**Programming Pervasive Computing Middleware based on Ubiquitous Interacting Objects (PI: Prof. Cao Jiannong; 2010/11)**

Most existing middleware systems for pervasive computing are based on a top-down, centralized model where a central controlling entity facilitates and coordinates the functional operations of component devices deployed in the system. As technology advances in nano-scale semiconductor, wireless communications and microelectro-mechanical system (MEMS), devices will be made smaller and smaller, and more and more intelligent in terms of sensing, computing and communication capabilities. In the foreseeable future, a pervasive computing environment will be embedded with large number of devices augmented with such intelligent capabilities. The current middleware models need to be improved because they are designed with the view that the component devices are passive objects and need to be centrally managed. Given the increasing number of embedded devices, centralized middleware architecture compromises the scalability of the middleware. More importantly, the increasing capability of the component devices can be used to alleviate the role and load of the central controlling entity and facilitate the design of distributed and localized algorithms for achieving middleware functions. In this project, we propose an alternative bottom-up, decentralized approach to designing and programming pervasive computing middleware functions based on ubiquitous interacting objects (UIOs), which are smart devices augmented with various processing capabilities. Many middleware functions, such as service discovery, service composition, context derivation and inconsistency checking, can be performed through the decentralized interaction and collaboration of the UIOs. Building these functions into individual UIOs will facilitate the deployment of pervasive computing

applications because the UIOs can autonomously discover and coordinate with each other to carry out the middleware and application-specific functions, with the minimum support from the central controller. Also, without relying heavily on central controllers, the proposed approach makes the middleware system more scalable and flexible. Designing UIO-based middleware functions using a bottom-up, decentralized approach faces many challenging problems. We will identify and address the fundamental issues, and seek for effective and efficient solutions. We believe that pervasive computing systems based on UIOs is the trend in the near future. The results and findings of this project will facilitate the development of high-performance pervasive computing middleware and applications, such as smart space, social networking, logistics, transportation, pervasive-care, and intelligent construction and building management. As the Hong Kong SAR government has been greatly promoting the development of innovative technologies, the contribution of this project is highly relevant and has special significance to Hong Kong scientific and industrial community and society.