



Revisiting AR Piano Projection

Chapter 0

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Hi, I'm Jordan!

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instagram



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github

about me



PhD
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CS program



HICUP Lab

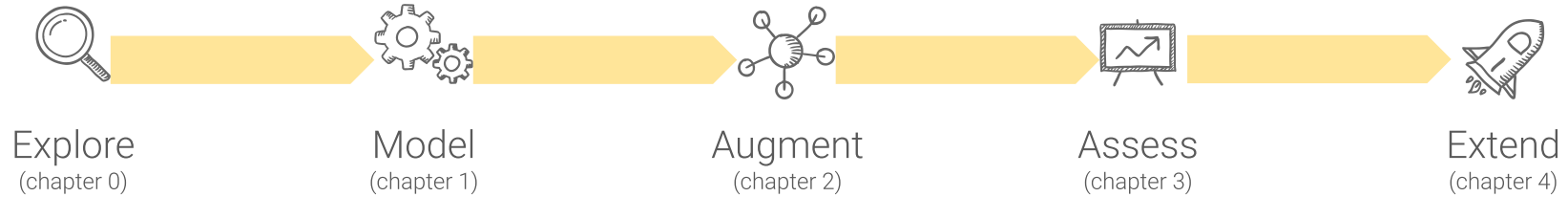


Filipino

my research (in plain english 😂)

use AR viz to help newbies learn the
piano in a less-overwhelming way

this presentation is part of a bigger story



key takeaways from this presentation..



how to do RL surveys (or at least an idea on how to..)



how to position your thesis (based on gaps in your findings)



key findings on AR piano

for today 🌟

we will look at existing AR piano
prototypes



in this survey 

 review
method

 trends

 strategies

 discussion

 future



PRISMA Technique (Moher, 2008)

Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PRISMA (steps done)



database search



IEEE Xplore[®]



remove
duplicates

conference proceedings, journal articles.



filter criteria

"augmented reality piano", "AR piano", "augmented reality keyboard", "AR keyboard"



analyse

publication details, contributions, AR application, citation count, study design, results



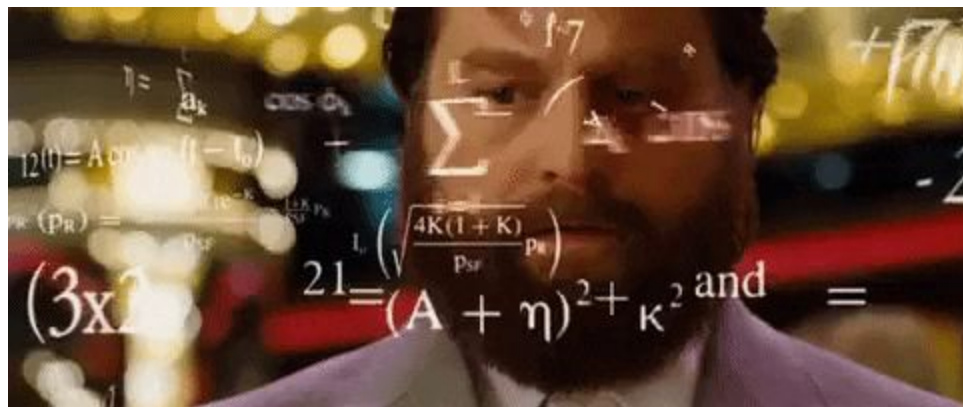
retrieve data



316



40 articles



disclaimer on my findings...



too few articles reviewed



field is underdeveloped



findings are only
“indicative”

6 contribution categories



AR keyboard

a keyboard rendered as graphics that users can “press”



AR agent/tutor

a virtual character that helps the user play/learn



piano roll

set of visualizations that guides users on what/when to press



user studies

design experiments and setups that evaluate usability, learning, etc



hand tracking

use of algorithms that track hand/finger/movement



learning modes

interfaces and modes to help the users learn

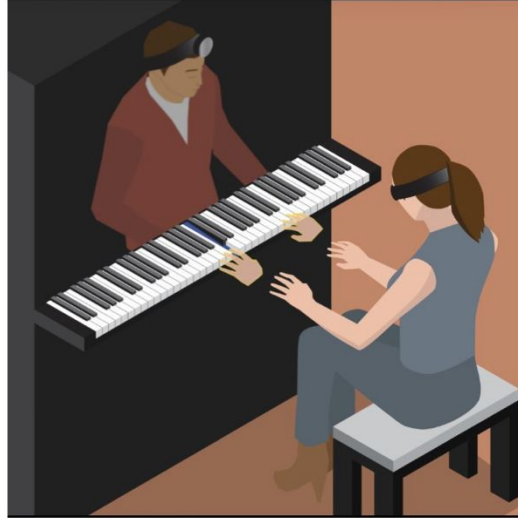


AR Keyboard





AR agent/tutor



piano roll





user studies



👉 hand tracking

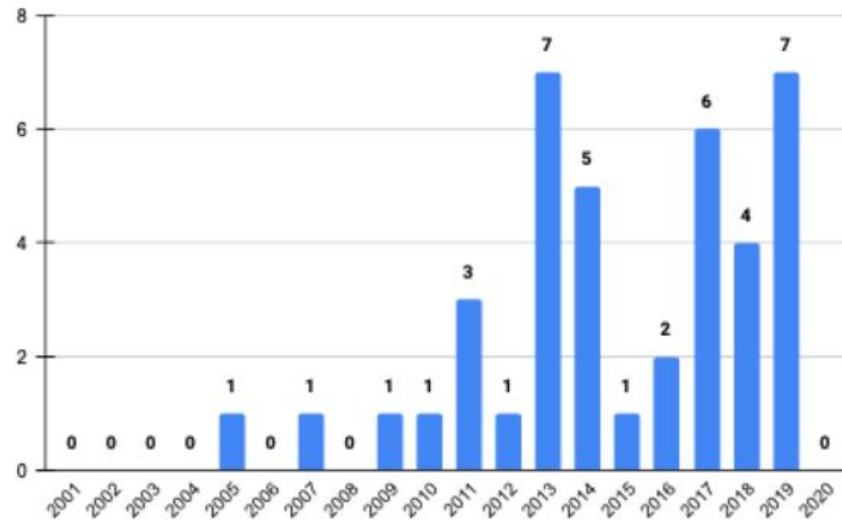




learning modes

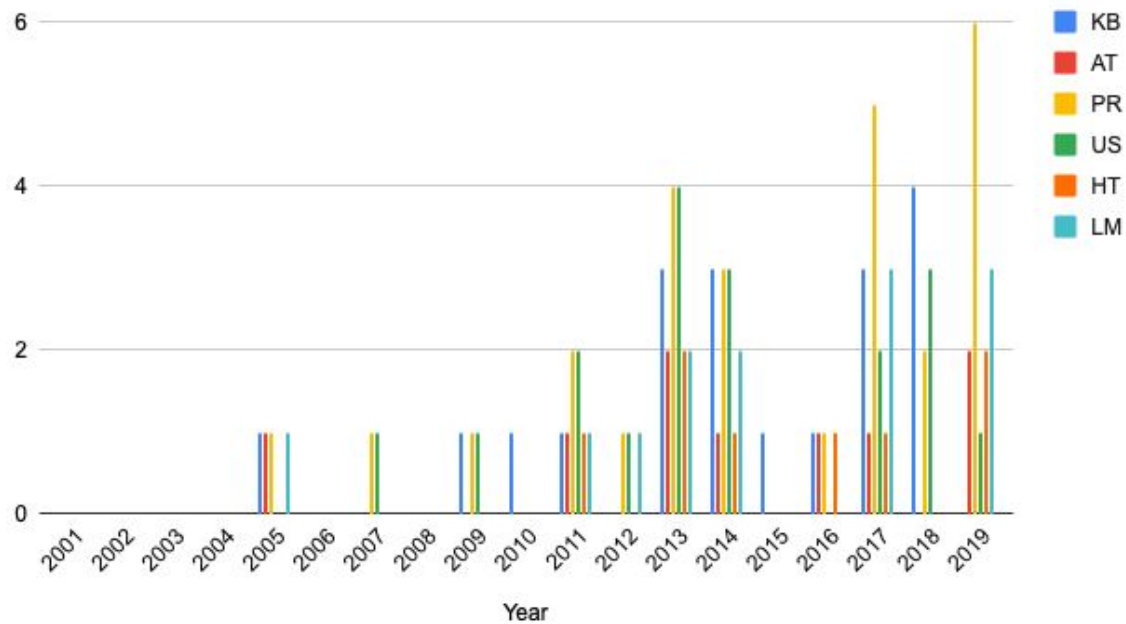


papers across the years



Paper	Author	Year	#	KB	AT	PR	US	HT	LM	Others
P1	Huang et al. [26]	2011	50	✓				✓		
P2	Nugraha et al. [41]	2014	38	✓			✓			
P3	Barakonyi and Schmalstieg [2]	2005	47	✓	✓	✓			✓	
P4	Chow et al. [11]	2013	45	✓		✓	✓		✓	
P5	Weing et al. [58]	2013	29			✓	✓	✓	✓	gamified viz
P6	Hackl and Anthes [23]	2017	7	✓		✓				
P7	Chouvatut and Jindaluang [10]	2013	8	✓		✓				supports PWD's
P8	Fernandez et al. [20]	2016	7		✓	✓				
P9	Das et al. [15]	2017	5	✓	✓	✓			✓	lesson builder
P10	Claudia et al. [13]	2017	0			✓				
P11	Trujano et al. [56]	2018	4	✓		✓				
P12	Kerdvibulvech [27]	2017	4	✓			✓	✓		users gesture on air
P13	Oka and Hashimoto [42]	2013	27					✓		piano fingering
P14	Liang et al. [34]	2016	20	✓				✓		
P15	Schmalstieg and Wagner [51]	2007	268			✓	✓			
P16	Correa et al. [14]	2009	63	✓		✓	✓			patients w/ cerebral palsy
P17	Xiao et al. [64]	2014	28		✓	✓			✓	
P18	Takegawa et al. [53]	2012	26			✓	✓		✓	
P19	Xiao and Ishii [62]	2011	31		✓	✓	✓			3 unique interfaces
P20	Xiao et al. [61]	2013	17		✓		✓			
P21	Li [33]	2018	1	✓			✓			
P22	Zaqout et al. [68]	2015	1	✓						
P23	Leonard et al. [31]	2013	9	✓			✓			
P24	Raymaekers et al. [45]	2014	14			✓	✓		✓	shooting game
P25	Rogers et al. [47]	2017	42			✓	✓		✓	
P26	Birhanu and Rank [5]	2017	2			✓			✓	
P27	Sun and Chiang [52]	2018	3	✓		✓	✓			one and two hand modes
P28	Goodwin and Green [22]	2013	10		✓	✓				
P29	Zeng et al. [69]	2019	2							used ar markers
P30	De Pra et al. [16]	2014	6	✓				✓		magnetic glove
P31	Molloy et al. [39]	2019	1			✓	✓		✓	cognitive load, motivation
P32	Cai et al. [9]	2019	1			✓			✓	formal & competition mode
P33	Gerry et al. [21]	2019	2		✓	✓		✓		leap motion capture
P34	Zhang et al. [70]	2010	22	✓						
P35	Pan et al. [43]	2018	2	✓			✓			single & pair modes
P36	Cai et al. [7]	2019	0			✓		✓		group piano
P37	Sandnes and Eika [49]	2019	0			✓				
P38	Kim et al. [28]	2014	11	✓		✓	✓			
P39	Xiao and Ishii [63]	2011	7			✓	✓		✓	practice modes
P40	Xu and Huisman [65]	2019	0		✓	✓			✓	self reflection
			\bar{x} =21	47%	22%	67%	45%	20%	32%	

Contribution types per year



Ref.	Size (n)	Treatment	Metrics or constructs	Tools	Notes
[41]	8	md, pc	At, Op, Us	SMQ	
[11]	7	pl	Sa, Us	OEQ	
[58]	5	ex, pr	CL, FI, No, Sa	SMQ	
[27]	1	pl	Sc, TI	TTM	
[51]	6	pl, qu	Sa, TI	PSP, SSI, TTM	
[14]	1	ex, qu	Op, Us*	REC, TTM	*patient motor effects
[53]	9	pl, pr	FI, No, Sc, TI	PSP, SSI, TTM	
[62]	5	pc, pl*	Im, Op	PSP, REC, SSI, TTM	*improvise a piece
[61]	15	ob	Im, Op, Us	SMQ, SSI	
[33]	17	ex, ob	Mo, Op	QUE*	*instrument from [71]
[31]	20	ex, pr	Op, Sa, Sk	OEQ, TTM	
[45]	–*	ex, pl, pr	At, Sa, Us	OEQ, REC	*open demo UT
[47]	74*	pc, pl, pr	At, CL, Sa, Sk, Us, TI	QUE†	*n ₁ =56, n ₂ =18, † [19, 25, 29, 60]
[52]	20	ex, pc, pl	Sc, Sk, Us, TI	PSP, TTM	
[39]	23	pl	At, Im, Mo, Us	OEQ, QUE*, SSI	*SUS [32]
[43]	13	pl, pr	Sc, Sk	OEQ, PSP, SMQ, SSI	
[28]	–*	ex, md	FI, Op	REC	*n not reported
[63]	3	ex, ob	Im, Us	SSI	
med.=8.5		\bar{x} =14.19			

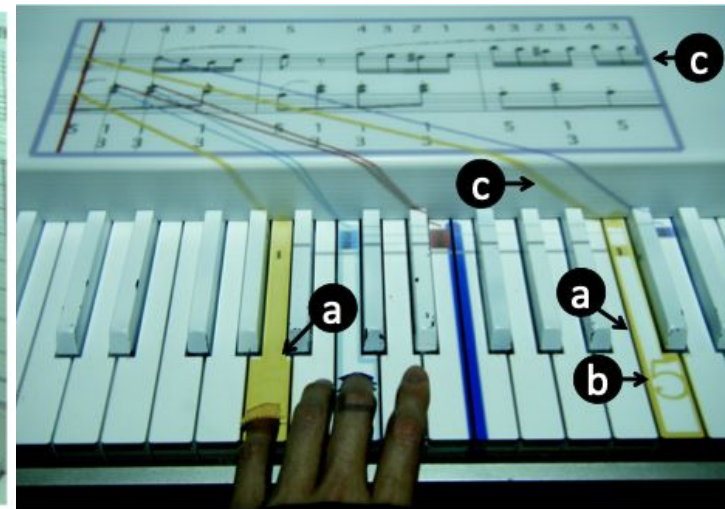
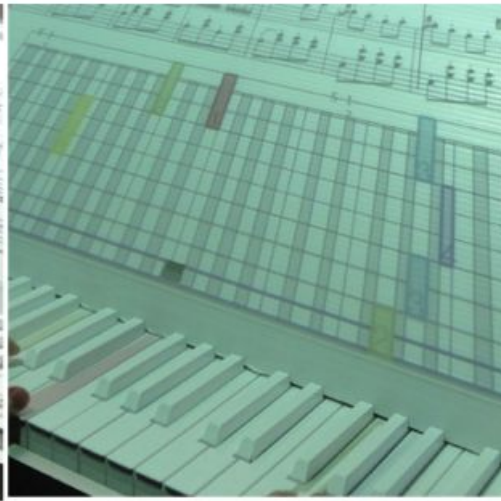
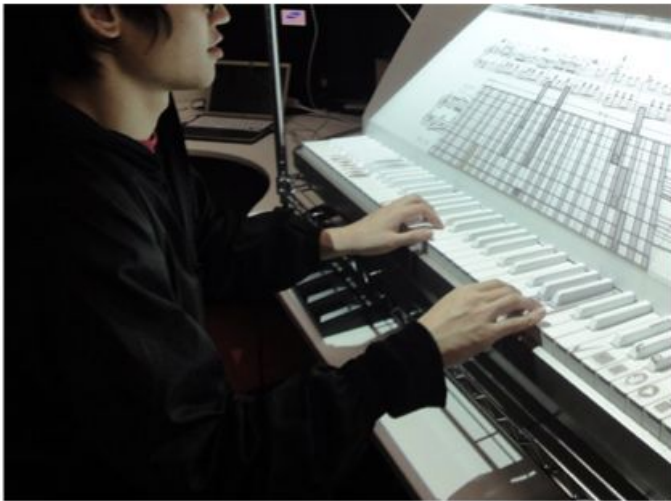
Treatment Legend: **ex**= free usage and exploration modes; **md**= marker detection; **ob**= observation of prototype usage; **pc**= play piano chords on the piano; **pl**= play a piece in the piano; **pr**= practice the piano; **qu**= complete quest in a game or gamified interface. **Metrics Legend:** **At**= attractiveness; **CL**= cognitive load; **FI**= accuracy of finger information; **Im**= level and quality of immersiveness; **Mo**= level of user motivation; **No**= accuracy of notation; **Op**= functional check of the different features of the prototype; **Sa**= satisfaction rating of the prototype; **Sk**= improvement in skill; **Us**= ease of use and usability; **TI**= time interval and usage of the system; **Sc**= scoring (for gamified prototypes). **Tools Legend:** **OEQ**= open ended questionnaires; **QUE**= used a peer-reviewed questionnaire/instrument; **PSP**= player scoring plug-ins; **REC**= observations from recordings; **SMQ**= self made questionnaire; **SSI**= semi structured interviews; **TTM**= time tracking mechanisms.

☀ highlights

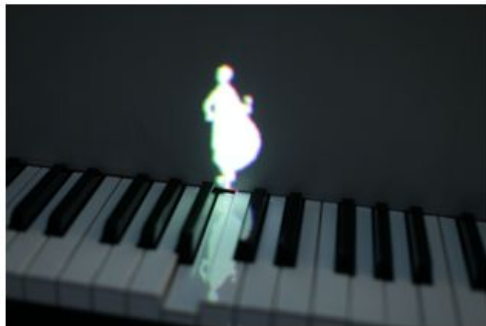
MirrorFugue reflections (Xiao 2010, 2011)



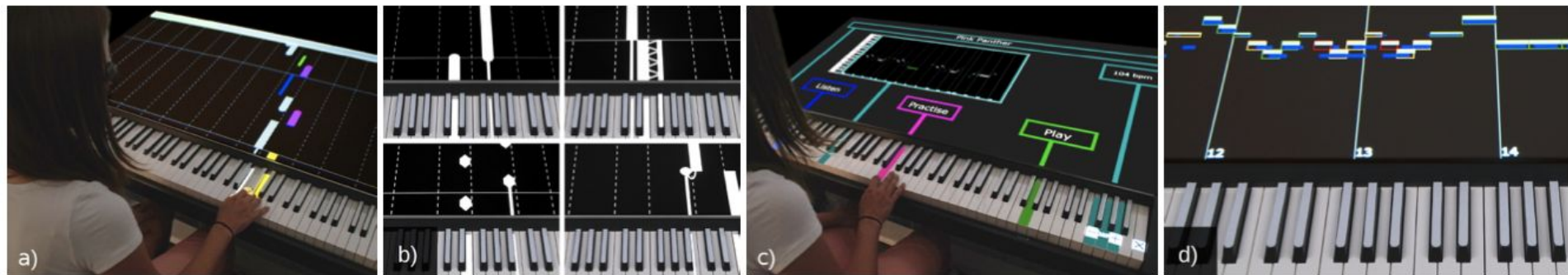
piano roll projections (Takegawa, 2012)



dancing agents (Xiao, 2013)



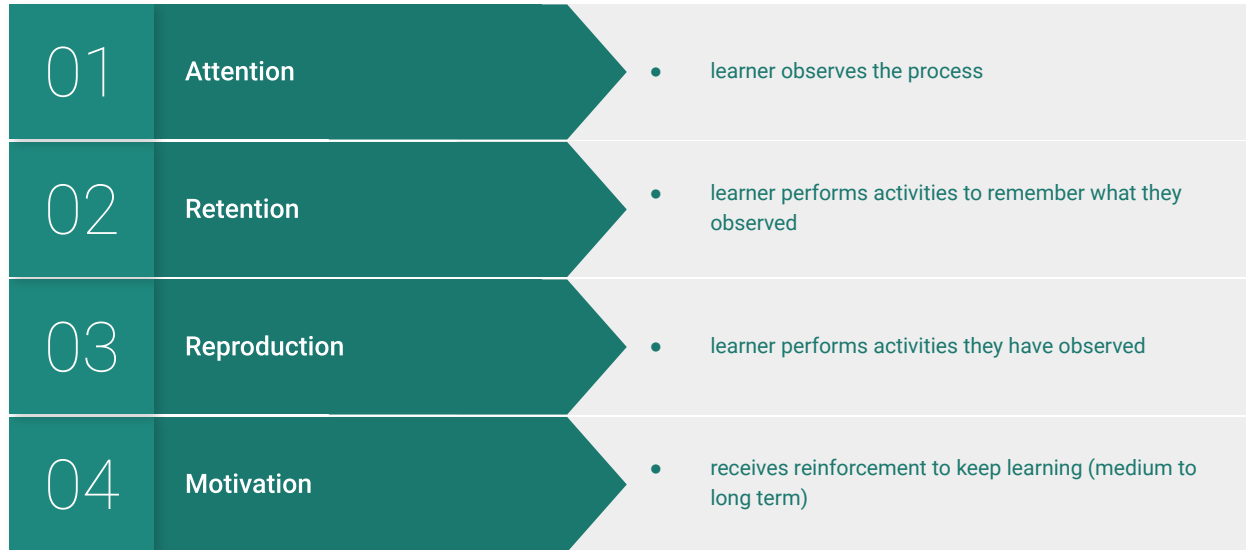
practice, listen, play modes (Rogers, 2014)



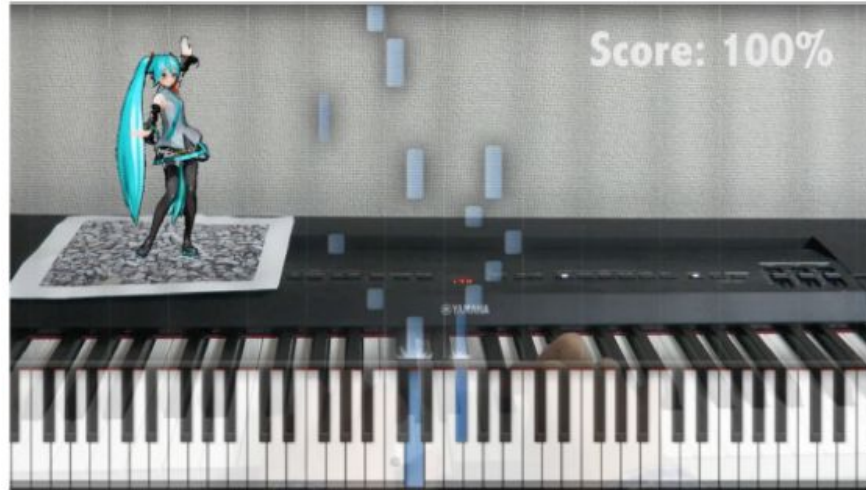
+ cognitive load

+ SLT

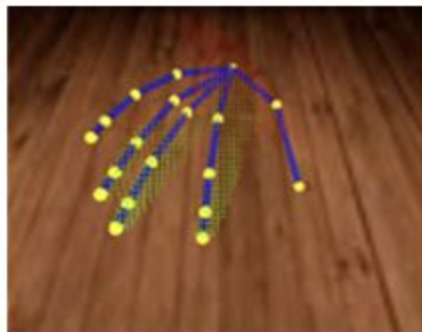
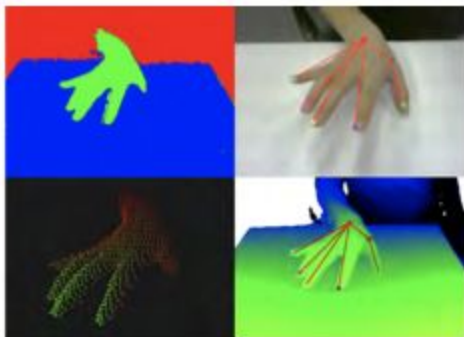
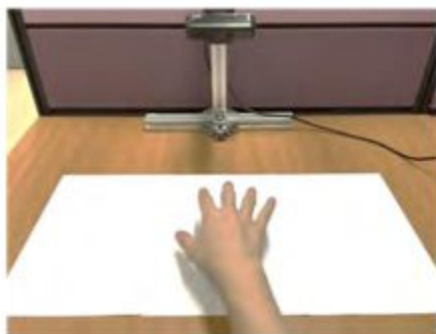
Social Learning Theory (Bandura & Walter, 1977)



anime agent (Goodwin, 2013)



hand tracking in pressing an AR piano (Liang, 2016)



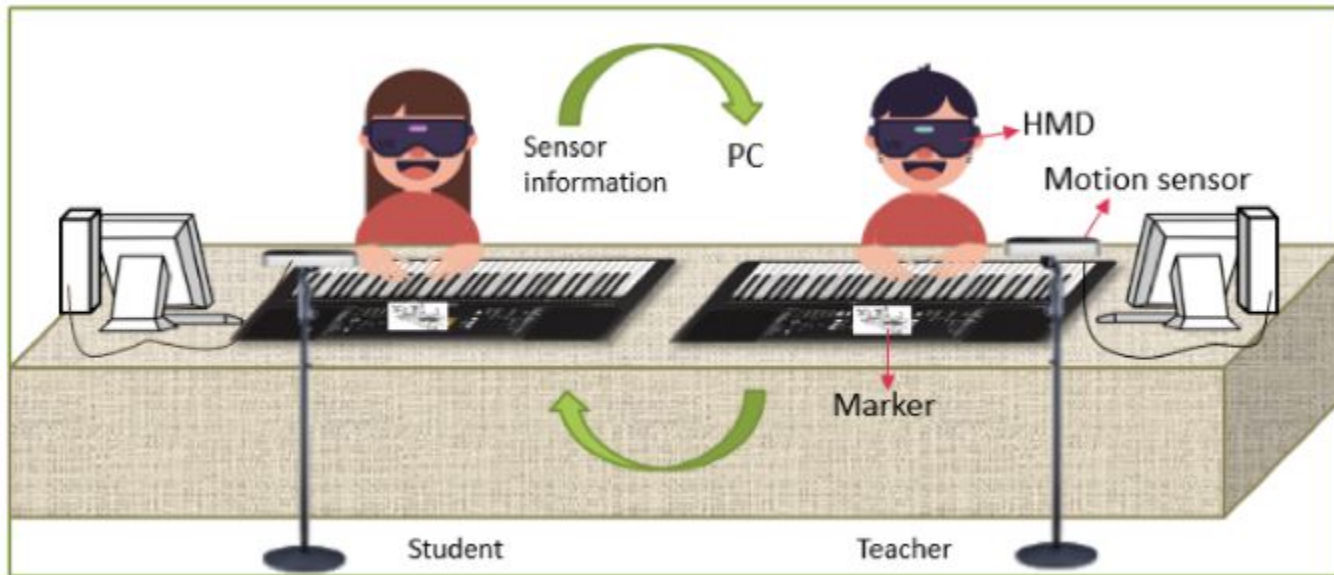
music everywhere-AR piano (Das, 2017)



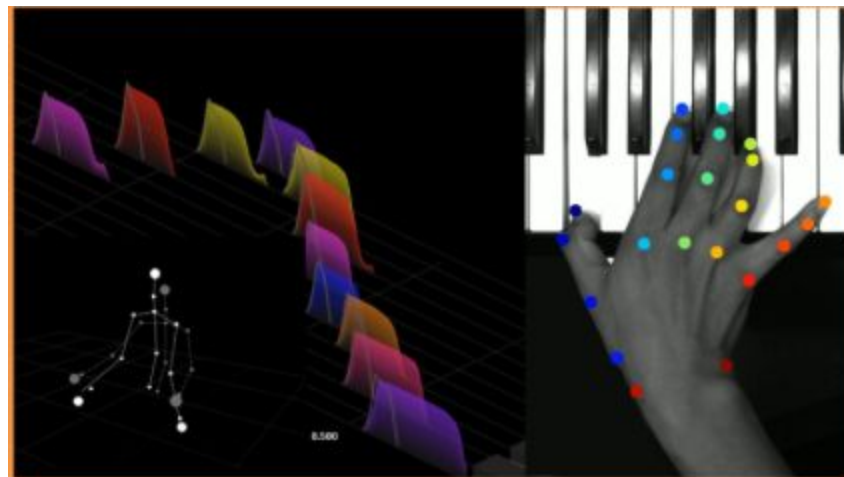
falling keys (Trujano, 2018)



competitive mode (Cai, 2019)



motion tracking injury prevention (Sony, 2020)



+ injury prevention

others



user affect

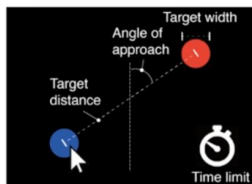
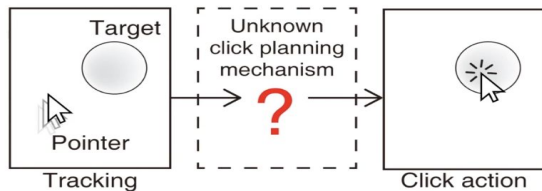


team/collaboration

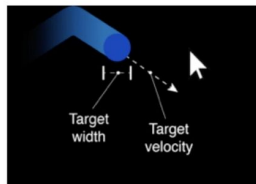


for rehab/injury prevention

recent work on spatiotemporal pointing (Park & Lee, 2020)



With stationary targets



With moving targets

spatio

with respect to space

temporal

with respect to time

spatiotemporal

with respect to both
time and space

what's lacking



“preventing errors”



modelling user movement

in summary



results of a literature
review



questions and
opportunities for future work

Jordan says **thank you!**

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