A CSCW System for Distributed Search/Collection Tasks using Wearable Computers

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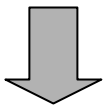
Table of contents

- Motivation
  - Early studies and technical issues
- Prototype system
  - Our approach to improve work efficiency
- Experimental task
- Highlight data
- Summary and our future plan

Background

- Wearable Computer
  - Turned on and running, hands-free, mobility
  - Appropriate for field work
- CSCW
  - Support cooperative desktop activities



Combined these techniques

WCSCW :
Wearable Computer Supported Cooperative Work

Focus on : Search/Collection tasks

- Look for and collect objects outdoors
- At geographically distributed points
- Work independently to cooperate
- Excavation at an archaeological site
- Disaster search/rescue operations

Technical issues

- Early studies
  - Shared map which enables workers to annotate with highlight marks
  - Audio and video link with other workers

In the search/collection tasks

Workers can not be aware of where others have searched

- Search the same area
- Ask others similar information about their targets

To save workers from unproductive search and communication...

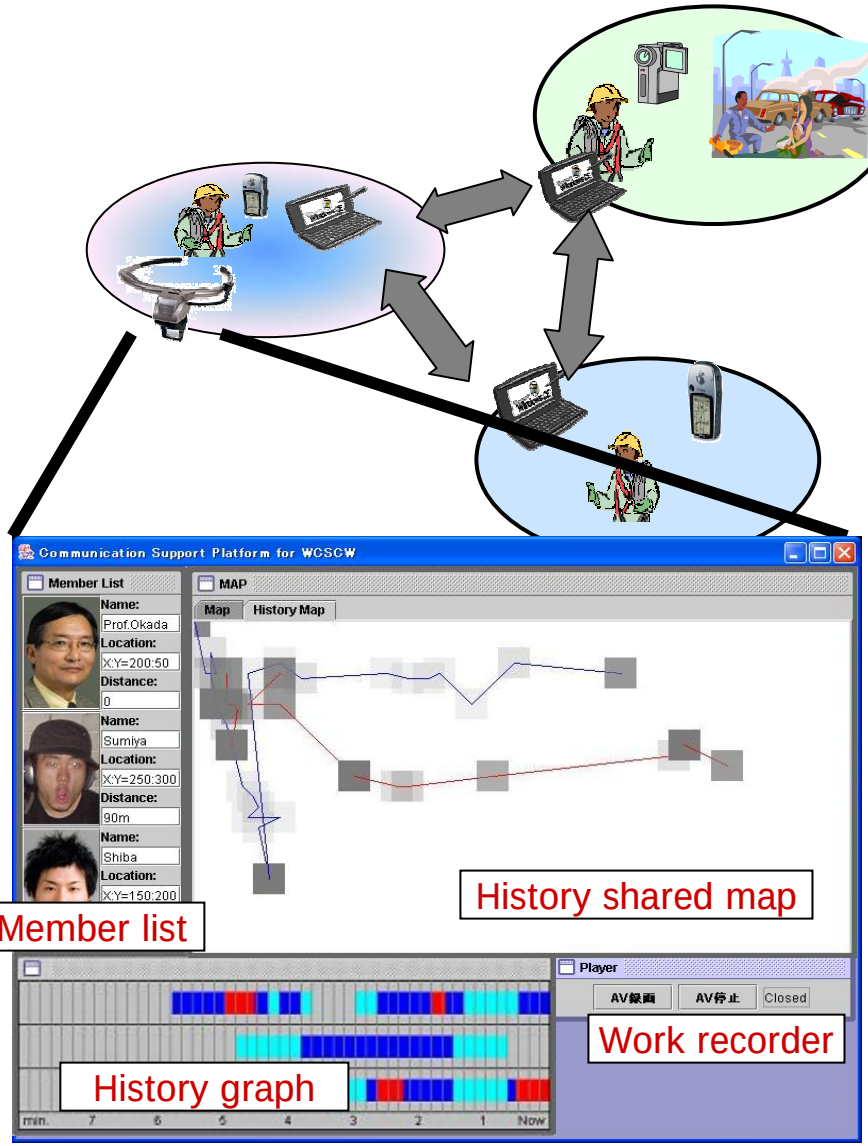
non real-time communication

workers accumulate their activities(When,Where,What they did) as information and refer others' information mutually

Objective

- Assess the value of non real-time communication for search/collection tasks
  1. Developed the WCSCW prototype system on actual wearable computers which provided the functions of non real-time communication
  2. Set up an experimental task
     - ✓ DPA: Distributed Puzzle Assembling
  3. Experimented to assess and discuss the value of the prototype system
- Discuss our findings to improve the design of our system

System overview



- The function to record and share "Work information" by simply depressing a button

Work information :
The data that workers recorded by video camera

By referring to this, each worker may see targets in his/her un-searched area

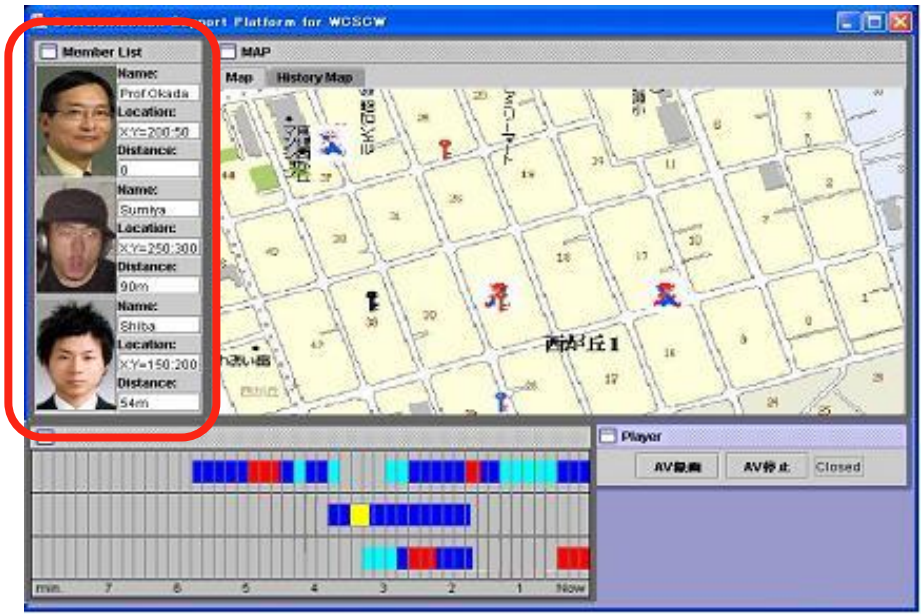
- The function to generate and share each worker's "History information"

History information :
Comprises the information of when, where and what each worker did

By referring to this, each worker can be aware of where others have not searched yet

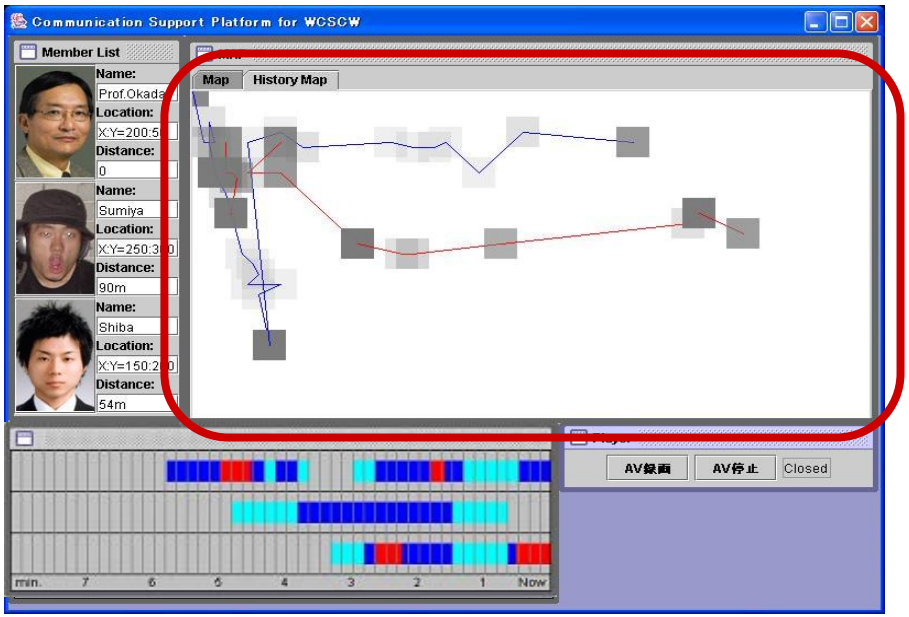
Okada & Shigeno Laboratories at Faculty of Science and Technology, Keio University

Member list



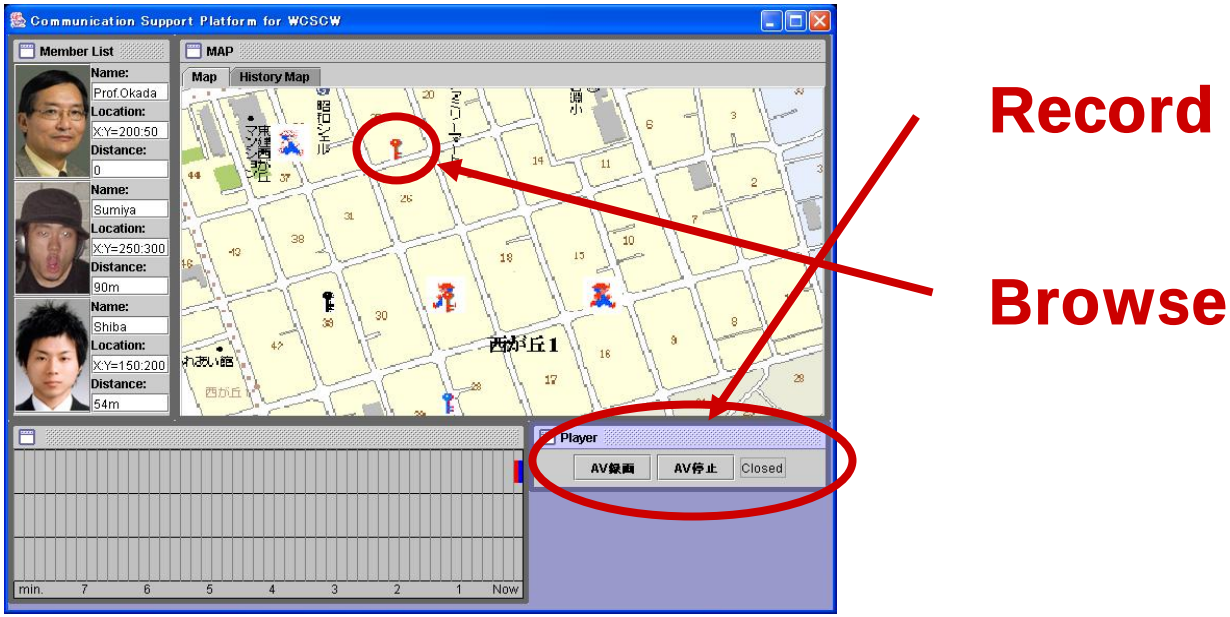
- Each workers' property and picture is listed
- Workers can communicate with the corresponding worker by audio and video

History shared map



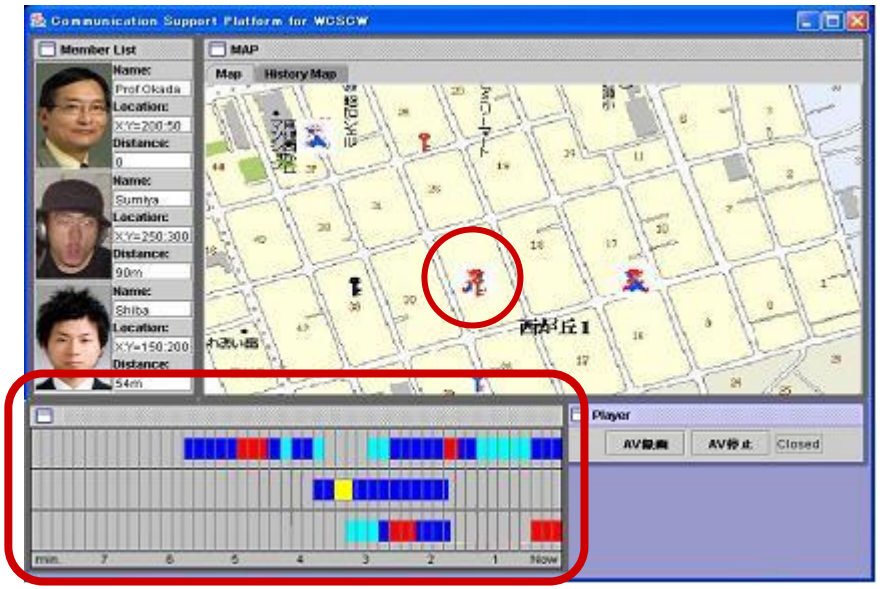
- All workers' tracks are shown as a line and a rectangle
- The rectangle's color strength represents the period of time a worker stayed there

Work recorder



- Workers can record “Work information” with video camera and microphone easily
- An icon is shown at the relevant place in the “Current shared map” which shows all workers’ present positions
- Workers can browse the corresponding “Work information” by clicking an icon

History graph



Blue : Moving

Light Blue : Staying

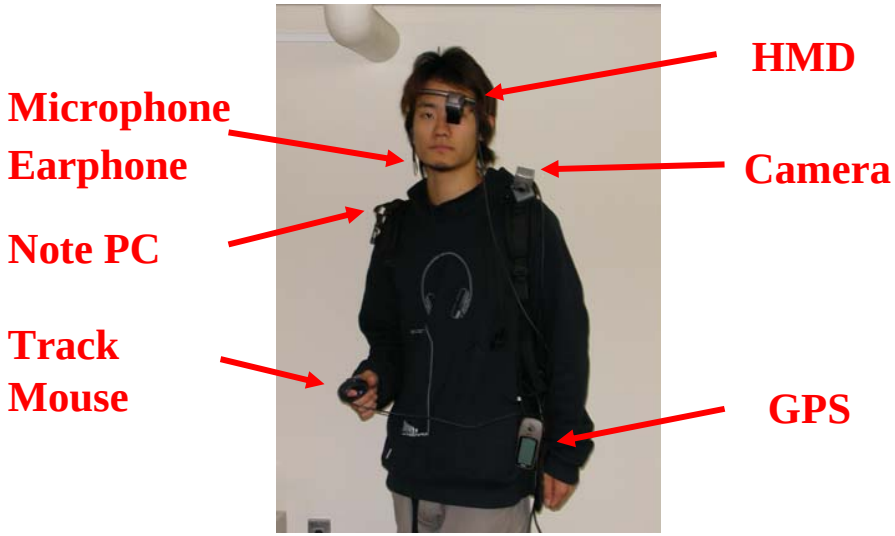
Yellow : Communicating

Red : Work recording

- History graph represents all workers' four types of activities in time series by four types of colors
- If the warning color (red, yellow) appears sequentially in one's graph, it indicates that the worker may find a important thing

Implement

- Hardware
  - Note PC:X31(IBM)
  - HMD:Data Glass 2/A (Shimazu)
  - GPS (e-Trex Garmin)
  - USB Camera (IO-DATA)
  - Micro/Earphone (IO-DATA)
  - Track Mouse (Metz)
- Network
  - Wireless LAN Network IEEE802.11b（BUFFALO)

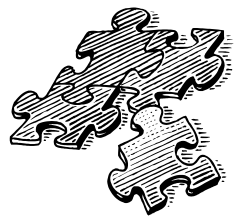


A worker with the prototype system

- Software
  - J2SDK1.4
  - Java Comm API （for GPS)
  - JMF API （for Camera)

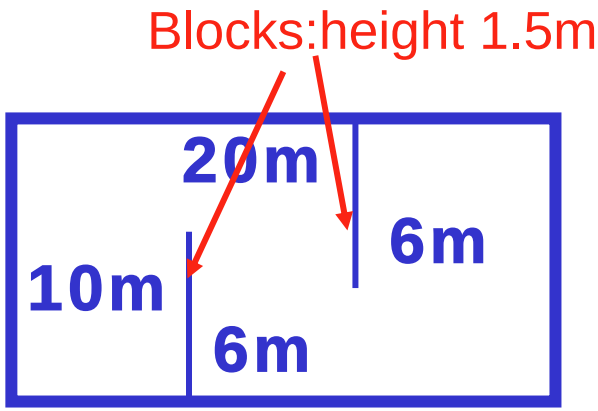
Distributed Puzzle Assembling

- Rules
  - Multiple workers search and assemble the pieces of puzzles which are geographically distributed
  - The number of workers and the number of types of puzzles are equal
  - Each worker selects the puzzle which he/she assembles in advance and must not move any pieces except the pieces of his/her puzzle
- The features of DPA

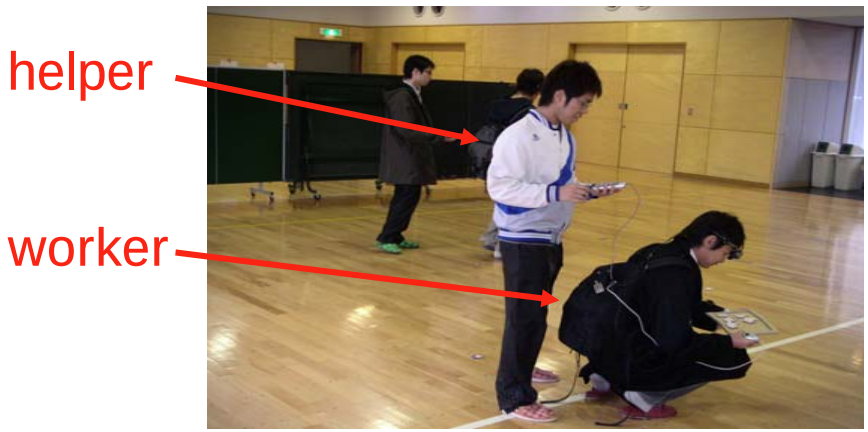


  - Distributed cooperative work
    - For the task performance, it is important to be aware of the area where other workers have searched
  - Workers look for their own puzzle pieces
    - Associating the image of the puzzle pieces with the place where it was found and sharing it on the map among workers are effective for work efficiency

Environment



Layout of the testing ground



During experiment

- Two obstacles were placed to interrupt face-to-face conditions
- A helper who input current position was prepared for each worker
  - Occurring undesired displacement of the pieces due to the weather conditions
  - The GPS accuracy was not enough for the size of a puzzle piece

Environment

Testing ground

Puzzles

- The condition of the testing ground was recorded through the experiment for post-experimental analysis of conversations
- Each puzzle consisted of 20 pieces, the difficulty of which was low, to save time for assembling a puzzle

Methods

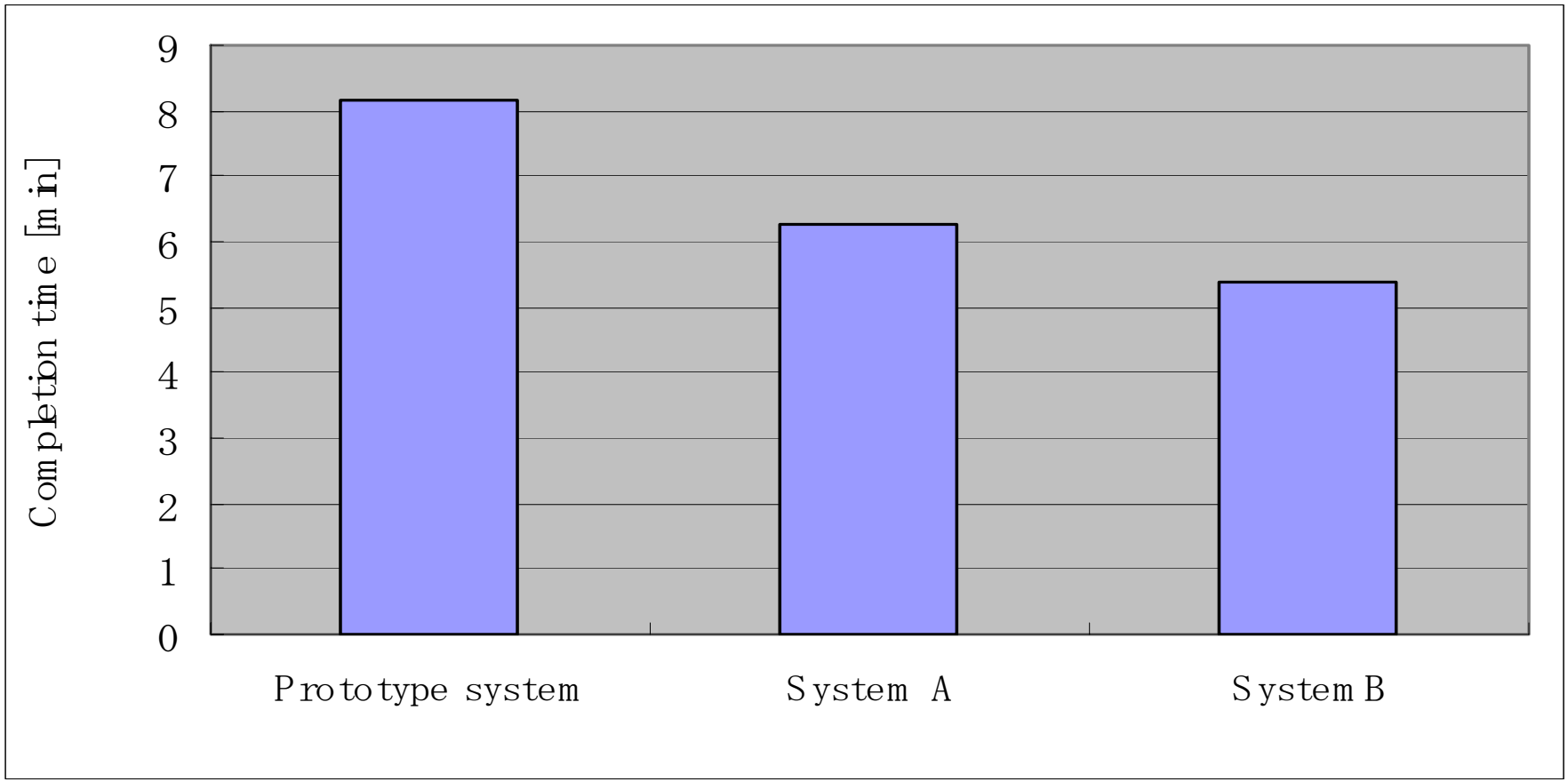
- Evaluation experiment : DPA
  - 3 workers searched and assembled the pieces of 3 types of puzzles
  - Each worker selected his/her own puzzle
- Environment
  - Prototype system
  - System A
    - Shared map which showed each worker's present position combined with real-time communication support
  - System B
    - Audio communication only
- Examinees
  - a total of 24 workers performed the task in these conditions

Measures

- Task completion time
  - The time all the puzzles were completed from the start of DPA
- Mean movement distance
  - Mean distance each worker moved around the field during the experiment
- Duplicate search area
  - Area where each worker searched redundantly
- Conversational segments
  - Number of conversational segments uttered by all workers during the experiment
  - One segment was equal to one spoken Japanese word

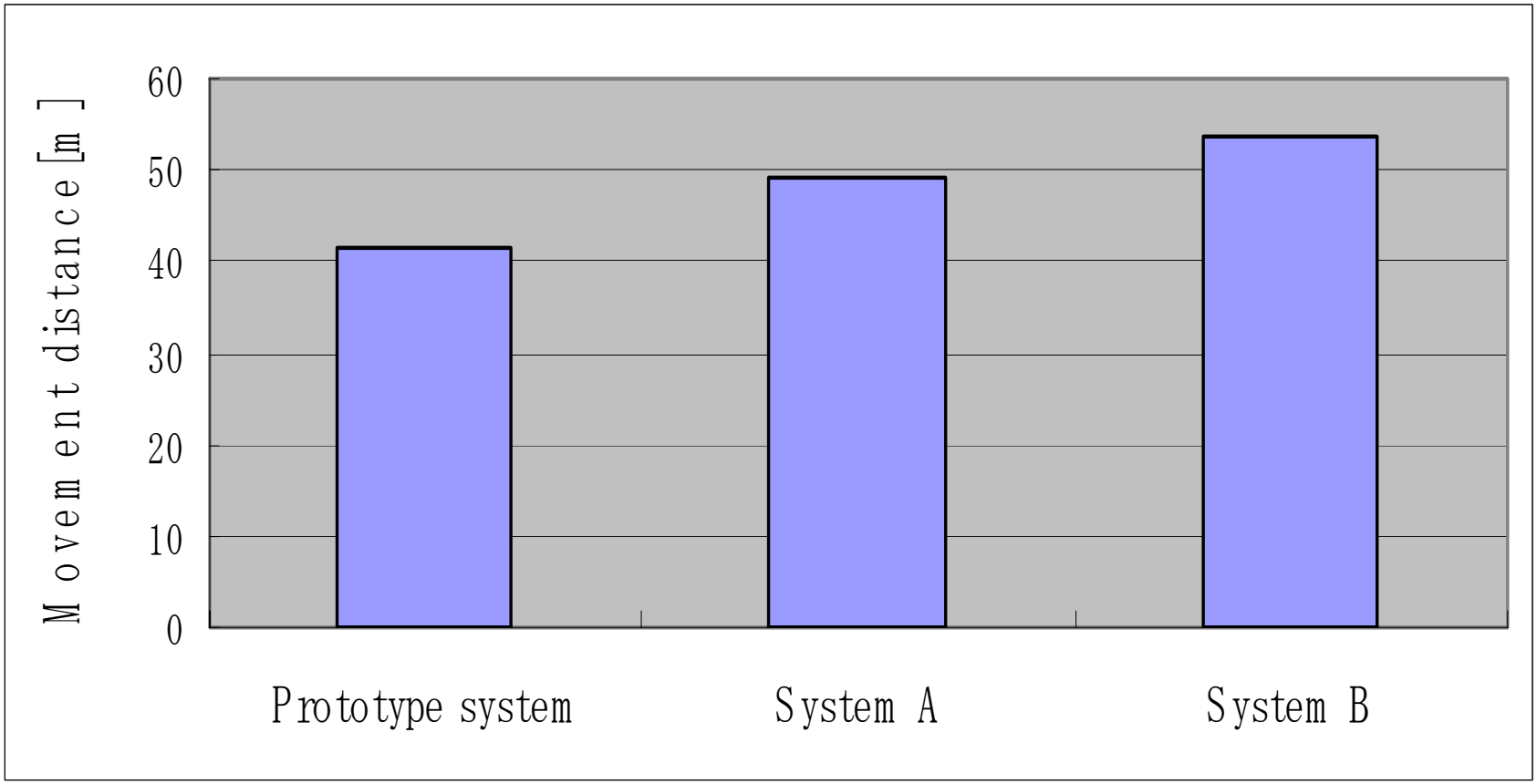
Examined the effects of each system condition on task performance and work efficiency by comparing these results

Result of completion time



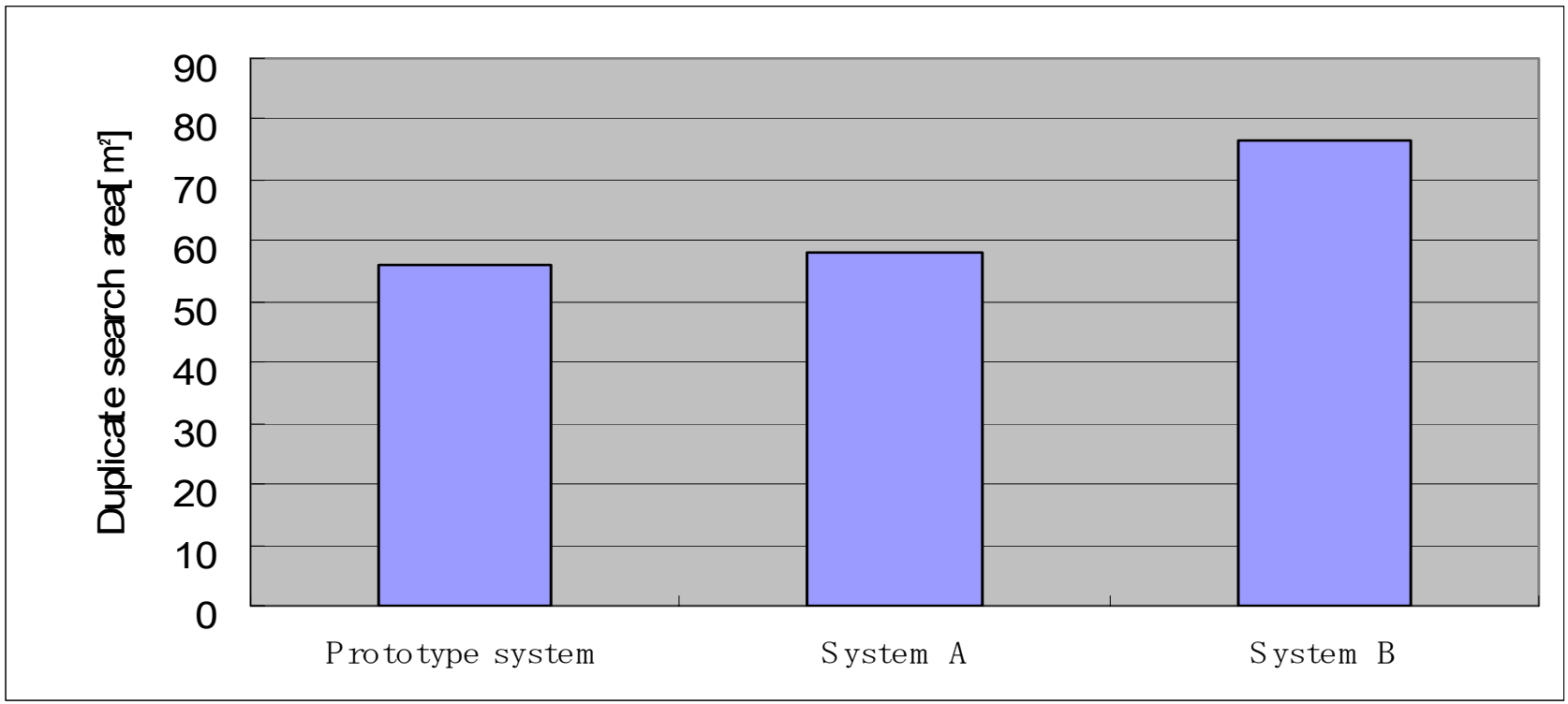
・The amount of information and functions distracted workers

Result of mean movement distance



・Workers with the prototype system could determine the next search area by referring to the“Work information” and the“History information”

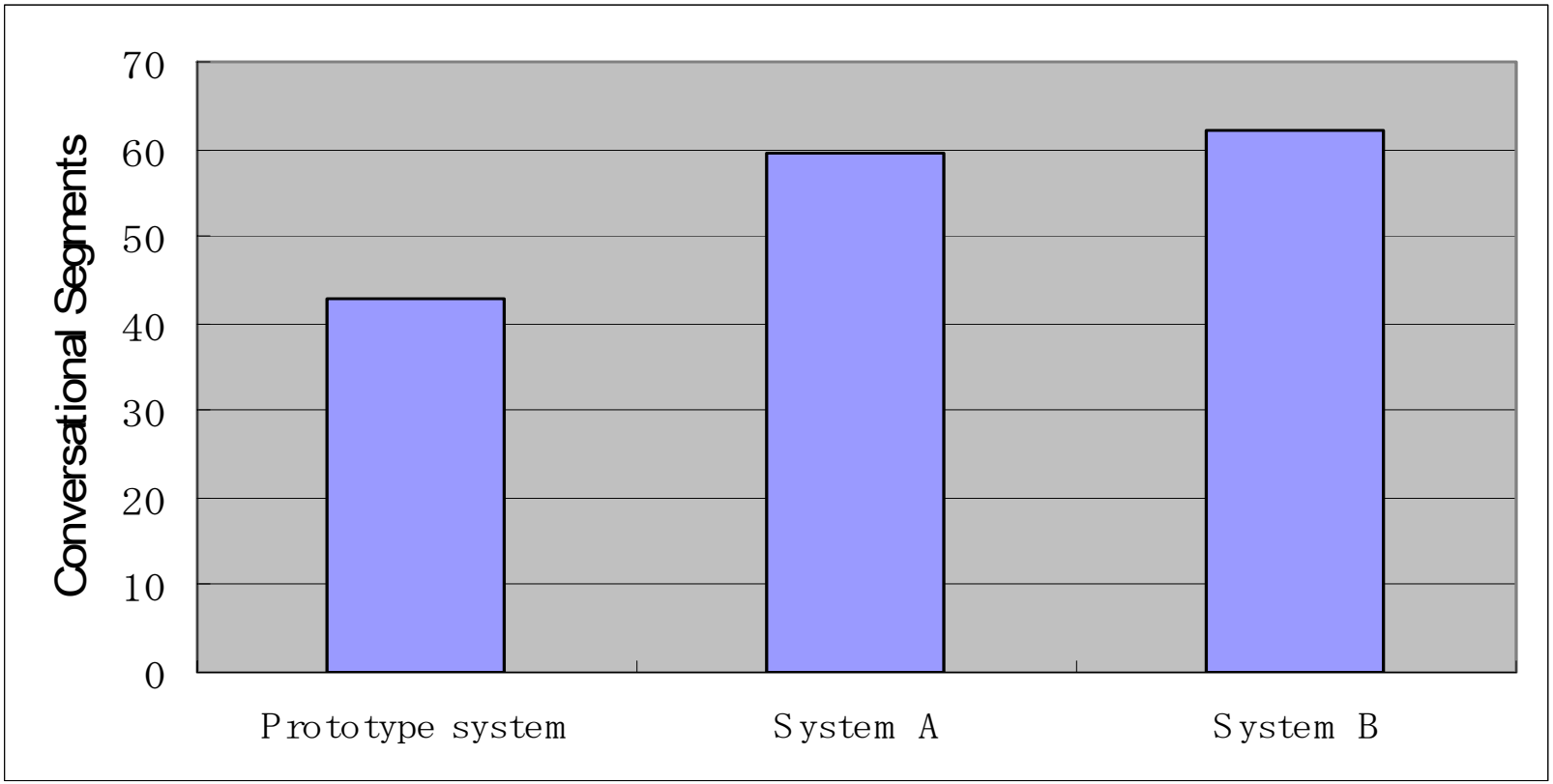
Result of duplicate search area



・Workers with system B often communicated with others face-to-face in order to communicate comfortably

・ Workers with the prototype system used the“History information”, then they could search areas where other workers have not searched yet

Result of conversational segments



・Workers with the prototype system could be aware of the place of specific pieces by the”Work information” and the place to search next by the”History shared map”

・Workers with system A and B increased the number of segments with statements and questions among workers

Discussion

- The slowest completion time with prototype system was caused by system's problems
  - Operational problem
    - Workers required extra time to stop and look at the screen of the HMD to use the GUI with track mouse for performing each function
  - System response time
    - Each time a function was operated, there was a response time of a few seconds
  - Vast information and functions
- Prototype system saved workers from unproductive search and communication
  - The functions of non real-time communication improved work efficiency

Summary

- Developed the WCSCW prototype system
- Set up an experimental task:DPA
- Experimented to assess and discuss the value of the prototype system

Assessed the value of non real-time communication for search/collection tasks

- Prototype system's problem distracted the workers
- The functions of non real-time communication improved work efficiency

Future plan

- Develop an interface that reduces the amount of distraction for workers
  - Realize a user-friendly system and interface
  - Stress-free equipment
- Conduct more complicated and practical tasks

Throughout these approach,
we will explore ways to enhance WCSCW system