# WEARABLE COMPUTING AS NEXT INTERACTION TECHNOLOGY AND ITS VALUE FOR VIRTUAL TEAM

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## ABSTRACT

The purpose of the study is to explore the potential of wearable computing for virtual team work and provide a guideline to choose best form of wearable computing based on job requirements. We address issues including virtual team technology requirements, wearable computing concept, features, form, and advantages over existing virtual team technologies in three domains: mobility, complexity data transmission, and flexibility. Based on the two dimensions of human contract and task complexity, the job requirements are categorized into four: nurse, mechanics, aerospace inspector, and journalists. We suggest wearable computing design fit to each job category.

**Key words**: wearable computing, virtual team, Information and communication technology

## INTRODUCTION

New technological innovation, wearable computing, is unveiling now, and the change brought by the technology to our daily life can be compared to that by auto motor in that the technology will eliminate limitation of place and time to access information. Thus, wearable computing is being highlighted as a promising research area. The majority of research has been dedicated to the development of technologies which are essential to introduce the wearable systems into our real world. Wearable computing is anticipated to be adopted widely in all business areas and changes the way of work in workplace. However, managerial issues of wearable computing have been rarely explored. Although wearable computing can be applied to numerous domains, we focus on its capability of fusing mobility, communication aid, and computing power. Such capability exactly is what virtual team task requires.

As the geographical dispersion of company's activities is growing and the effective communication technology is emerging, the awareness of the virtual teams has been increasing. The work process has not been confined to specific locality, and the projects have employed the multinational, interdisciplinary, and multiorganizational partnership to leap the inefficiency due to the dispersion [7][5]. However, the managerial issues which are related to technology choice and use by the virtual teams have not been widely noticed [14]. Also fixed phone and fax, the most used technologies in virtual teams, fail to meet the asynchronous or synchronous manipulation requirement of virtual teaming. In addition, virtual teaming fitted technologies such as video conferencing are used rarely [5].

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## VIRTUAL TEAM TECHNOLOGY REQUIREMENTS

Since virtual team members are dispersed geographically, the members have different backgrounds in culture, language, organizational form, and personality [8]. Therefore, technology tools in virtual teams are required to have capacity to send and receive the various types of information for effective communication. However, the technology-base communication tools such as fixed phone or fax are restricted to visual or audio information transmission only. It is pointed out that silent behavior such as body orientation, facial expression, and eye movement are critical factors in effective and interactive communication [20]. When virtual team members work together, many miscommunications occur because technology cannot communicate non-verbal cues such as body language and emotional expressions [12].

The degree of the effect of technology upon the performance of virtual teams is not certain. Research has been dedicated to social or organizational factors more than it has been to technology even though some studies have emphasized the importance of technologies in virtual teams performance [14][12].

It is worth referring to the technology categorization of [5] to look over the features of virtual team interaction technologies. They categorized the technologies for virtual teams into three spectrums: communication, cooperation, and collaboration. They divided the technologies based on their role and features (e.g., synchronous data exchange or real-time data manipulation exchange).
Research has pointed that the most frequently used tools for interaction among the team members are fixed phone and voice mail but the videoconferencing is used very rarely [14][13].

## WEARABLE COMPUTING CONCEPT AND FEATURES

### The Concept of Wearable Computing

Bulky form and low usage are referred to as the major drawbacks of hand-held computers and other electronic devices because their small size and multifunction are rarely comfortable to carry them in one's pocket [1]. Wearable computing is designed to solve these problems and provides new paradigm in computing systems [17]. Providing an active, virtually invisible, and intelligent personal assistant system is the goal of wearable computing [2].

Studies present some requirements for wearable computing to be successful. These requirements include light-weight, low energy consumption, high computational performance, environment/activity awareness, fashionable, large memory, network connectivity, and cost [4][19][2]. Usually, a wearable computer consists of a CPU, a battery, input devices, output devices, wireless internet connection, and other adds-on like a Global Positioning System (GPS) [18].

### The Features of Wearable Computing

Wearable computing has offered distinct advantages and benefits that outweigh the limitations or difficulties involved in caring for the system [10]. Such desired features of wearable computing are identified and presented by the researchers. [15] emphasized that wearable computing provides portability, hands free activities, and availability in sizes and functions. [9] presented three characteristics of wearable computing, which distinct the system from other technologies. Users 'wear' the computer so they don't need to use hands to browse information (Hands-free). Wearability enables users to access the system anytime and anywhere (Always on). Wearable computing can be applied to the activities of daily life (Supporting daily life). Some researchers provide more detail and specific features of wearable computing [1].

## WEARABLE COMPUTING FORMS AND APPLICATIONS

The usefulness of wearable computing is able to be measured by its form factor which includes size, shape, and the way of wear [10]. Wearable computing is a heterogeneous system because various devices are placed on different locations of the user's body [2]. The form of wearable computing could be changed depending on its function or purpose. Studies present a variety of distinct forms of wearable computing, and these include watch form, glove form, belt form, pocket form, general form, and bag form.

[16] argued that the efficiencies of wearable computing enable workers to save labor hours for deployments in shipbuilding and commercial aircraft inspection. [9] suggest that one of the promising applications of wearable computing is a navigation system since wearable computing supports can monitor the user's situation and motion and present situation suited information. As it is referred to initially, a variety of practical applications of wearable computing has been explored including fire service [3], aircraft inspection [11], the police force [6], crane service [18], security guards, fast food outlets, maintenance work, and construction [19].

## WEARABLE COMPUTING AS VIRTUAL TEAM INTERACTION TECHNOLOGY

Wearable computing provides significant advantages over other interaction technologies in mobility, data complexity, and computing power. First, wearable computing provides team members with mobility like cell phone, resulting in expanding the scope of activities whereas most communication technologies used in virtual team do not. Second, wearable computing improves the performance of virtual team by enhancing complexity data transmission. Third is flexibility to equip many add-ons such GPS and RFID reader.

Wearable computing provides enhanced communication aid in terms of data complexity and communication synchronization. It delivers compound and multipurpose information in mobile through wireless area network, whereas existing electronic interaction technologies provide their own specific, limited kinds of information. Consequently, wearable computing provides enhanced interaction technology and improves performance of virtual team collaboration by the feature described in 'Always on'.

## BEST FORM OF WEARABLE COMPUTING BASED ON JOB SPECIFICATIONS

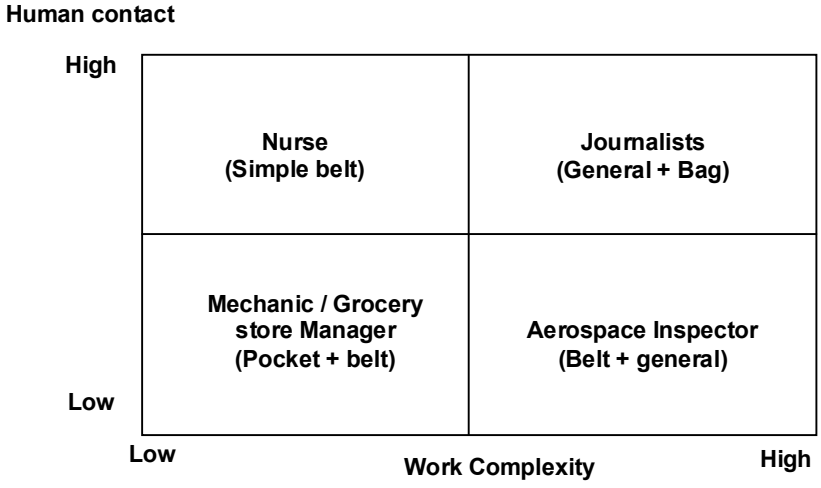
Based on the literatures and our discussion, we classify four job categories by two factors, human contact and work complexity. A job belonging to Nurse has high human contact and low work complexity. Workers in the job category are required to meet people frequently but their task is relatively simple. Consequently wearable computer design for them should be fashionable not to interrupt their moving or working whereas the required performance of computer is relatively not so high. Thus, we think that belt typed wearable computing suggested by [1] is fit to this job category.

A job belonging to Mechanic category has low human contact and work complexity is also low. Workers in the category are conducting simple works using wearable computing such as data input /output or data search. They mainly deal with machines or products not human. The required function includes data exchange and car inspect add-on sensor. The pocket typed wearable computing suggested by [16] is fit to this job category.

Workers in the Aerospace Inspector have low human contact and high work complexity. They require high performance computing to inspect complicate objects such as aero spaceship or air flight. To inspect such objects, they need wearable computers that provide powerful computing performance, add-ons such as detectors, communication aids to transmit multimedia data, and powerful battery. But the design has no need to be fashionable because the workers deal with machines not human.

A job belonging to Journalist category has high human contact and work complexity. Journalists have high human contact because they produce information from humans in most case through interview or observation. At the same time, the job requires high performance wearable computing because journalists keep moving to trace information sources even in the distance. They produce, edit, and transmit multimedia data such as video in a place far from broadcasting camp. They are required to have many add-ons for taking high density photos or special video. The belt and general typed combined wearable computing is fit to this job category.

**<Fig 1> The Job Categories and Corresponding Wearable Computing Designs**



## CONCLUSION

Emerging technologies have been creating opportunities as well as challenges to the people especially in business. Wearable computing is being highlighted as a next generation interaction technology. Wearable computing is anticipated to be adopted widely in all business areas and changes the way of work in workplace. However, managerial issues of wearable computing have been rarely explored. Although wearable computing can be applied to numerous domains, we focus on its capability of fusing mobility, communication aid, and computing power. Such capability exactly is what virtual team task requires.

The purpose of the study is to explore the potential of wearable computing for virtual team work and provide a guideline to choose best form of wearable computing based on job requirements. We address issues including virtual team technology requirements, wearable computing concept, features, form, and advantages over existing virtual team technologies. Especially, we explore the advantage of wearable computing in three domains: mobility, complexity data transmission, and flexibility. The significant competitive advantage of wearable computing is come from the convergence of the three functions. Finally, we present the form of wearable computing depending on job requirements. Based on the two dimensions of human contract and task complexity, the job requirements are categorized into four: nurse, mechanics, aerospace inspector, and journalists. Job in each category has different level of human contact and job complexity. We suggest wearable computing design fit to each job category.

## REFERENCE


[1] Amft, O., Lauffer, M., Ossevoort, S., Macaluso, F., Lukowicz, P., & Tröster, G. *Design of the QBIC wearable computing platform*, Proceedings of the 15th IEEE International Conference on Application-Specific Systems, Architectures and Processors (ASAP'04), IEEE, 2004, 398-410.

[2] Anliker, U., Beutel, J., Dyer, M., Enzleer, R., Lukowicz, P., Thiele, L., & Tröster, G. *A Systematic Approach to the Design of Distribute Wearable Systems*, IEEE Transactions on Computers, 2004, 53(8), 1017-1033.

[3] Baldegger, J. & Giger, C. *Wearable GIS: A Smart Assistant in Disaster Management*, Proceeding of the 6th AGILE Conference on Geographic Information Science, 2003, 10-26.

[4] Barber, C., Haniff, D. J., & Woolley, S. I., *Contrasting Paradigms for the Development of Wearable Computers*, IBM Systems Journal, 1999, 38(4), 551-565

[5] Chinowsky, P. S. & Rojas, E. M. *Virtual Teams: Guide to Successful Implementation*, Journal of Management in Engineering, July 2003, 98-106.

[6] Haniff, D. J. & Baber, C. *Wearable Computers for the Fire Service and Police Force: Technological and Human Factors*, Proceeding of International Symposium on Wearable Computing 1999 (ISWC'99), IEEE, 1999, 185-186.

[7] Horwitz, F. M., Bravington, D., & Silvis, U. *The Promise of Virtual Teams: Identifying Key Factors in Effectiveness and Failure*, Journal of European Industrial Training, 2006, 30(6), 472-494.

[8] Kankanhalli, A., Tan, B. C. Y., & Wei, K-K. *Conflict and Performance in Global Virtual Teams*, Journal of Management Information Systems, Winter 2006-7, 23(3), 237-274.

[9] Miyamae, M, Terada, T., Tsukamoto, M., & Nishio, S. *Design and Implementation of an Extensible Rule Processing System for Wearable Computing*, Proceedings of the First Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services (MobiQuitous'04), IEEE, 2004, 392-400.

[10] Narayanaswami, C. & Raghunath, M.T. *Designing a new form factor for wearable computing*, Pervasive Computing, IEEE, Oct.-Dec. 2002, 1(4), 42-48.

[11] Ockerman, J. J. & Pritchett, A. R. *Preliminary Investigation of Wearable Computers for Task Guidance in Aircraft Inspection*, Digest of Papers. Second International Symposium on Wearable Computers, IEEE, Oct. 1998, 33-40.

[12] Rosen, B., Furst, S., & Blackburn, R. *Training for Virtual Teams: An Investigation of Current Practices and Future Needs*, Human Resource Management, Summer 2006, 45(2), 229-247.

[13] Scott, C. R. & Timmerman, C. E. *Communication Technology Use and Multiple Workplace Identifications Among Organizational Teleworkers with Varied Degrees of Virtuality*, IEEE Transaction on Professional Communication, Dec. 1999, 42(4), 240-260

[14] Sivunen, A. & Valo, M. *Team Leader's Technology Choice in Virtual Teams*, IEEE Transaction on Professional Communication, March 2006, 49(1), 57-68.

[15] Spells, L., McBride, M., & Graves, C. *Wearable Computing System for Embedded Instruction of Manual-Intensive Procedural Tasks in Clean Room Environments*," Information Technology Based Higher Education and Training (ITHET) 2005, 6th International Conference on 7-9, July 2005, F3A/21 - F3A/26.

[16] Stanford V., *Wearable Computing Goes Live in Industry*, Pervasive Computing, IEEE, Oct.-Dec. 2002, 1(4), 14–19.

[17] Starner, T, *The challenges of wearable computing: Part 1*, Micro, IEEE July-Aug. 2001, 21(4), 44 – 52.

[18] Sydänheimo L., Salmimaa, M., Vanhala, J., & Kivikoski, M. *Wearable and Ubiquitous Computer Aided Service, Maintenance and Overhaul*, 1999 IEEE International Conference on Communication (ICC), IEEE, 3, 1999, 2012-2017.

[19] Tsukamoto, M., *Wearable Computing in Daily Life*, Proceedings of the 2004 International Symposium on Application and the Internet Workshops (SAINTW'04), IEEE, 2004, 291-292.

[20] Ucok, O., *Transparency, communication and mindfulness,* Journal of Management Development, 2006, 25(10), 1024-1028.