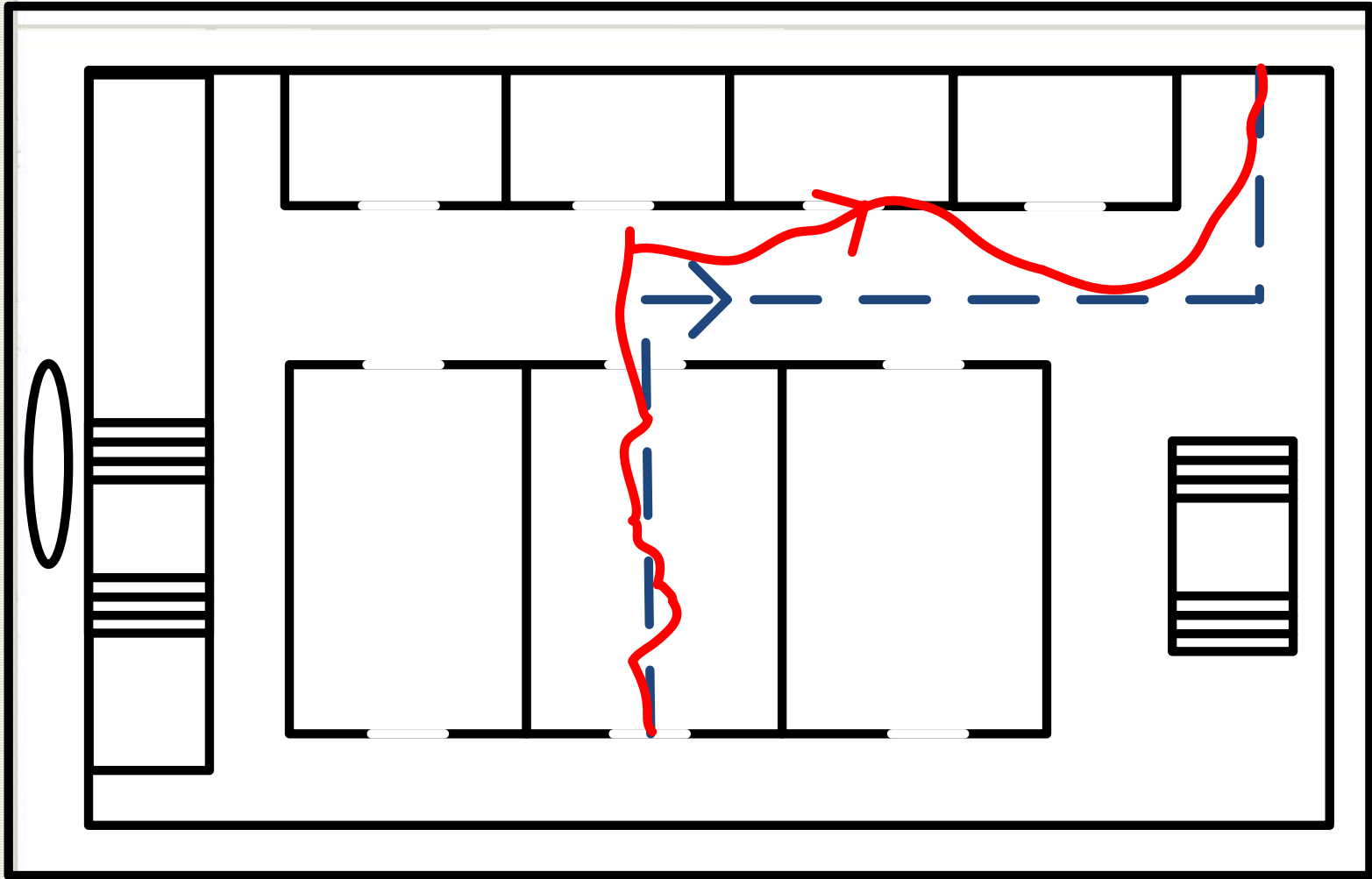
Good results

Indoor Positioning – Inertial navigation

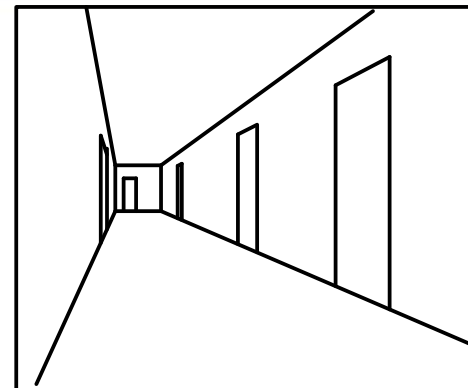
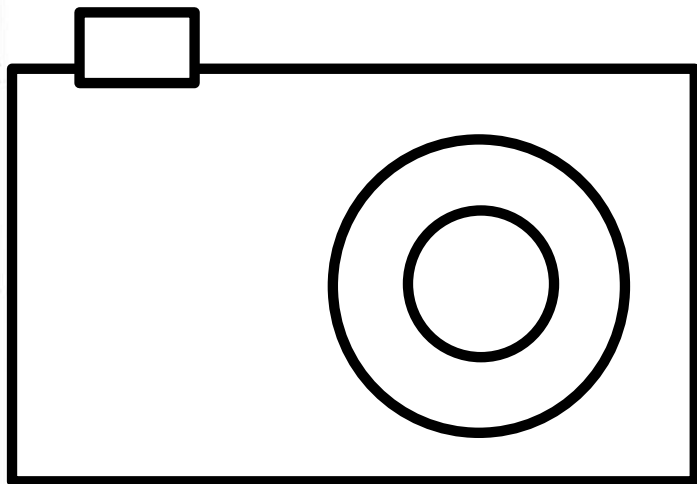


Excellent results

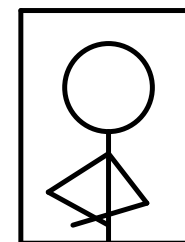
Indoor Positioning – Inertial navigation+



Indoor Positioning – Image processing

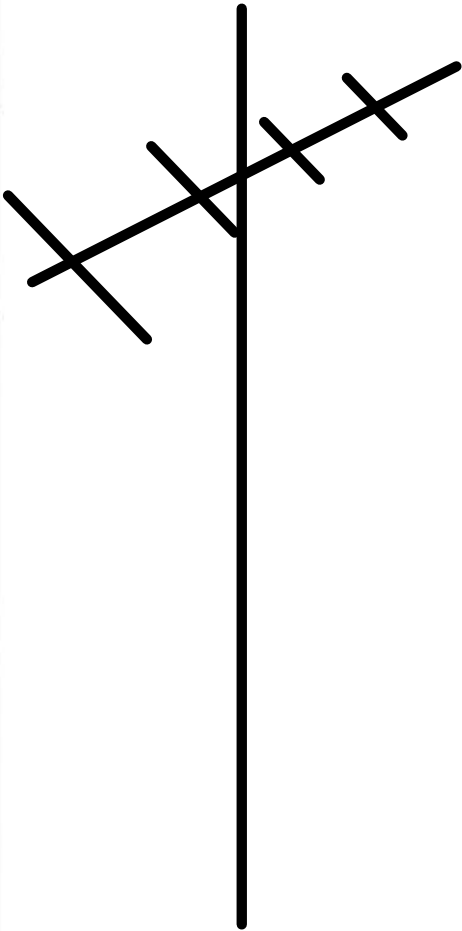


Space recognition

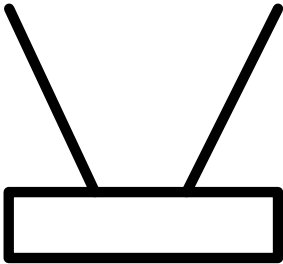


Content recognition

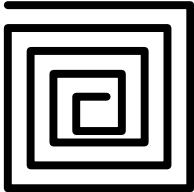
Indoor Positioning – Electromagnetism



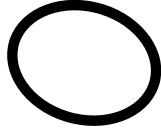
Wi-Fi



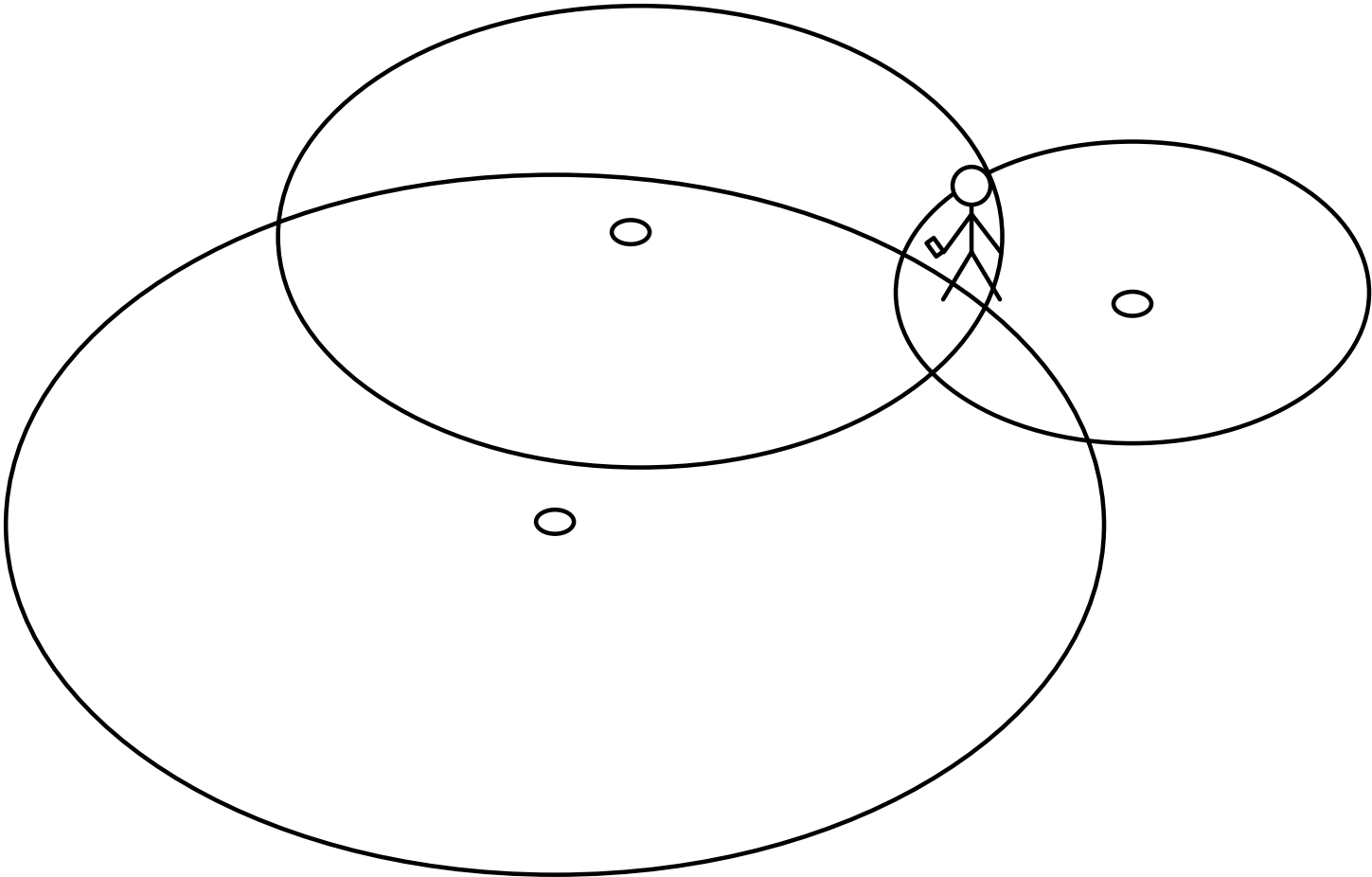
NFC



Bluetooth



Indoor Positioning – Electromagnetism



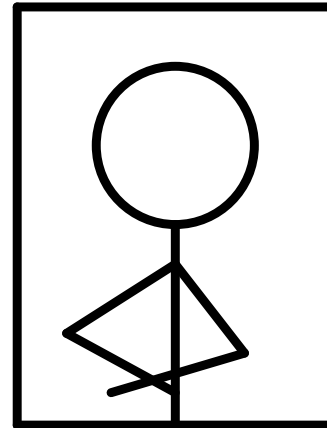
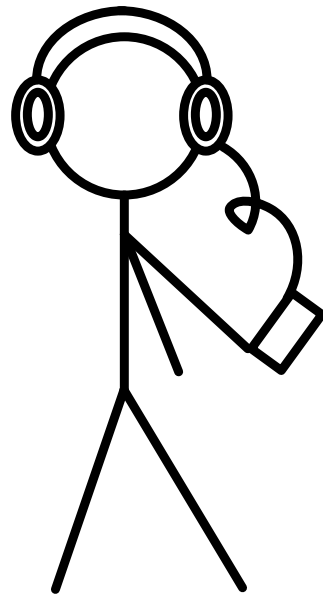
Trilateration

Augmenting reality

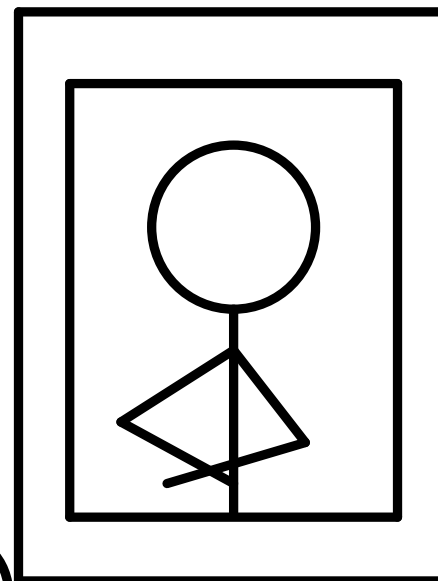
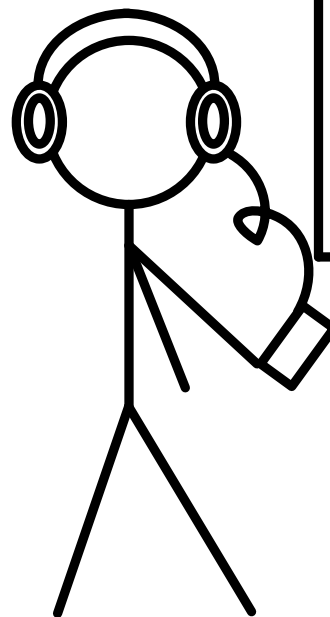
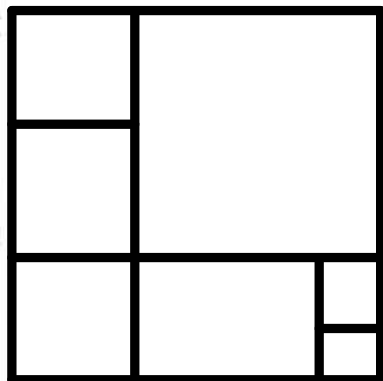


- Speakers
- Screen
- Vibration

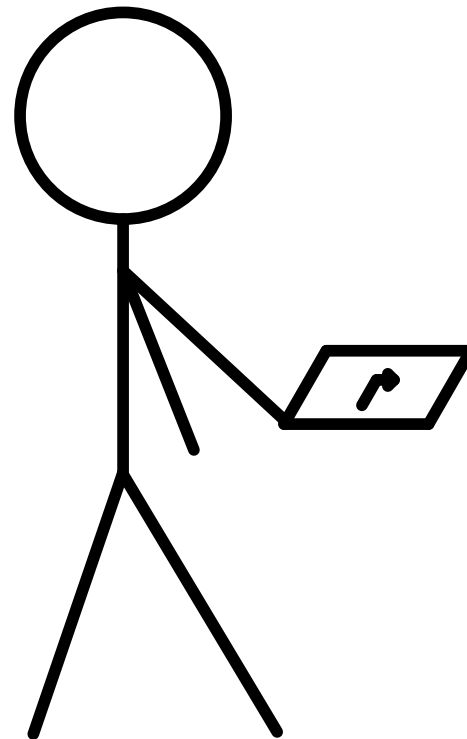
Augmenting reality 1



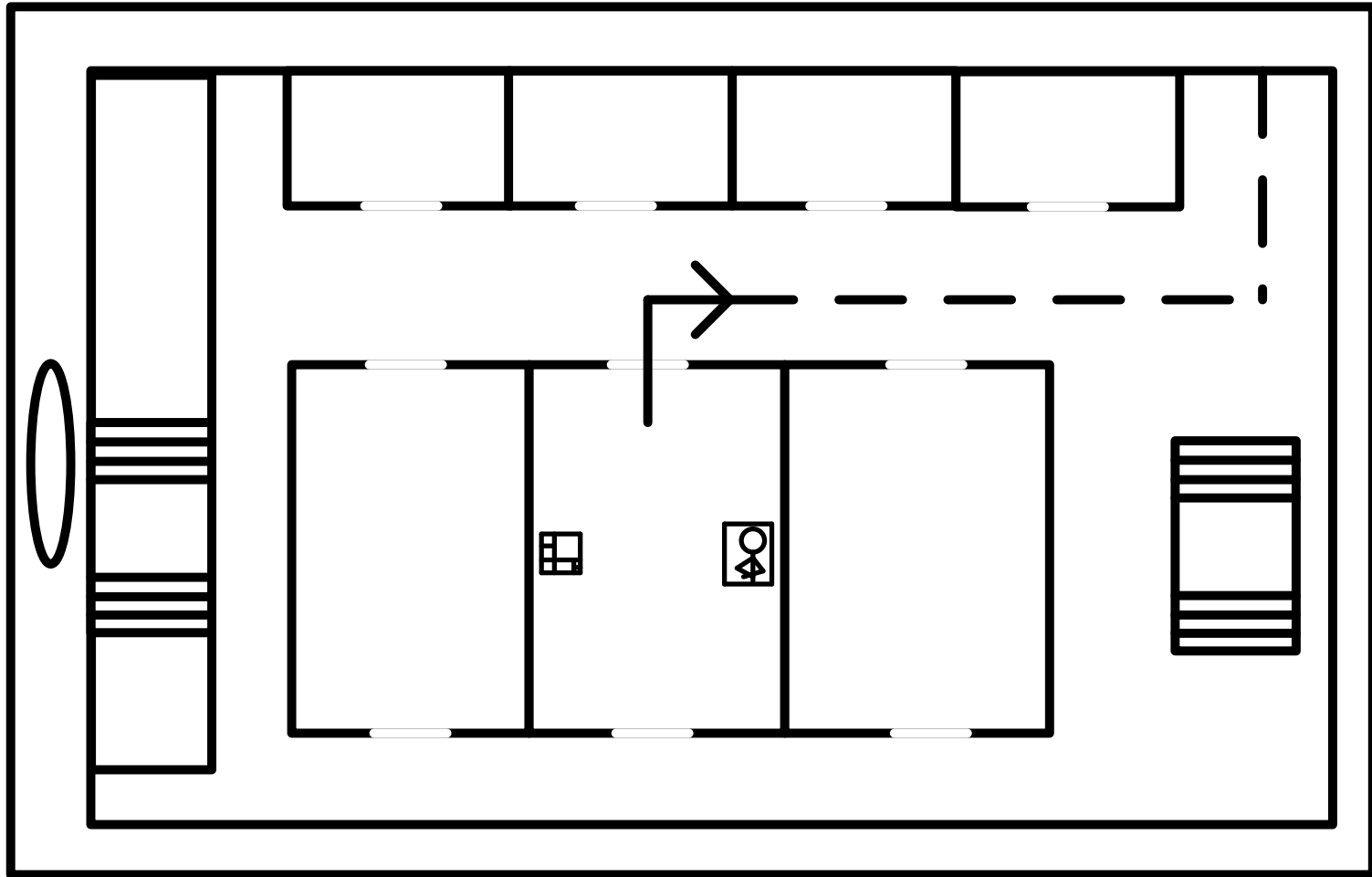
Augmenting reality 2



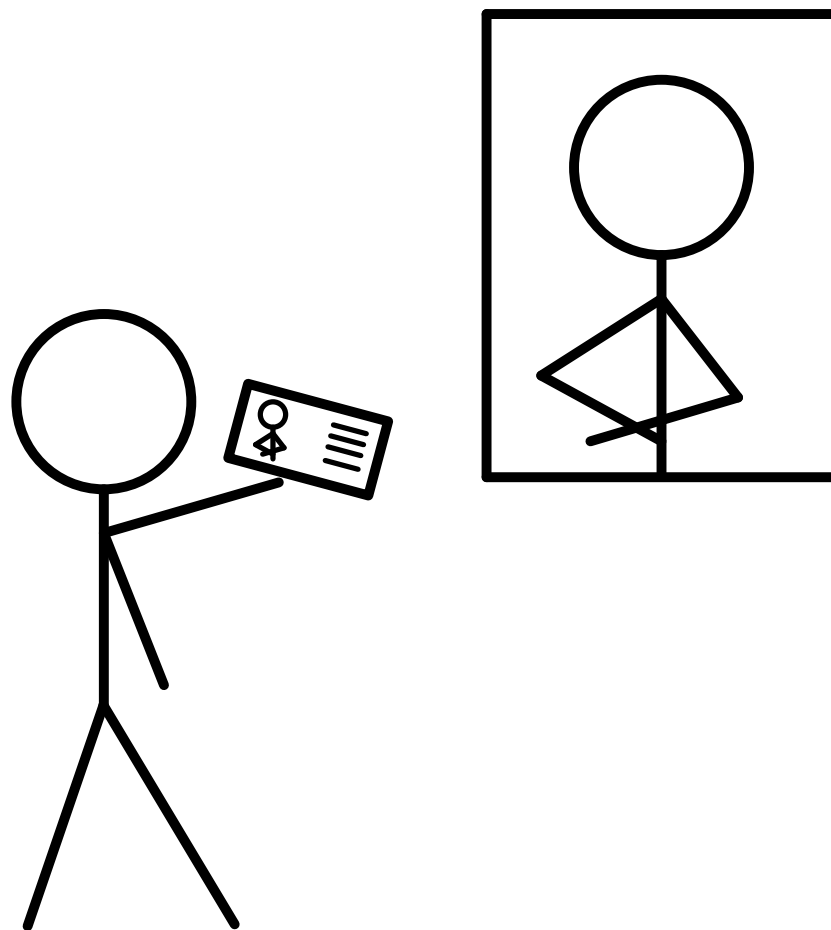
Augmenting reality 2



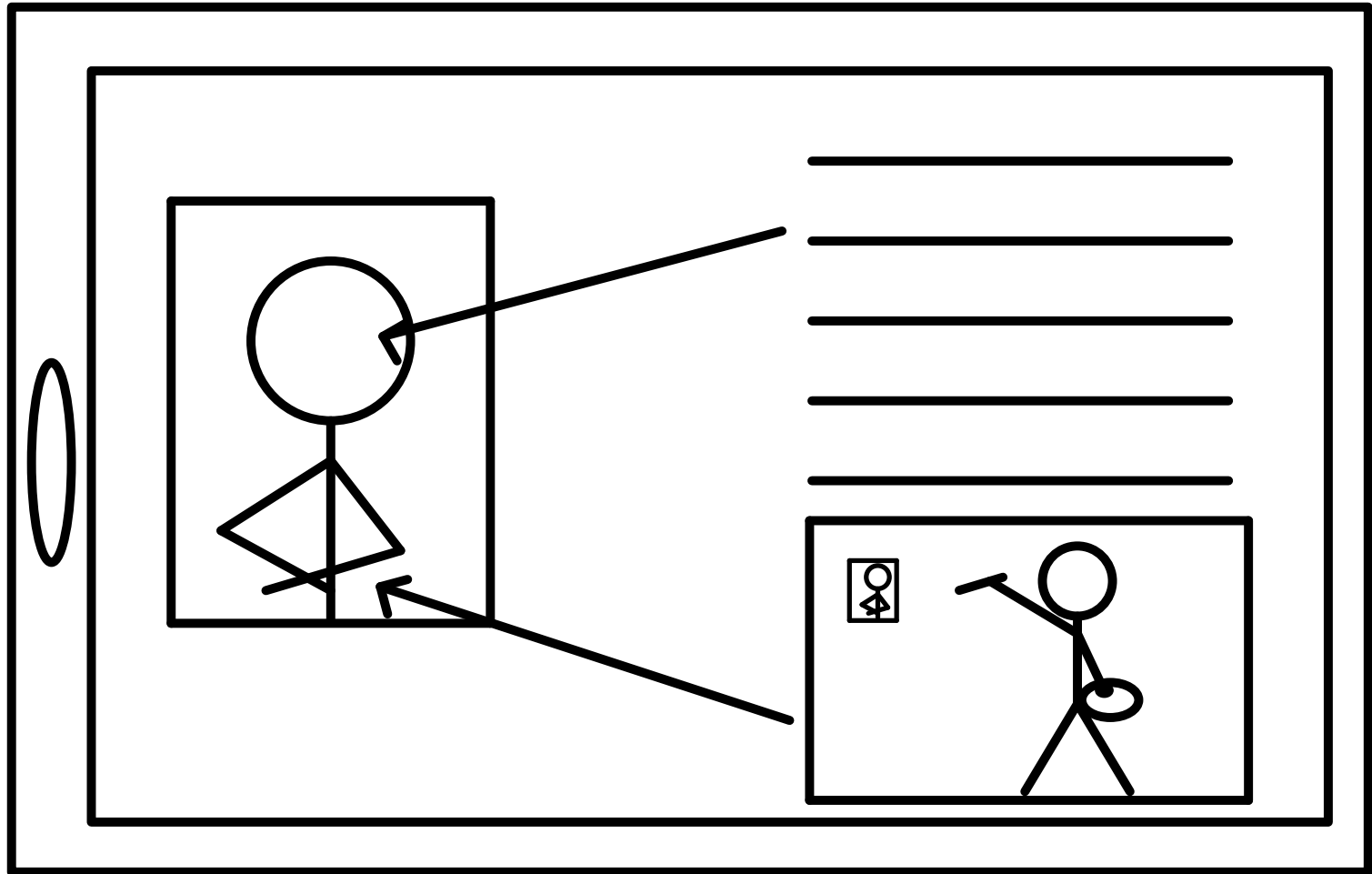
Augmenting reality 2



Augmenting reality 3



Augmenting reality 3



Results



Testing new technology

2017 – 4 bachelor thesis, 1 master thesis

2018 – 4 bachelor thesis, 1 master thesis – in progress

Conclusion



- Combine multiple sensors for precise indoor location.
- Beacons enable fine location, but require additional hardware.
- Image processing and inertial navigation do not require additional equipment.
- Augmented reality can be used in combination with location.



Thank you!

Zaharije Radivojevic

