

Ten Years of Magic Mirror: I and My Avatar

Alexander K. Seewald¹ and Alexander Pfeiffer²

¹ Seewald Solutions, Lärchenstraße 1, 4616 Weißkirchen a.d. Traun, Austria

² Danube University Krems, Dr. Karl Dorrek Straße 30, 3500 Krems, Austria

alex@seewald.at, alexander.pfeiffer@donau-uni.ac.at

What is Magic Mirror? (1)

Augmented Reality with Magic Mirror metaphor: shows mirrored camera images with overlaid graphical elements

- Shows face mesh over each person's face which tracks face poses in real time, leaving the eyes and mouth of the person visible for interaction ~ an Avatar
- Replaces background with images that may be changed, smoothly zoomed and dragged
- Allows to take screenshots which are automatically printed out on photo cards with QR code linking to its digital twin
- Control via easily learned hand gestures similar to multitouch screen gestures known from mobile phones and tablets
- First demonstrated at FROG 2012 (12.-13.10)
(also at FROG 2013,2014,2017 and in many other places)

Motivation: Building demo for gesture recognition ;-)

What is Magic Mirror?

At previous FROG conferences we put up a live demo for the duration of the conference so everybody could take a look and try it out themselves.

That is sadly not possible due to COVID19 and this being an online streaming conference, so we will show a short video (3min) instead.

Many more videos can be found at <https://mm.k4w.at>

Supported Hand Gestures (1)

	move		<p>Slide with your hand to the left or the right to activate left or right move gesture. Either hand will work, only the direction of movement is important.</p>	
	zoom		<p>Make a diagonal movement with both hands. Push both hands out to the front and move them away from each other (zoom in) or towards each other (zoom out), then retract them again.</p>	

Supported Hand Gestures (2)

one-handed-drag



Raise either hand to press the left mouse button. Afterwards push the other hand out to the front. This controls the mouse cursor. By moving the other (non-raised) hand you can drag the background image around just like normal drag-and-drop.

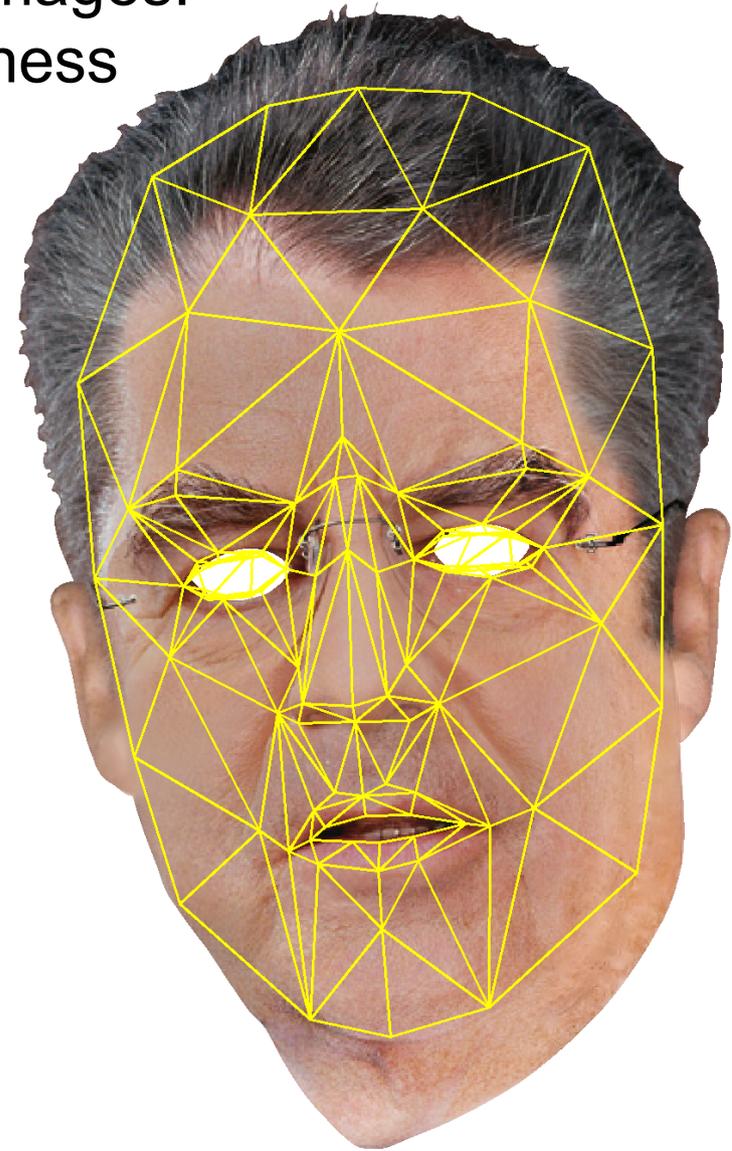
two-handed-drag



Push both hands out to the front. This controls the mouse cursor. By moving either or both hands, you can drag the background image around just like drag-and-drop. The center point between both hands is used for dragging, so using both hands will make the drag faster.

Creating High-Quality Face Textures

0. Actually get a face mesh from 2D images!
1. Remove highlights, equalize brightness
2. Make eyes larger and see-through
3. Finetune using face mesh editor
4. Parts outside face = transparent



Extended Face Mesh

Using 3D vector arithmetic to extend face mesh, allows rendering out-of-face parts such as hair, beards, forehead, ears - and also enables see-through face masks!



Face Sets

Faces	Comments
	<p>One-face version</p>
	<p>Two-face version</p>
	<p>Easter Bunny Theme, see also Sec. 4.2</p>
	<p>Halloween Theme; printout with QR- code; pseudo-alpha- blending; z-Skeleton filtering (see text)</p>
	<p>X-Mas Theme</p>

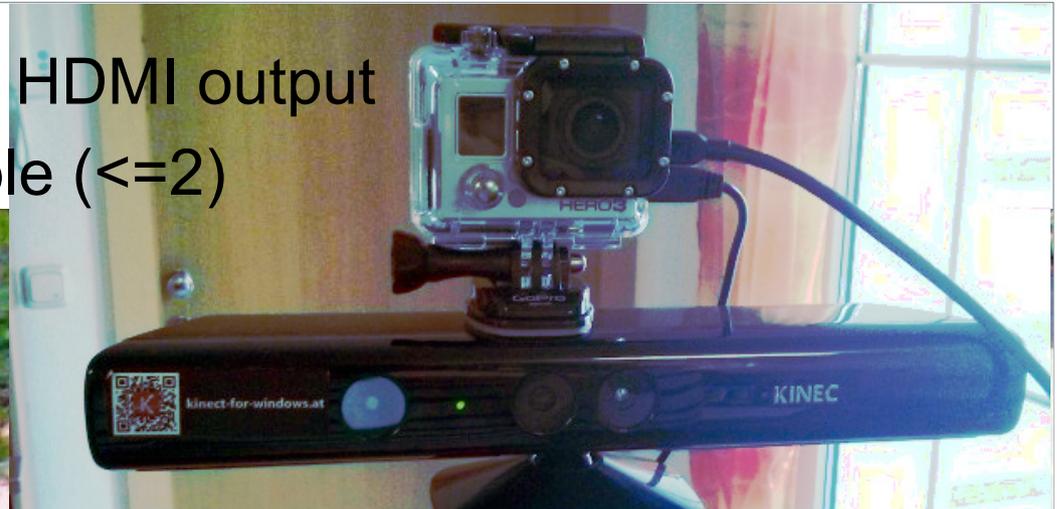
V1.0

1280x720 resolution fixed-focus; using z-filter with user-configurable cut-off distance (~ chair & table); 1 person



V1.5

1920x1080 by 2nd camera w/ HDMI output
Shows only recognized people (≤ 2)



MAGIC MIRROR

UNIVERSAL
REMOTE



KINECT
FOR WINDOWS

<http://magic-mirror.kinect-for-windows.at>

PFEIFFER-MEDIEN
IMAGE- UND WISSENSTRANSFER

SEEWALD
SOLUTIONS

V2.2

1920x1080 (Kinect V2 native), up to six people in parallel: print cards w/ QR-Code link; Major effort: API completely changed!



MAGIC MIRROR

UNIVERSAL
REMOTE

KINECT
FOR WINDOWS

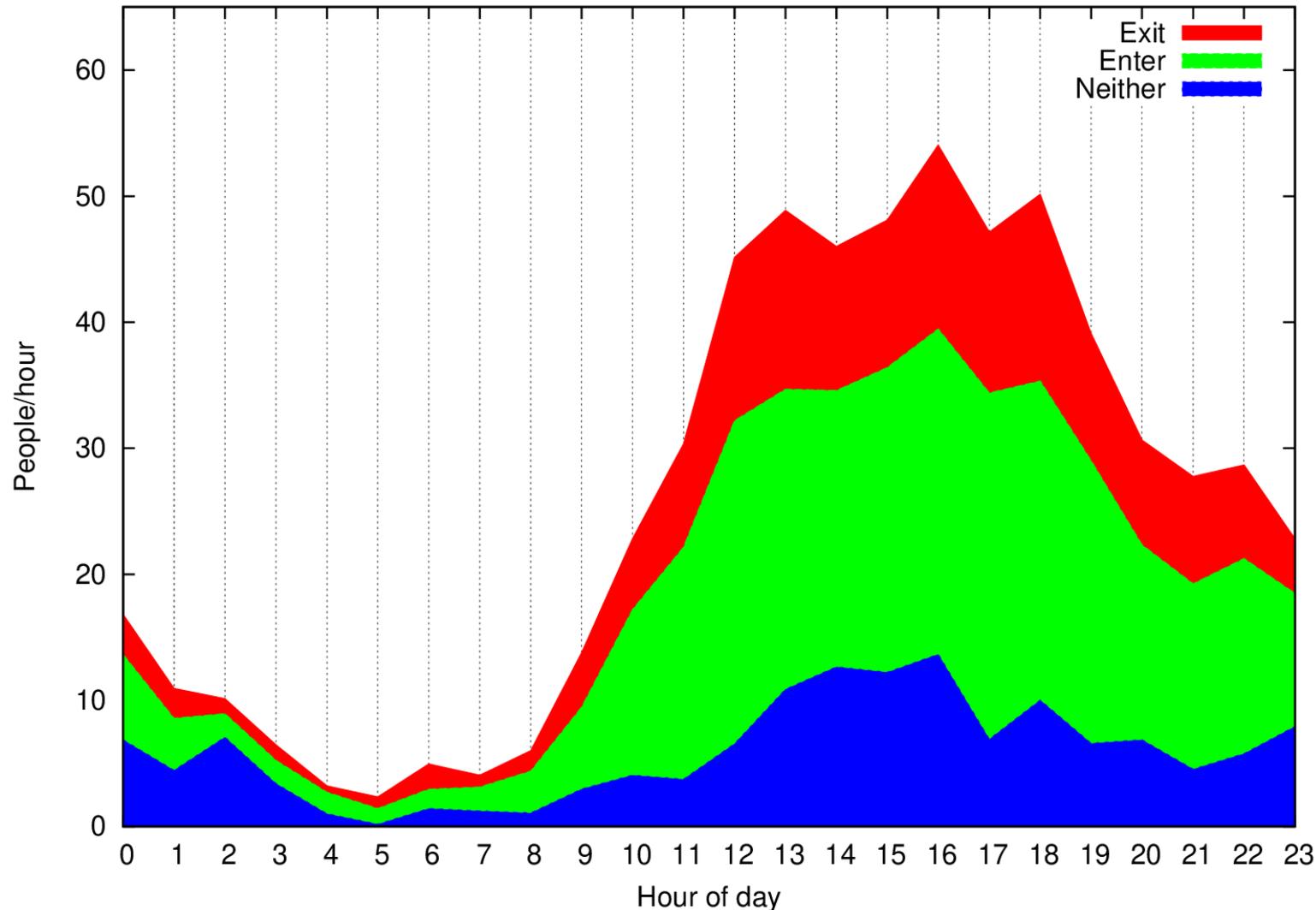
<http://magic-mirror.kinect-for-windows.at>

PFEIFFER-MEDIEN
IMAGE- UND WISSENSTRANSFER

SEEWALD
SOLUTIONS

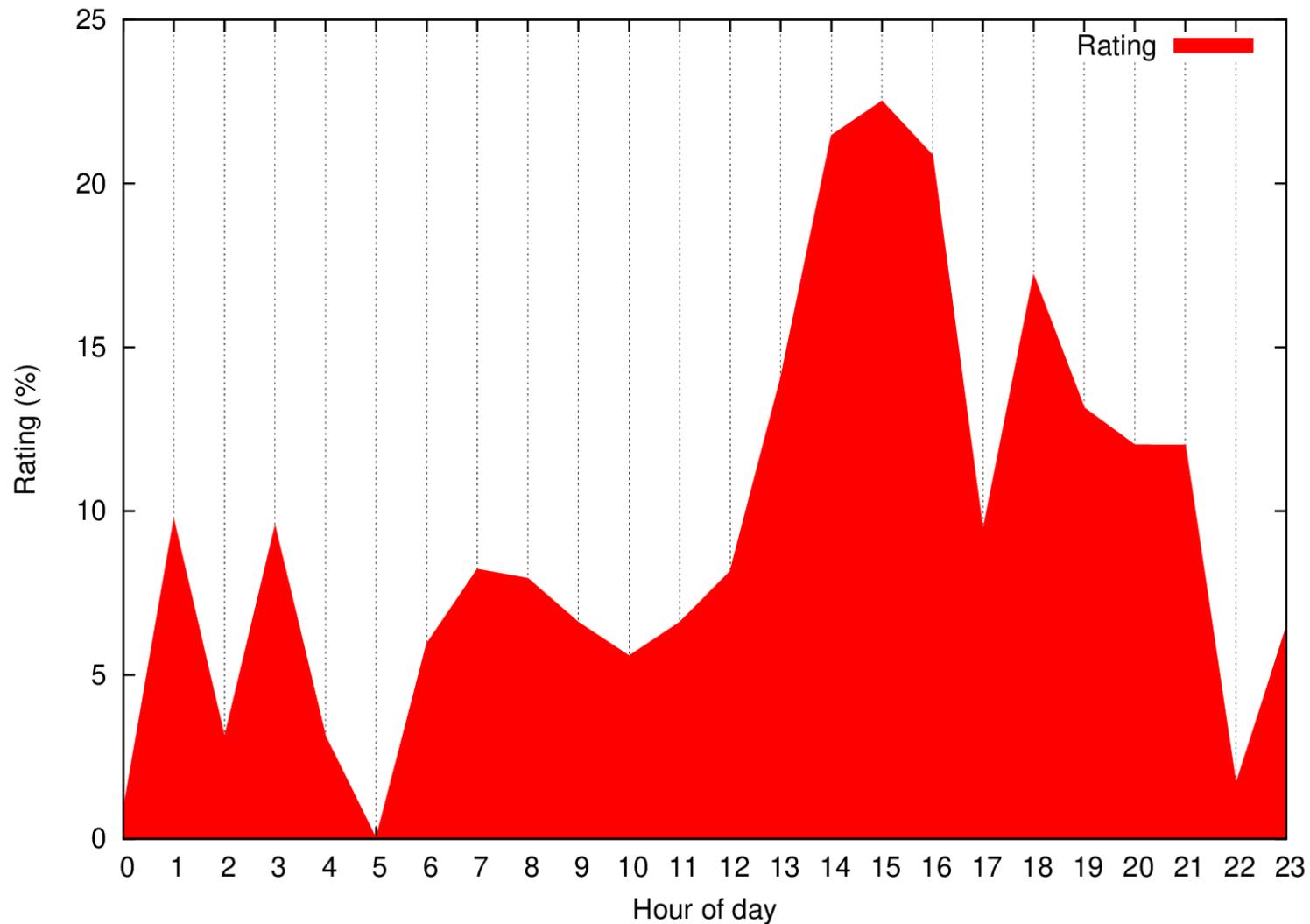
Counting People Passing

Counting people entering and leaving Museumsquartier Vienna (MQW) over 21 days, averaged by hour-of-day



Shopping Window Rating

Computing proportion of recognized faces by recognized people averaged over hour-of-day (~ *window attractiveness*)



Gaze Direction Heatmap

What people are - very roughly - looking at, depending on head position, and relying on idiosyncrasies of face tracker...



Estimate Body Height

- Estimate body height by computing distance from floor plane for head center + (head center - shoulder center)
- Best case: 4.3% accurate (based on one sample)
- Worst case: True height is within +/- 0.3 σ of average height

$$plane_{floor} = a * x + b * y + c * z + d \quad (6)$$

$$dist_{part} = \frac{|a * part_x + b * part_y + c * part_z + d|}{\sqrt{a^2 + b^2 + c^2}} \quad (7)$$

$$height = dist_{head} + (dist_{head} - dist_{shoulderCenter}) \quad (8)$$

(Works only for Kinect V2)

What did we learn?

- Looking through shopping windows w/ depth cameras is **hard**
- Depth cameras do not work at all in bright sunshine (need at least *some* shadow)
- People with a distinct face will tend to be less recognizable since their irregular face mesh will be mapped to the - usually more regular - source face mesh for rendering (e.g. Barack Obama)
- It's possible to track people movement, head and gaze direction, even create a gaze direction heatmap, and determine approximate height of people *without* storing any personal data, by subtle analysis of native API output.
- People really enjoyed our system every time we demonstrated it (especially kids - we must have printed hundreds of cards)
- Never rely on a single hardware or software platform ;-)

Future Work

- Adapt Magic Mirror to other related sensors (depth cameras, laser-range sensors, ultrasound, ..., stereo cameras)
- Make it run on smaller non-Windows platforms (e.g. Raspberry Pi, Smart-TVs)
- Enable high-quality tracking through window glass and outside in sunshine. This will likely need specially developed hardware.

Ten Years of Magic Mirror

In 2022 it will have been 10 years since we started this project.

To celebrate this, we will make a publicly available long-term installation ($\geq 3M$) with multiple Magic Mirrors - as many as we have functioning Kinects left, and at least all previous versions.

Location Constraints

- Must be in summer and w/o FFP2 masks
- Must be indoors or outdoors in all-day shadow, no rain
- You'll probably need to come to Austria...

If interested, please check <https://mm.k4w.at> for updates or send an email to alex@seewald.at .