

Visual Assist with a Laser Pointer and Wearable Display for Remote Collaboration

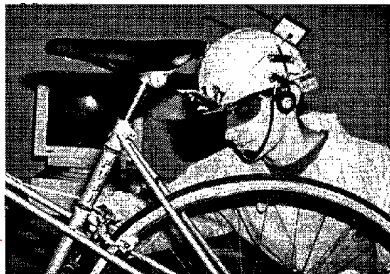
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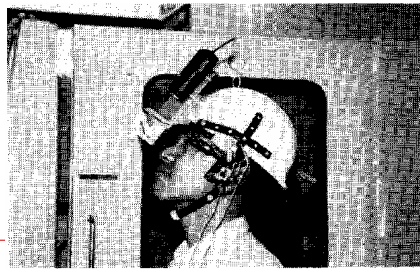
² AIST, Japan

Introduction

- Wearable collaborative system
 - Features
 - Moving in real workspace
 - Interacting with real object (not only with the system)
 - What's important?
 - Hands-free
 - Easy to move
 - Easy to use



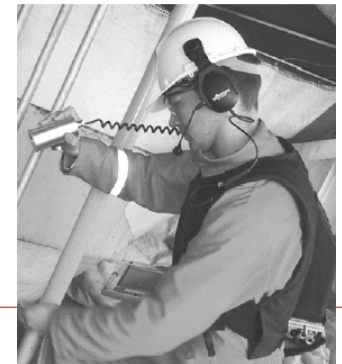
Kraut, et al CSCW96



Kuzuoka CHI'92



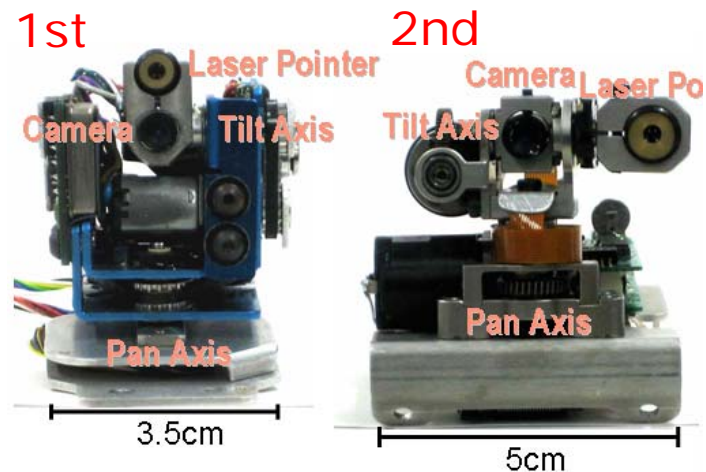
Mann, et al Telepointer



Bjørn Hestnes, et al ISWC'01

WACL (Wearable Active Camera with Laser)

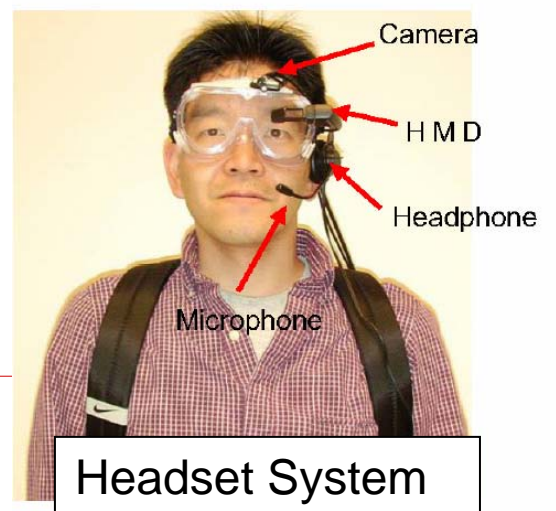
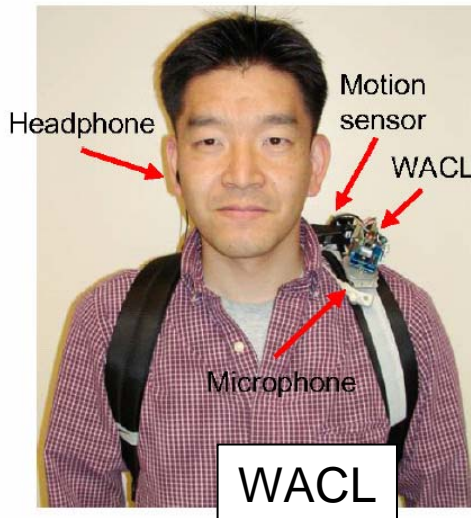
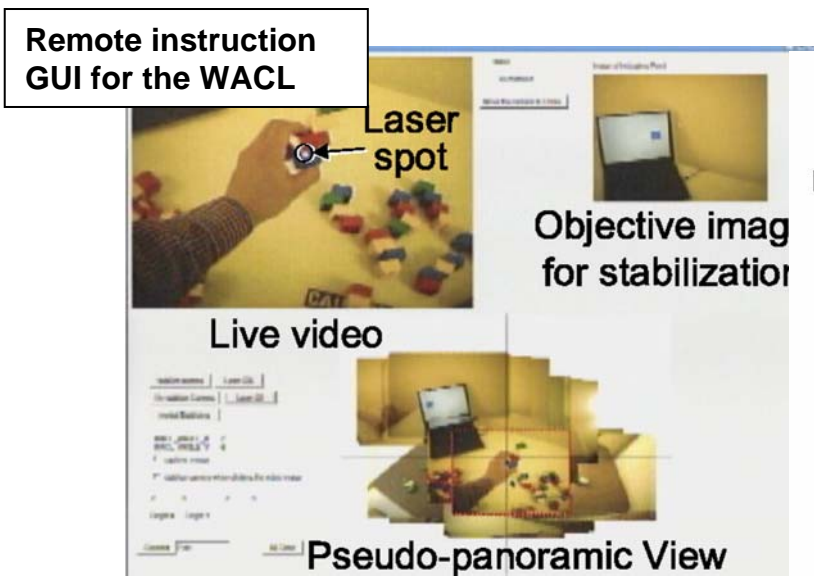
- A camera and a laser pointer on pan/tilt platform
 - The laser spot always exists in the center of captured videos.
 - Direct instructions by the laser spot
- Equipped with a motion sensor for stabilization of the camera head



Our previous research (1)

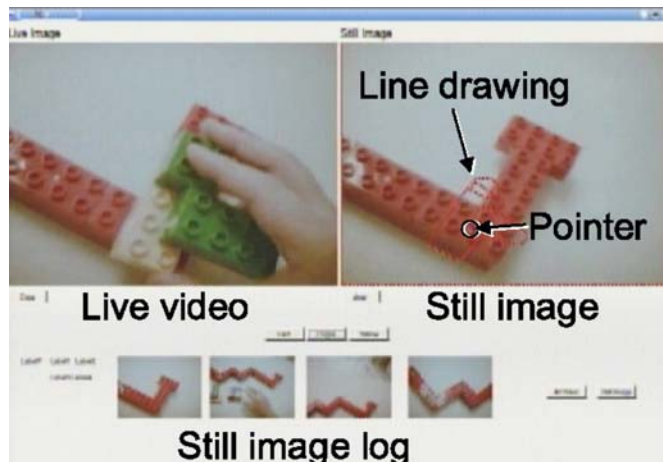
ISWC2004

- Compared the WACL to a typical headset system
 - No significant difference in the total completion time
- Advantages of the WACL
 - More comfortable to wear
 - More eye-friendly and head-friendly
 - Better view-controllability (Not dependent on worker's head)
 - Instructor can observe incoming work place while the worker is working.

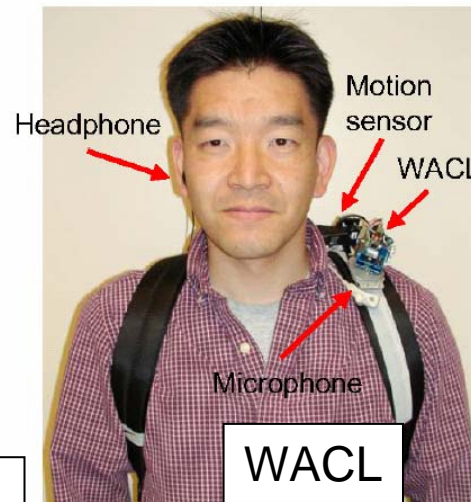


Our previous research (2)

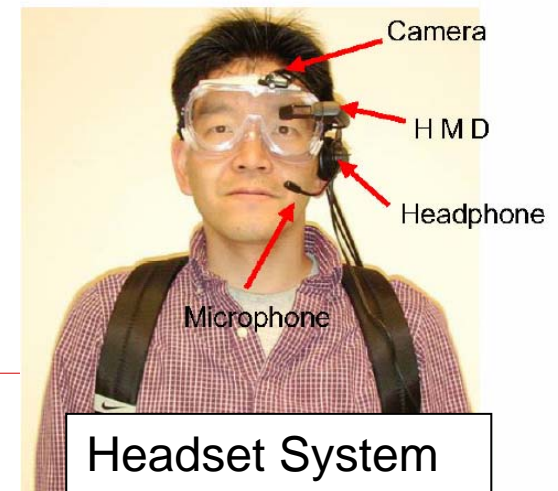
- ❑ Just saying “**The spot**” is enough for Object/Location identification.
- ❑ **But...**
- ❑ **When detailed instructions were needed, the expert talked more to the workers.**
 - Providing line drawings with HMD was very effective.



Remote instruction GUI for headset System



WACL



Headset System

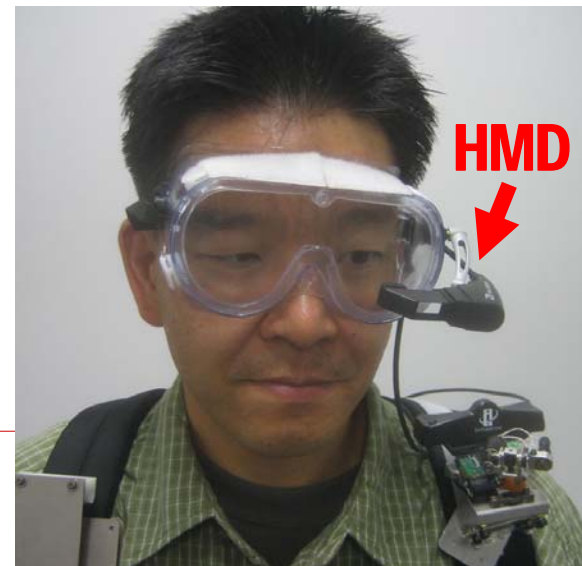
Focus of this research

CollabTech2006

- Explore additional displays suitable for providing workers wearing the WACL with advanced visual assists.
 - Chest-Worn Display (**CWD**)
 - Preserved the WACL advantages (hands-free, eye-free and head-free)
 - **HMD**
- User study to compare **WACL/HMD** condition with **WACL/CWD** condition



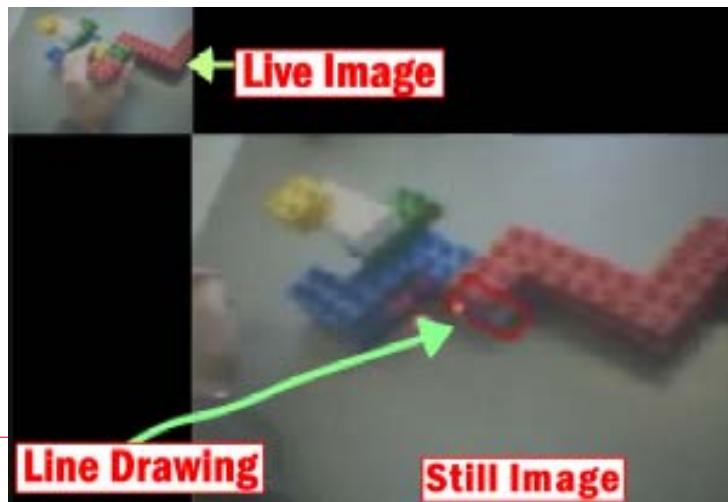
VS



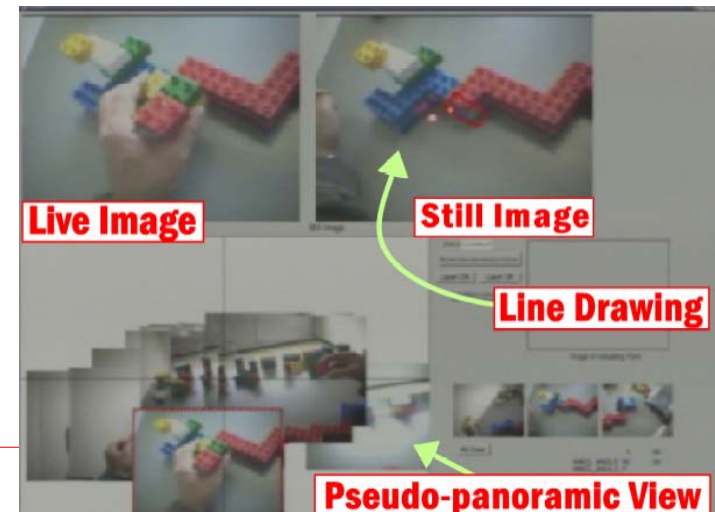
User Test



- Display a still image with line drawing on the additional display
- Examine task performance and difference of usability
- **Hypotheses**
 - The workers wearing the HMD can watch visual assist efficiently.
 - Because of less change in the field of view
 - The HMD imposes more burdens than wearing the CWD.
 - Because of tightening users' head and binocular rivalry



Visual assist displayed on the CWD or HMD.



GUI for remote experts.

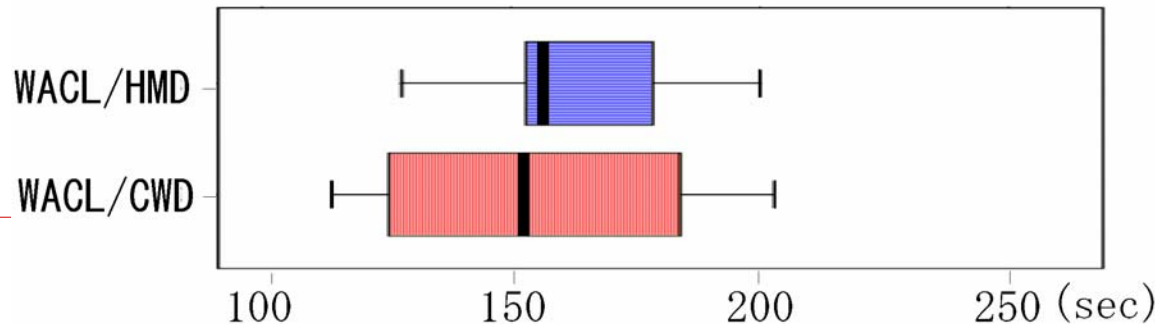
Video

<http://unit.aist.go.jp/itri/itri-rwig/cie/ari/Demo-e/Videoclips-e.html>

Completion time



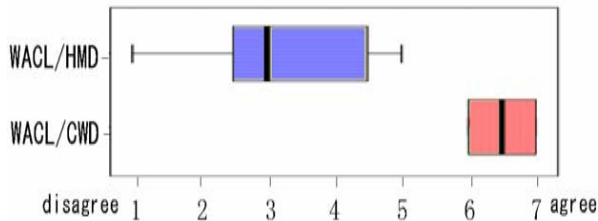
- No significant difference between WACL/HMD and WACL/CWD ($p=0.208$)
 - Even if comparing only
 - “block-cluster selection phase” (identification) or
 - “connection phase” (detailed explanation)



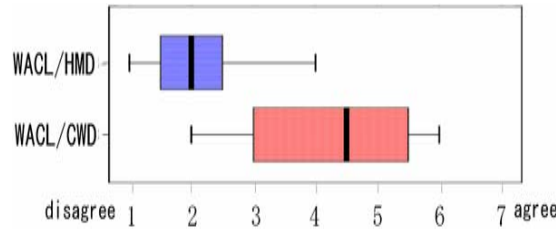
Workers' impressions (relative & absolute)



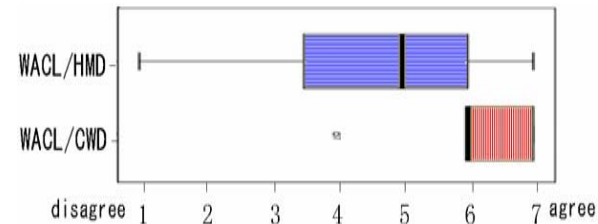
- The relative ratings
 - "WACL/CWD" can be adapted faster and ease the tasks more.
 - "WACL/HMD" made workers more tired. (By a one-sample t-test test value: 4)
- The absolute ratings
 - "WACL/CWD" got good impressions. (By the Wilcoxon signed rank test)



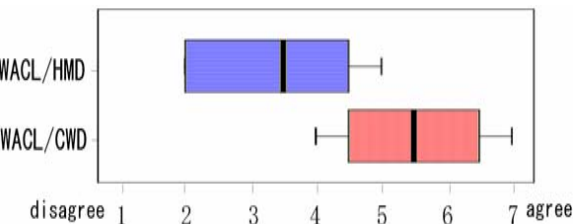
"Was it easy to see the real workspace?"



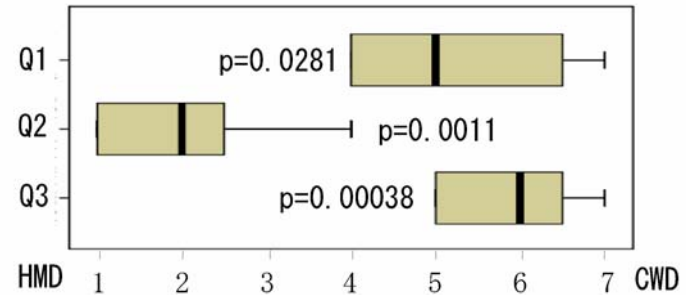
"Wasn't there any Uncomfortable feeling by wearing the device?"



"Was it easy to find the indicated block and place?"



"Was it easy to see visual assist?"



Q1: Which device did you feel that you could adapt yourself to faster through training?

Q2: Which device made you tired more when you did the trial?

Q3: With which device was it easy to do the task?

p=0.0281

p=0.0011

p=0.00038

Visual Link



□ Hypothesis, “The worker wearing the HMD can watch visual assist efficiently”, differed from the results.

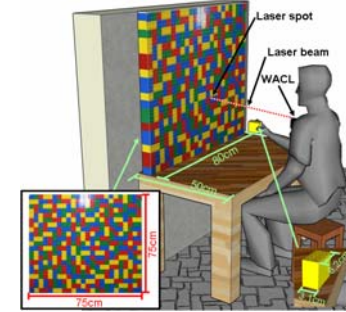
- It was TRUE that change in the FOV is smaller when wearing HMD.
- But NO significant difference in the completion time

The laser spot is capable of effectively linking the real workplace to advanced visual assist on either the CWD or HMD.



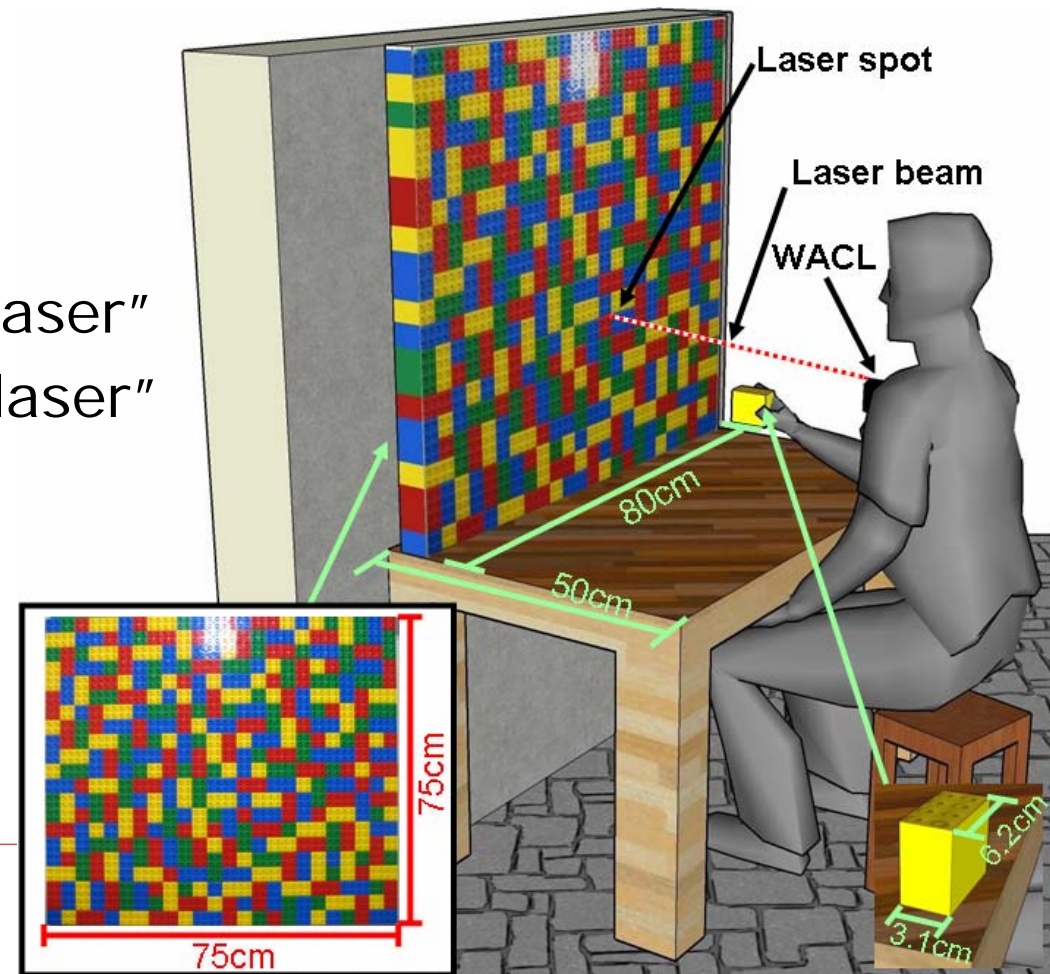
Visual link

Another user test

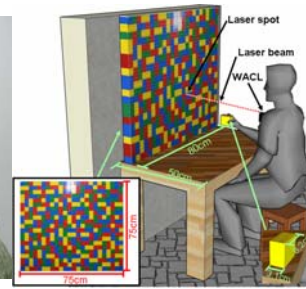


□ Examine the Visual Link effect with four Conditions

- "WACL/HMD"
- "WACL/CWD"
- "WACL/HMD without laser"
- "WACL/CWD without laser"



Impressions (relative)



- Analyzing the result of relative ratings.
All of the items went for the with laser case.

Q1: Which condition made you tired more when you did the trial?

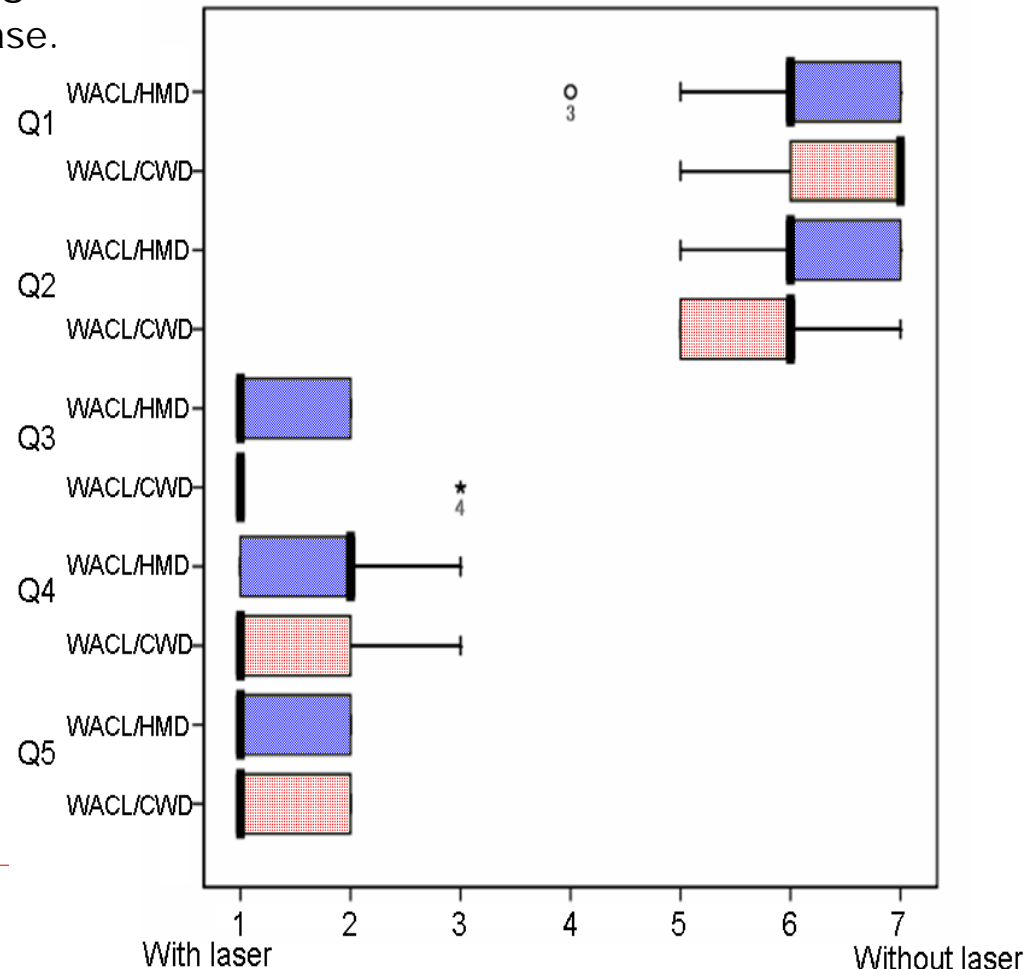
Q2: Which condition let you see the display frequently?

Q3: Which condition did you finish the task faster?

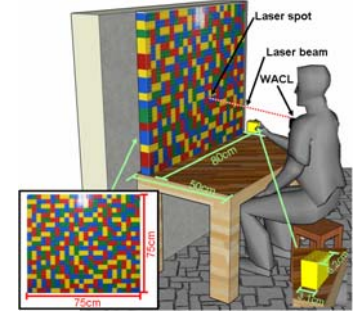
Q4: With which condition was it easy to correspond between the indicated place of the real work space and the indicated place by visual assist on the display?

Q5: With which condition was it easy to find the indicated place?

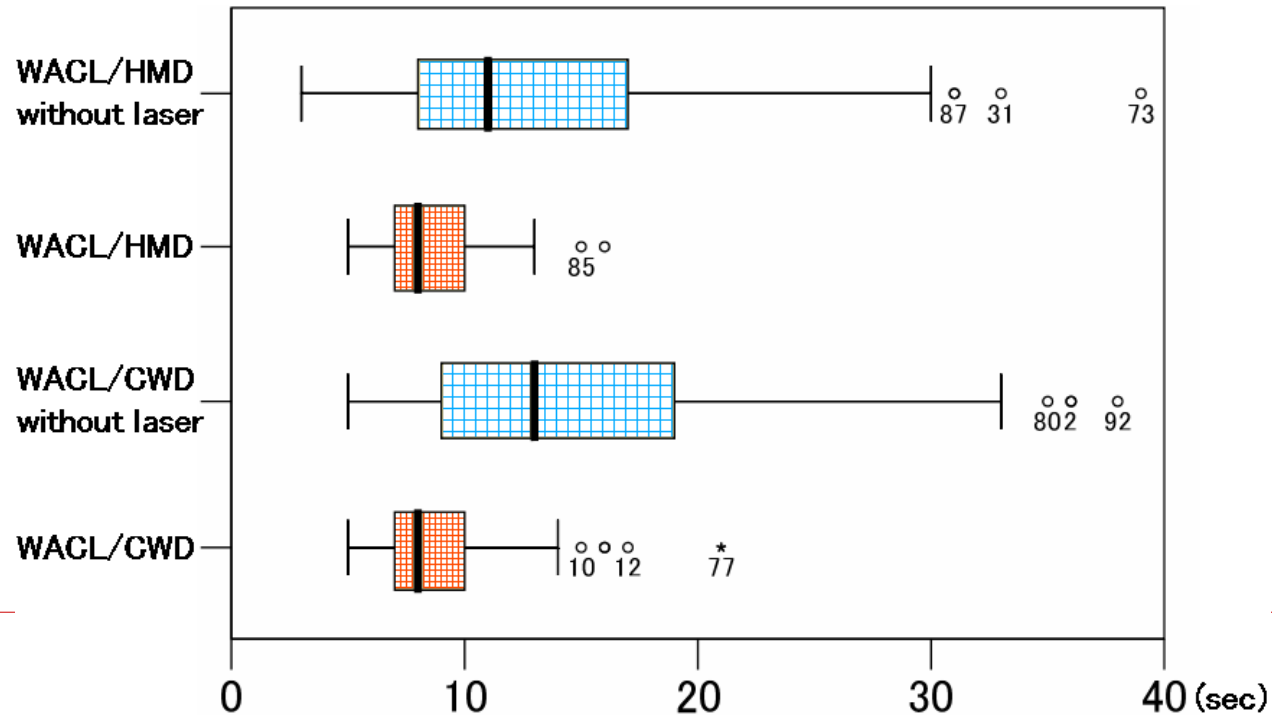
(By a one-sample t-test (test value:4))



Completion time



- Significant differences
 - Between "WACL/CWD" and "WACL/CWD without laser" ($p < 0.001$).
 - Between "WACL/HMD" and "WACL/HMD without laser" ($p < 0.001$).
 - Between "WACL/CWD without laser" and "WACL/HMD without laser" ($p = 0.040$).
- No significant difference between "WACL/CWD" and "WACL/HMD" ($p = 0.221$)



Discussion-Visual Link



- Significant difference in task performance between with and without the laser spot
- In with-laser conditions
 - The worker was able to carry out the task favorably.
 - No significant difference between "WACL/CWD" and "WACL/HMD"
 - The CWD bears comparison with the HMD even in remote collaboration involved various changes in the field of view.
- In without-laser cases
 - The task performance: "WACL/HMD w/o laser" > "WACL/CWD w/o laser"
 - The workers with CWD moved their neck very often.
 - To watch the base block in the real workspace.
 - To watch visual assist displayed on the CWD.
 - To find where the indicated place is.
 - To link visual assist to the indicated place.
 - But, about the HMD, just by moving the eyes.

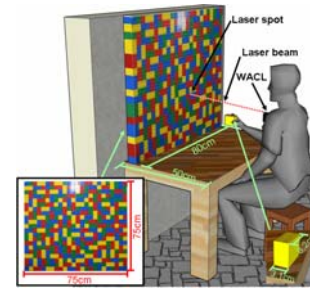


No significant difference in completion time between "WACL/CWD" and "WACL/HMD"

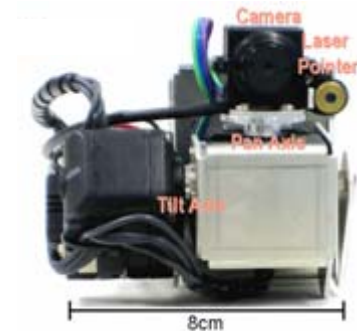


The visual link by the laser spot works more helpfully for the CWD.

Conclusion



- ❑ The WACL/CWD has the same task performance as WACL/HMD.
- ❑ The CWD is superior in preference to HMD as an additional display device of the WACL.
- ❑ The combo of the laser spot and wearable display can enhance both task performance and usability.
- ❑ 3rd WACL system
 - Embedded system, Simple shape drawing, Lower cost



Future Works

- Support remote collaborative works between a small number of experts and a lot of workers.
- Clarify how burdens of experts are alleviated through interface devices.

Thanks!

<http://itri.aist.go.jp/rwig/ari/>

<http://www.grouplab.esys.tsukuba.ac.jp/>

