Keyrtual

A Lightweight Mixed Reality Musical Keyboard For Smartphone

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Keyrtual

FONDAZIONE CATALANO

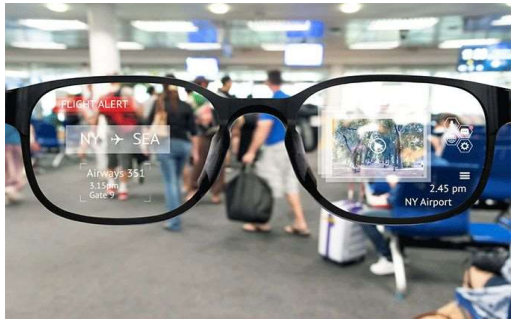
CULTURA TURISMO LAVORO

FONDAZIONE TIM

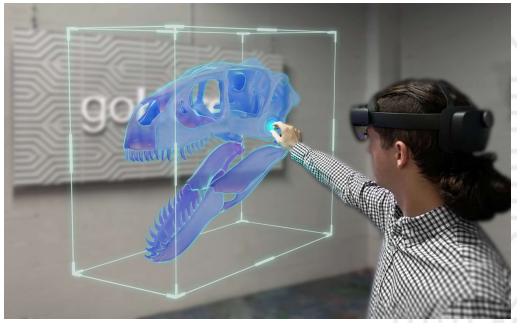
The new Reality

Virtual Reality

Augmented Reality

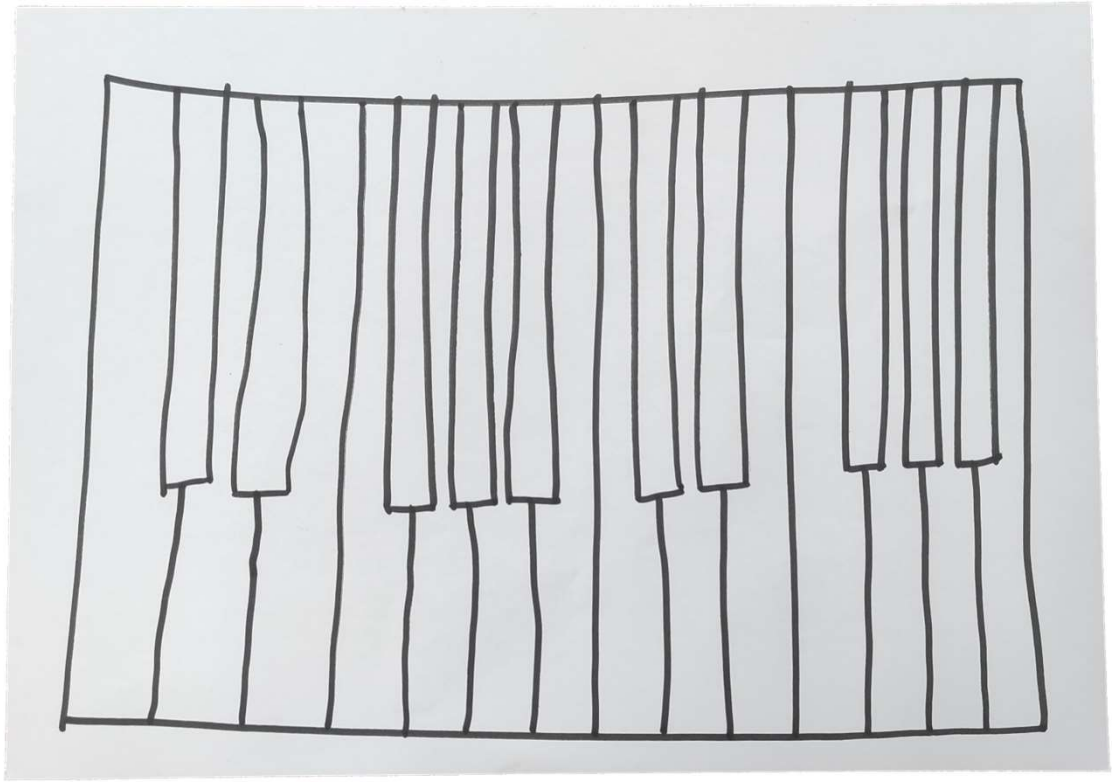


Mixed Reality



The goal

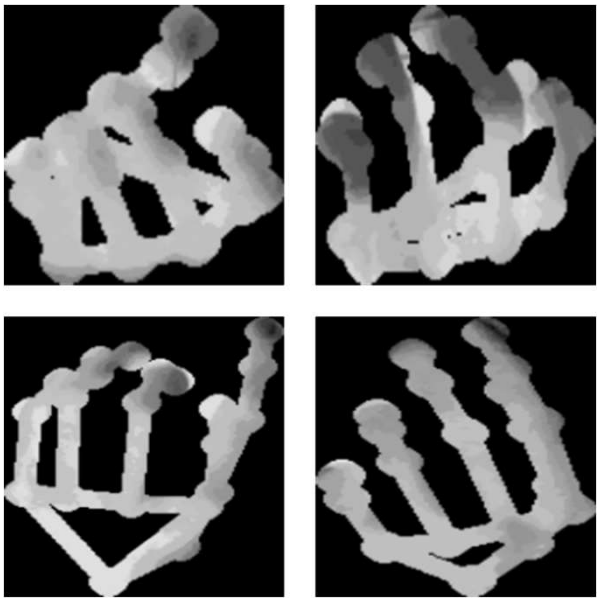
Hand-drawn keyboard, real notes



- Education
- Cheap
- Lightweight

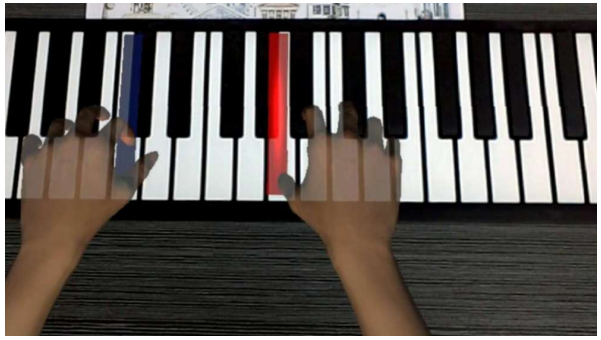
Related work

VR, AR and MR in music education and training

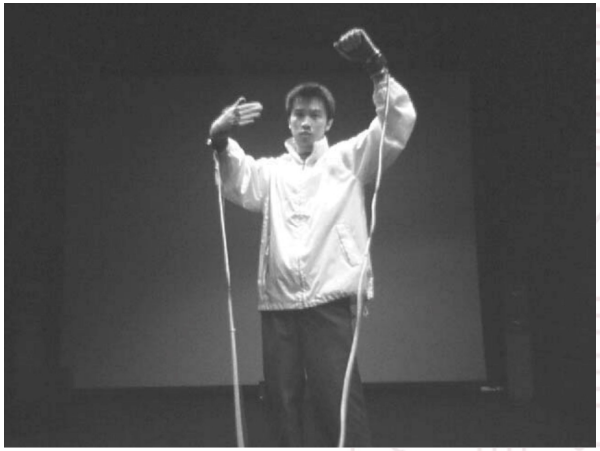


V. Nagpurkar, N. Pattankar, T. Nayak, A. D'Souza, and N. Henriques, "GuitarGuru: A Realtime Guitar Chords Detection System," in 2023 International Conference on Communication System, Computing and IT Applications (CSCITA), 2023

S. Serafin, S. Gelineck, N. Böttcher, and L. Martinussen, "Virtual reality instruments capable of changing physical dimensions in real-time," 2005



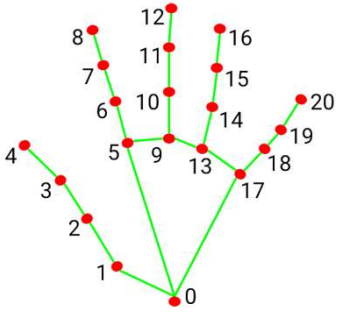
R. Guo, J. Cui, W. Zhao, and S. Li, "AI and AR Based Interface for Piano Training," in 2020 International Conference on Virtual Reality and Visualization (ICVRV), 2020

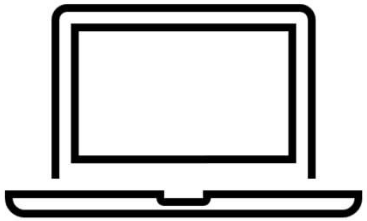


H. H. S. Ip, K. C. K. Law, and B. Kwong, "Cyber Composer: Hand Gesture-Driven Intelligent Music Composition and Generation," in 11th International Multimedia Modelling Conference, 2005

The first prototype

Webcam, LeapMotion, MediaPipe





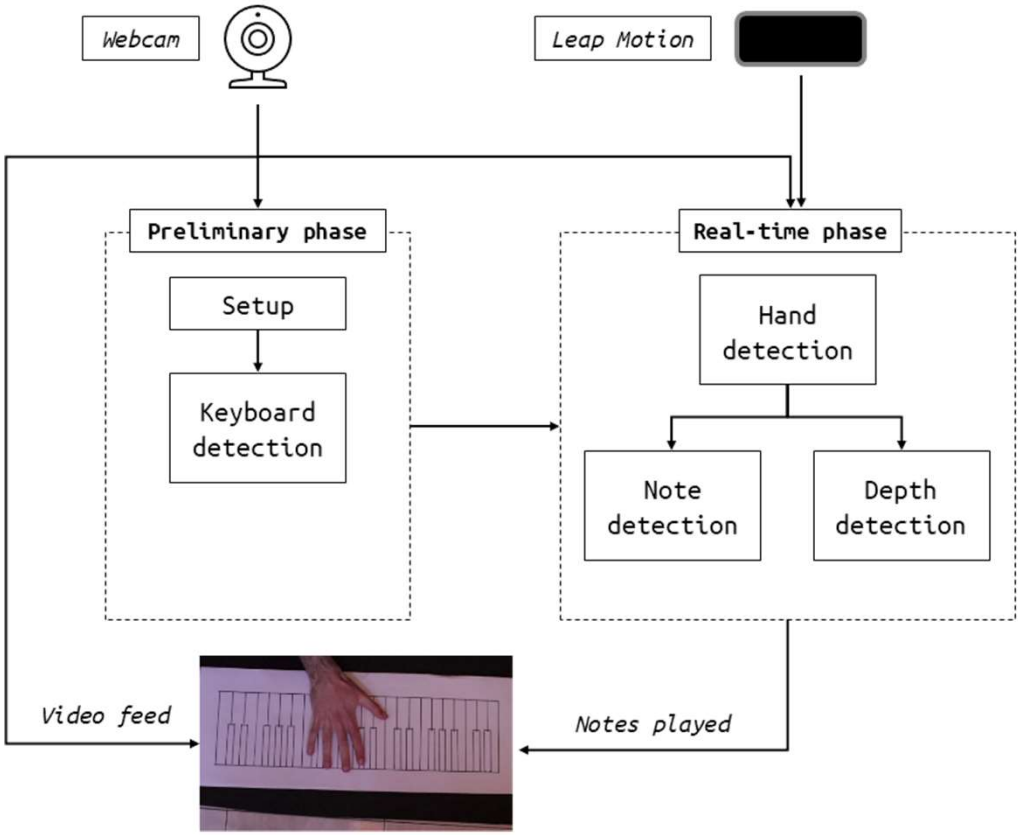
CAIP 2023

VisionLab

D. Avola, L. Cinque, M. R. Marini, A. Princic, and V. Venanzi, “Keyrtual: A Lightweight Virtual Musical Keyboard Based on RGB-D and Sensors Fusion,” in Computer Analysis of Images and Patterns, 2023

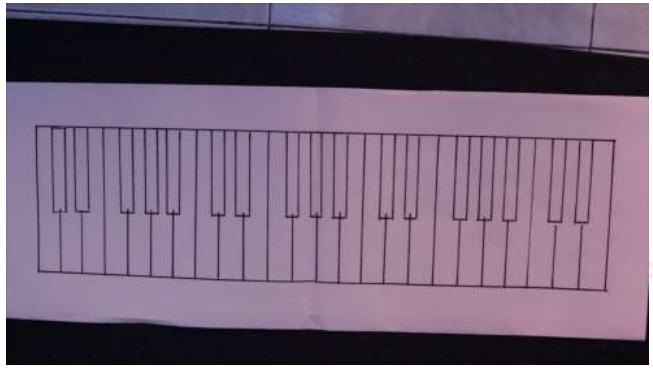
The first prototype

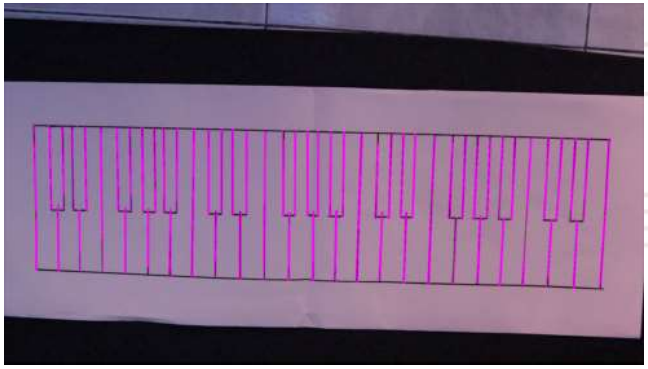
Architecture



The first prototype

Keyboard detection

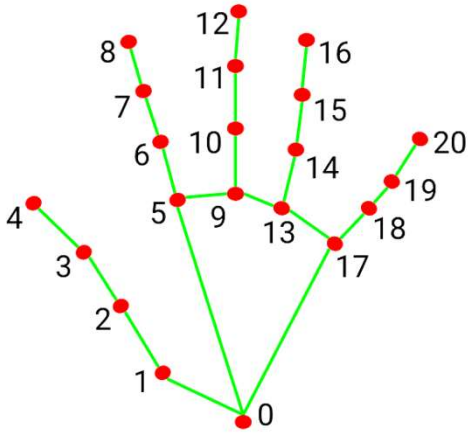


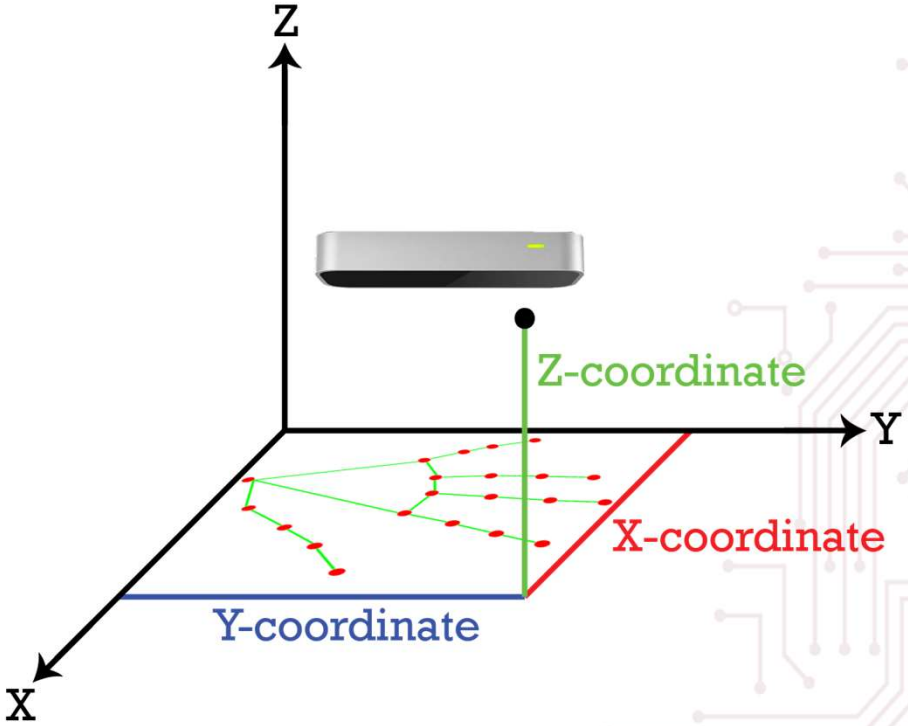


- Background subtraction
- Adaptive thresholding
- Canny edge detector
- Hough lines
- K-means

The first prototype

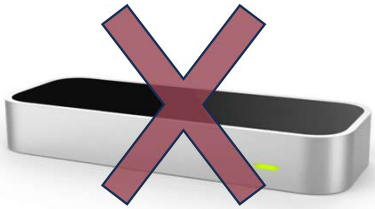
Hand detection

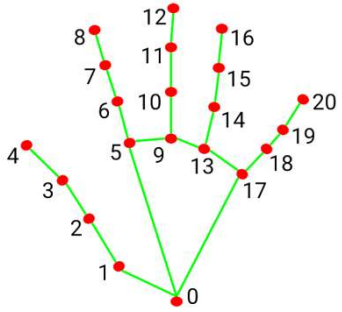


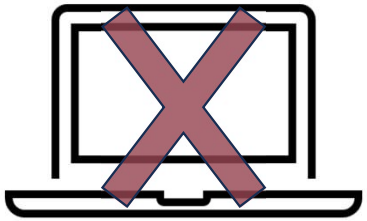


The application

All you need is a smartphone





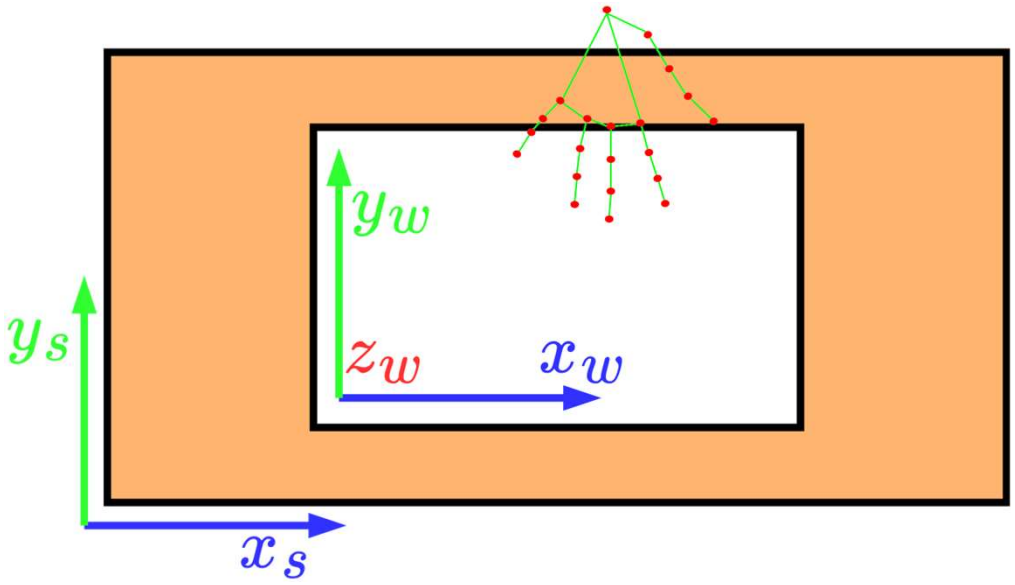


The application

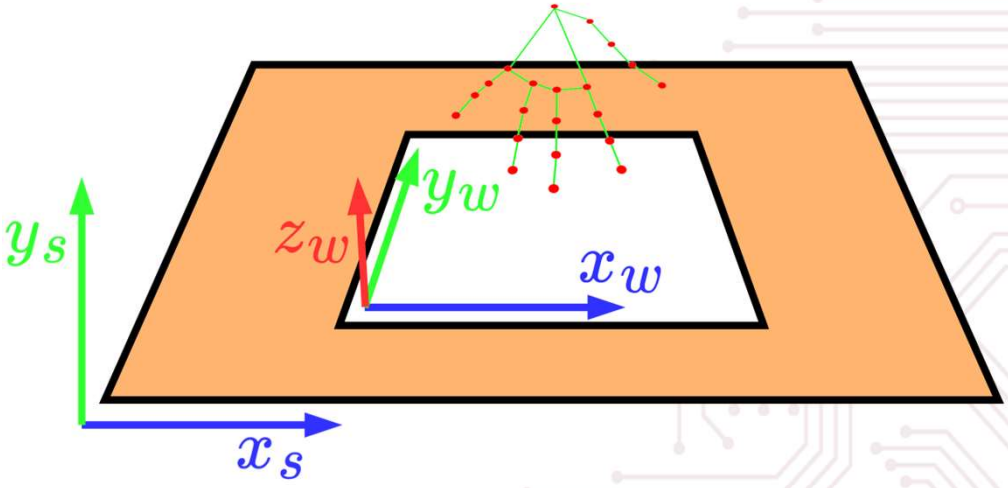
Porting strategies: depth sensors and stereo vision

The application

Porting strategies: camera angle



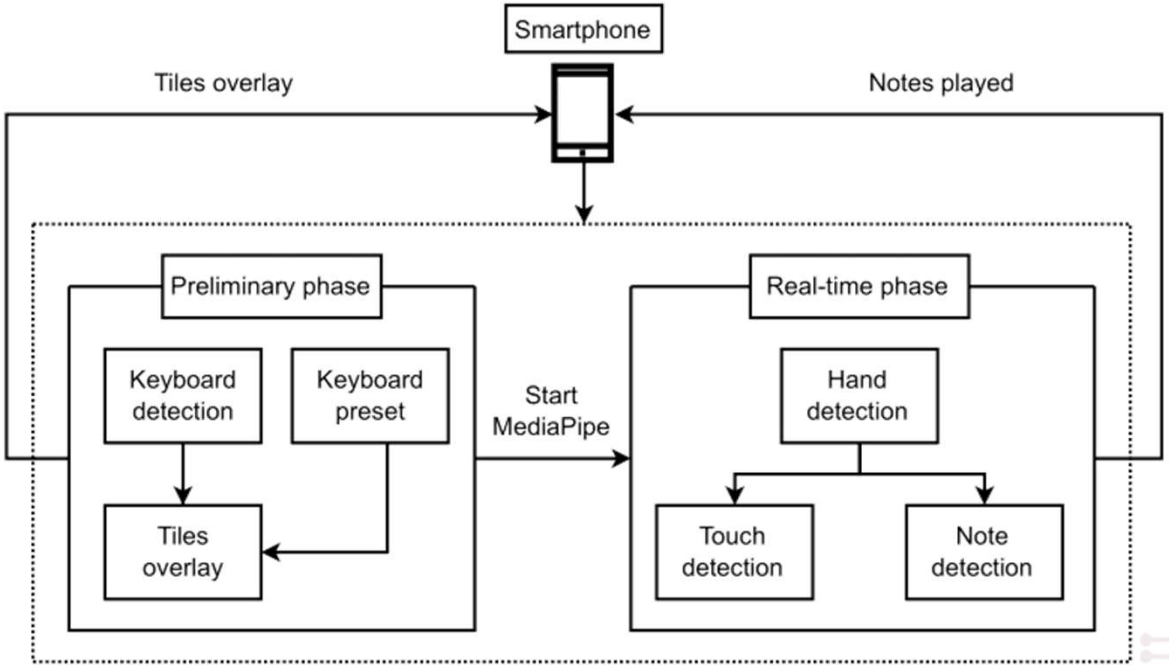
90°



45°

The application

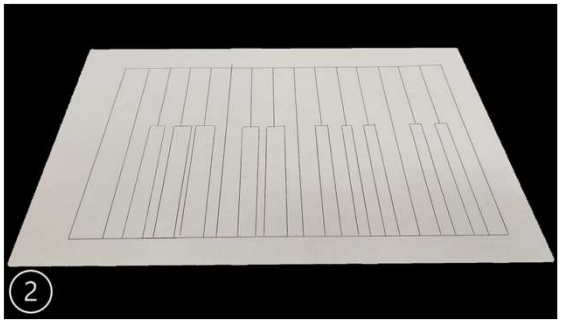
Architecture



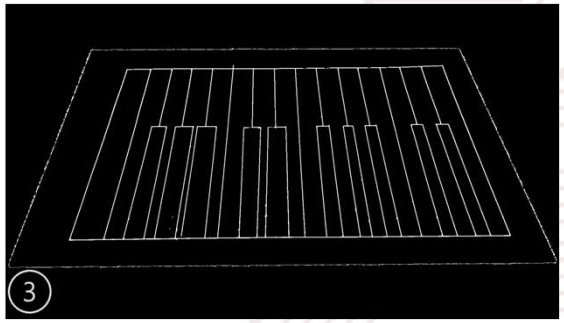
The application

Keyboard detection

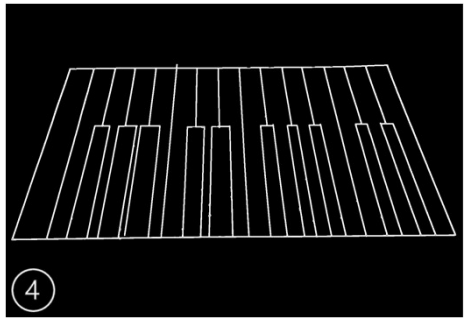
Perimeter



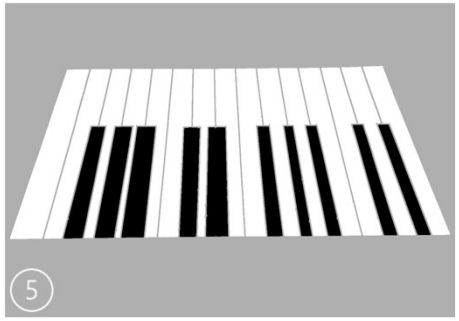
Background subtraction



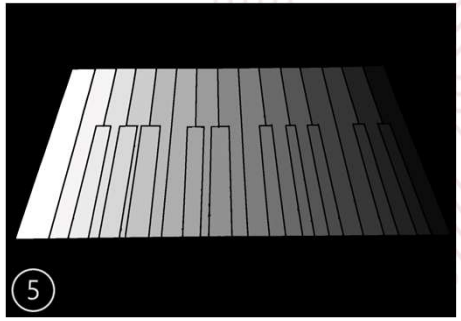
Canny edge detection



Contour detection



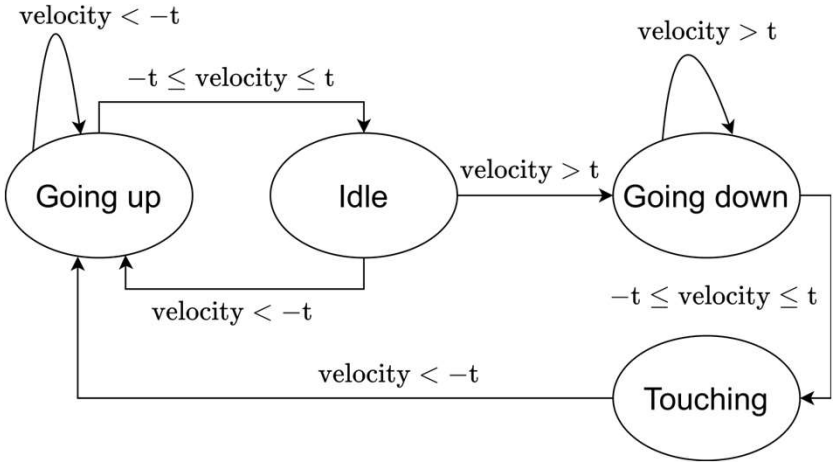
Tiles overlay

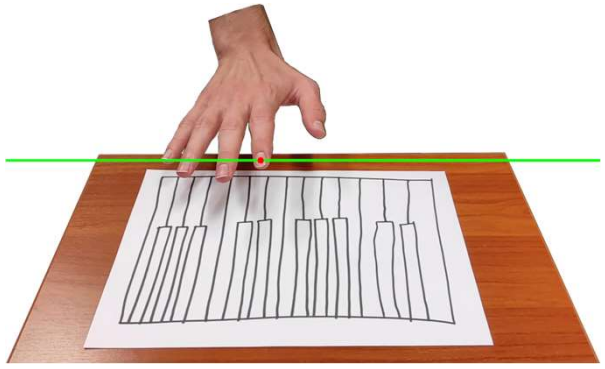


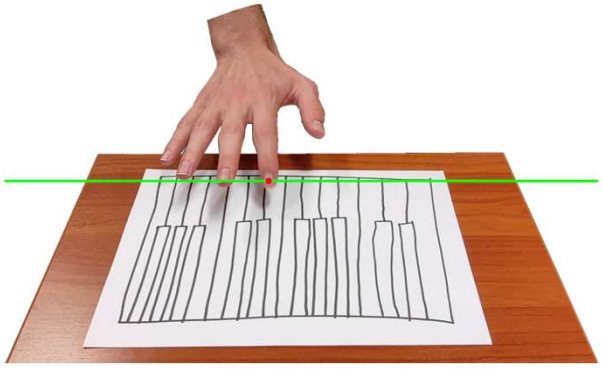
Notes array

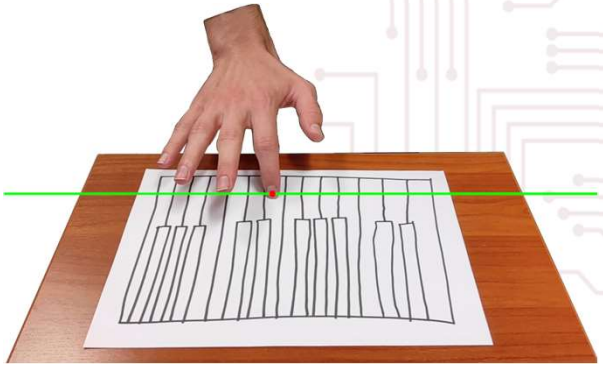
The application

Touch detection



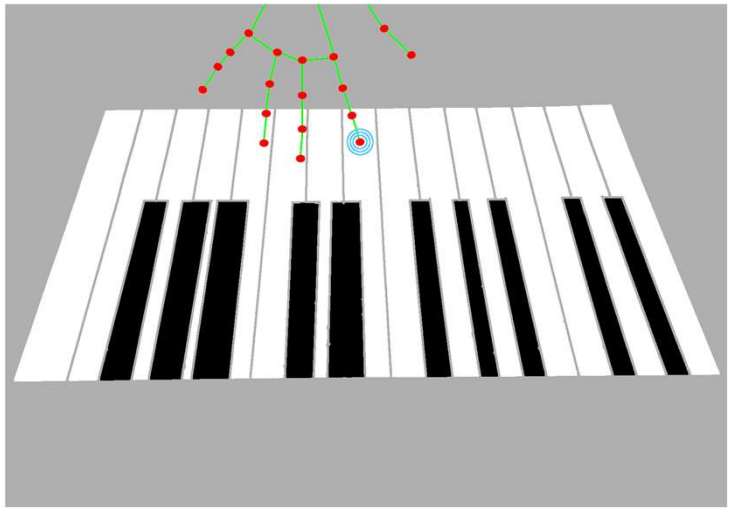


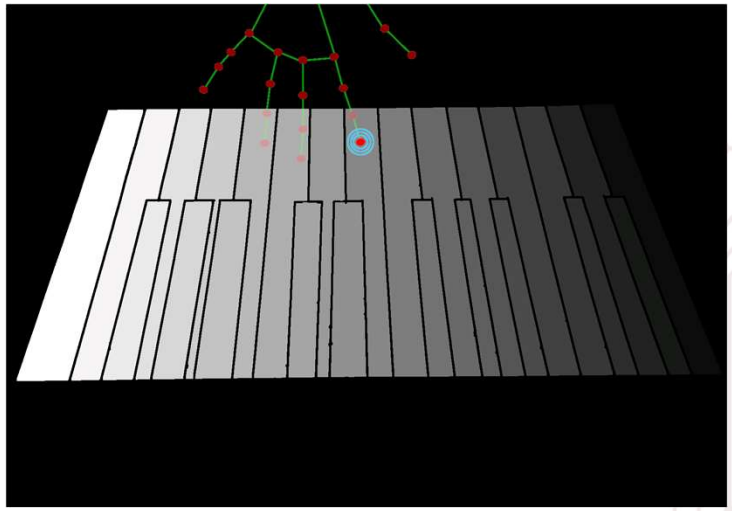




The application

Note detection





Results

Prototype vs Application

Quantitative results

Keyboard detection

	Pixel accuracy
Hand-drawn	95.00%
Drawn with ruler	96.74%
Printed	97.69%

Real-time phase

	Accuracy	Precision	Recall	F_1
Prototype	90.27%	56.87%	99.40%	72.35%
Application	87.40%	80.23%	81.18%	80.70%

Qualitative results

Usability questionnaire (UMUX)

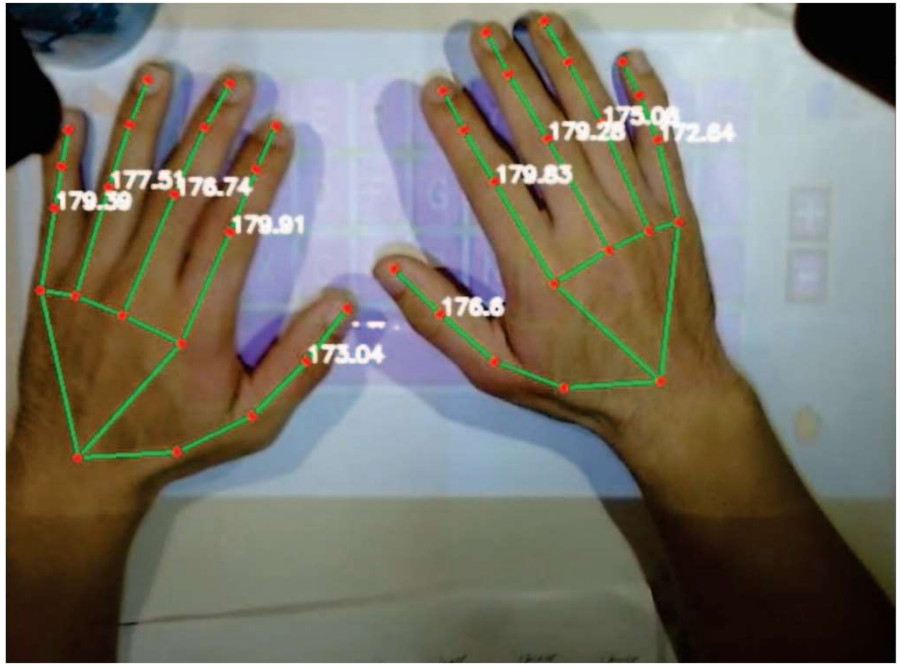
	Minimum	Average	Maximum
Prototype	70.83%	79.86%	87.50%
Application	84.11%	92.28%	97.91%

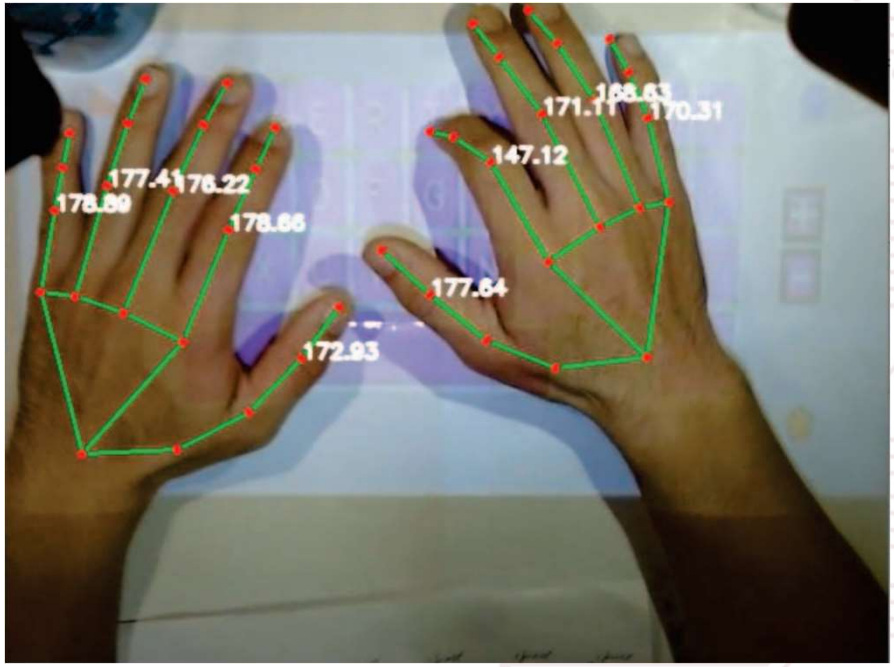

21°
Roma
Soleggiato
Google
Play Store
Galleria
Archivio
17:31

Thank you!

The application

Future development





D. Bisht, A. Pal, and S. Banerjea, “VKM: A Virtual Keyboard and Mouse Solution Towards a Lightweight Computing System,” in 2024 20th International Conference on Distributed Computing in Smart Systems and the Internet of Things (DCOSS-IoT), 2024

The application

Future development