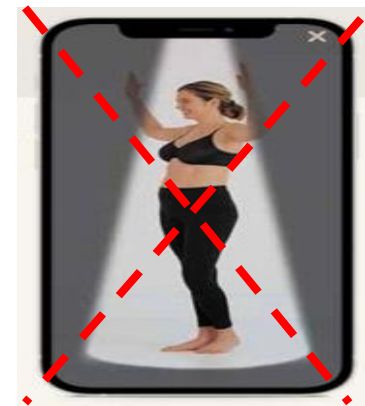


# 3D Geometry Recognition by RFID Box based on deep learning

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# 3D geometry recognition for garment telemarketing

- ❑ **Limitation in camera-based virtual fitting :**
  - **High cost** of geometry reconstruction
  - **Privacy** concern
- ❑ **3D geometry recognition using RFID box or closet:**
  - **Cost-effective.**
  - Maintenance-free **passive** tags.
  - Convenient deployment and easily portable.
  - **No privacy concern** not only because no camera is used, but also because the user can be in their daily garment for the body shape.



# 3D geometry recognition for gesture identification

- ❑ Convenient setup for accurate static hand gesture recognition.
- ❑ Facilitate Human Computer Interaction (HCI) applications including 3D virtual reality control and sign-language detection.



virtual reality gesture control



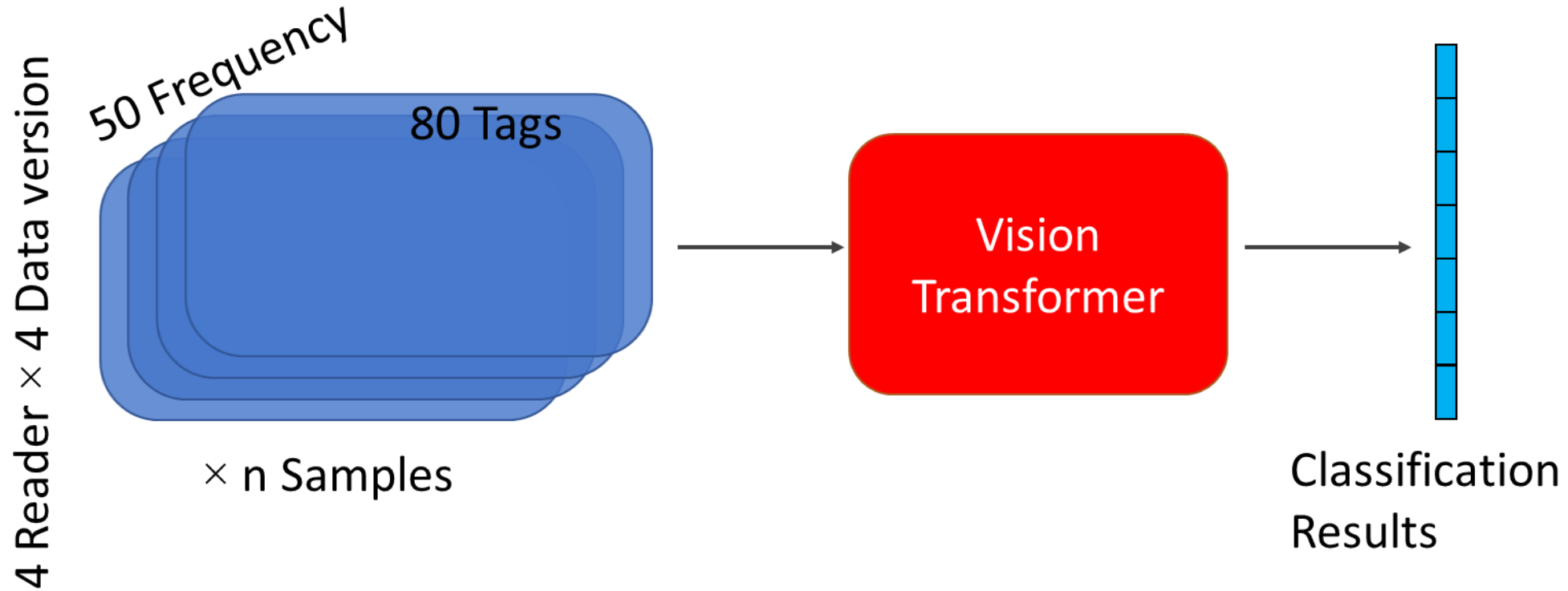
Smart device control

# Passive UHF RFID tags for spatial diversity

- ❑ **80** commercial passive RFID tags inside the four sides of a cubic cardboard box of 45 cm.
- ❑ **4** reader antennas were placed at the bottom driven from the Impinj reader.
- ❑ **50** carrier frequencies in the range of 902-928 MHz. Employed time division multiplexing (TDM).
- ❑ retrieved the tag ID, RSSI, phase, carrier frequency, and reader antenna port.



# Deep learning model for geometry recognition



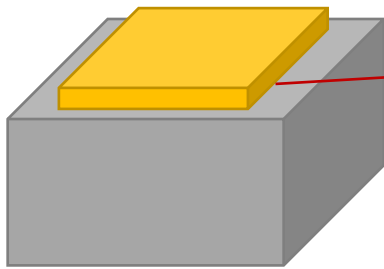




# Geometry recognition in RFID-Box

14 shapes

6 shapes

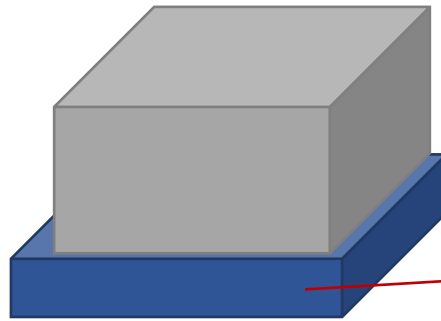


N=1,...6

Stacked Notebook Number  
=1,2,3,4,5,6

Box 1 doesn't change

4 shapes

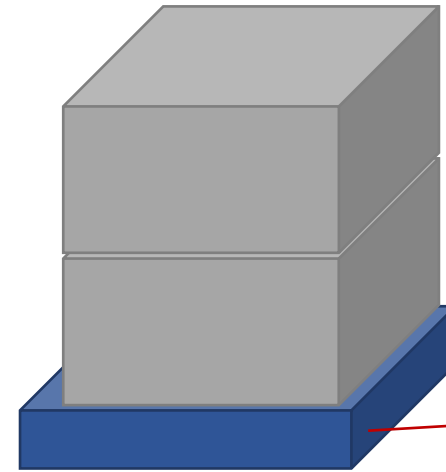


N =0,...3

Stacked Box2 Number  
=0, 1,2,3

Box 1 doesn't change

4 shapes



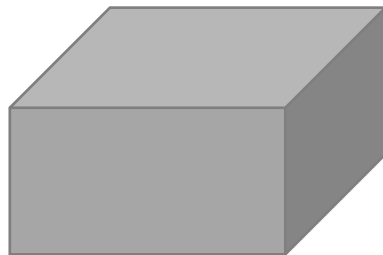
N =0,...3

Stacked Box2 Number  
=0,1,2,3

Box 1 doesn't change



Notebook:  
3inch\*3inch \* 0.5 inch



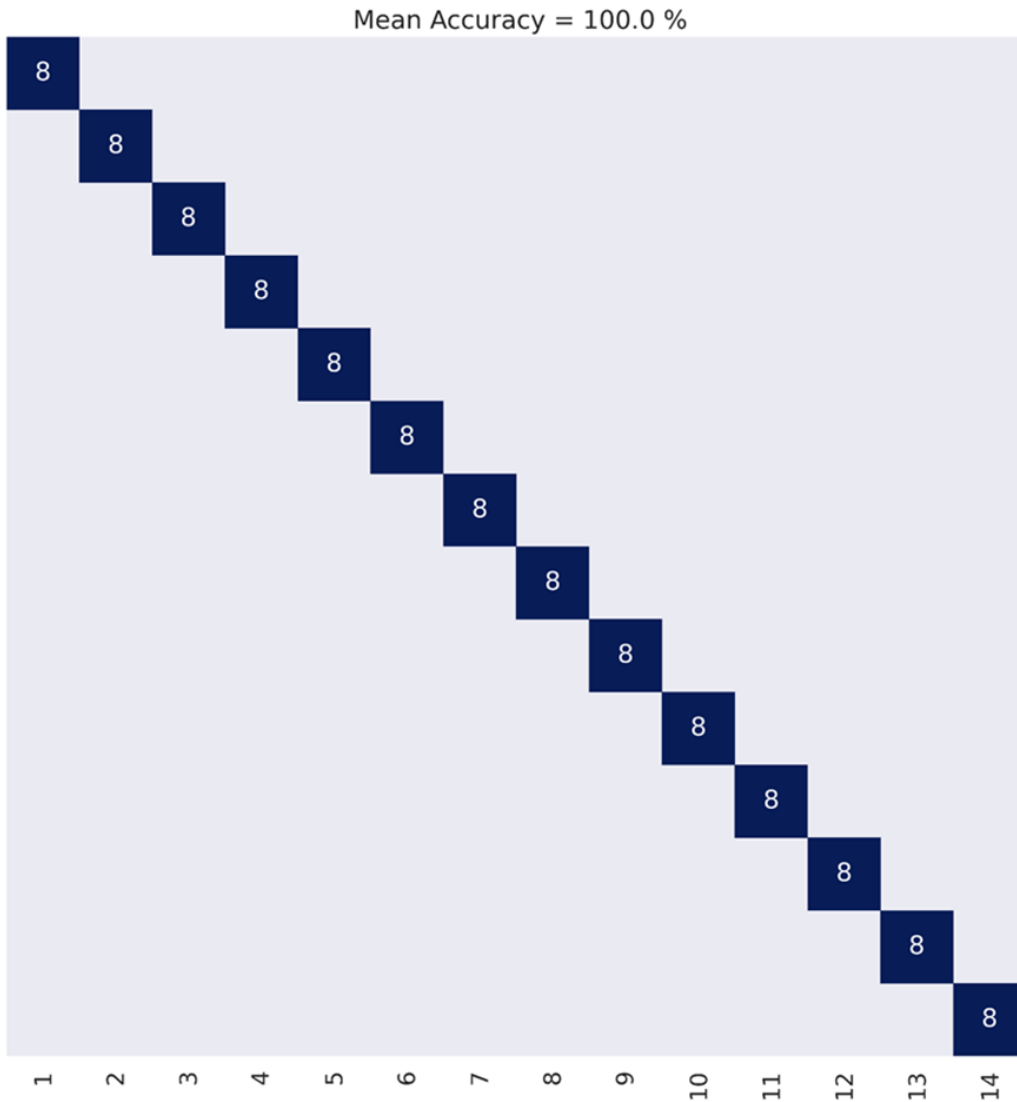
Box1 :  
4inch\*4inch \* 2 inch



box2:  
6.4inch\*4.8inch \* 1.2  
inch

# Geometry recognition in RFID-Box

Confusion matrix for **14** shape recognition



- ❑ Tested on objects wrapped in aluminum foils.
- ❑ 14 shapes consist of Lego blocks ( 4"×4"×2" ) with additional thin layers ( 3"×3"×0.5" ), imitating shoe size fitting.
- ❑ **Spatial resolution**: around 0.25" until recognition accuracy starts to degrade.





# Future improvement

- ❑ Our equivalent spatial resolution is high, and the 3D geometry is more complex than conventional RFID-based fingerprinting.
- ❑ The study can be applied to **garment** and **shoe fitting** setups with larger data sets of human study.
- ❑ Even **higher spatial resolution** of geometry recognition can be potentially achieved by adapting the system to mmID with higher carrier frequency.