Research and Development of a Cyber-I Open Service Platform

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(開始ページ / Start Page)
1
(終了ページ / End Page)
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(発行年 / Year)
2018-06-12

様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９　（共通）

科学研究費助成事業　　研究成果報告書

平成　３０　年　　６　月　１２　日現在

機関番号：　３２６７５
研究種目：　基盤研究(C)（一般）
研究期間：　2014～2017
課題番号：　２６３３０３５０

研究課題名（和文）Research and Development of a Cyber-I Open Service Platform

研究課題名（英文）Research and Development of a Cyber-I Open Service Platform

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交付決定額（研究期間全体）：（直接経費）　　3,400,000円

研究成果の概要（和文）：Cyber-Iは、Real-Iのデジタル対応であり、個人データの収集と分析を行い、人の行動や感情に近づけます。本研究では、複数のデバイスから多くの個人データを収集して処理を行い、Cyber-Iの作成と管理を行うようなオープンサービスプラットフォームを開発しました。異なるデバイスやデータを柔軟でスケーラブルな管理をするために、スマートフォンをゲートウェイとして使用するクラウドやフォグベースのデータベースシステムを実装しています。また、Cyber-Iの成長をコントロールするような基本的技術やメカニズムを提案しています。さらにCyber-I関連における個人情報の保護と利用についても検討しています。

研究成果の概要（英文）：Cyber-I, short for Cyber Individual, is a digital counterpart of Real-Individual (Real-I), and is expected to continuously approximate a real person’s behavior and even mind with collections and analyses of increasing personal data. In this research, a Cyber-I open service platform has been researched and developed to collect and process rich personal big data from various sources and multiple devices for Cyber-I creation and administration as well as its modeling and life control. A cloud-fog based database system using smartphones as gateways has been implemented for flexible and scalable managements of heterogeneous devices and data. Basic strategy and mechanism have been proposed for scheduling and controlling Cyber-I growth. Cyber-I related data privacy protection and personal information usage are also studied. A series of researches on personality and affective computing has been carried out to model personal characteristics.

研究分野：　Internet Computing

キーワード：　Internet　Web　Cyber　Modeling　Personality　Wearable

１．研究開始当初の背景

Cyber-Individual (Cyber-I) is a digital counterpart of Real-Individual (Real-I), and is expected to continuously approximate a person's behavior and even mind with collections and mining of increasing personal big data. However, the realization of such Cyber-I approximation to Real-I is a worldwide grand challenge, and needs multi and inter disciplinary studies in long term.

２．研究の目的

To support joint efforts on Cyber-I studies and novel personalized services, this project is aimed at research and development of a Cyber-I open service platform (COSP) that is able to (1) collect rich personal big data from various sources and multiple devices; (2) build a generic mechanism and related methods for effective management and usage of the heterogeneous data; (3) make a common platform for Cyber-I's creation, administration and control; (4) study the core Cyber-I models as well as some sample applications for personalized services. The COSP platform forms a base for further study of novel personal models and novel Cyber-I applications.

３．研究の方法

The project has been carried out in three aspects as the following. (1) A user-oriented platform has been built for creation, interaction, control and utilization of Cyber-Is. The main research focus has been the Cyber-Is' management including Cyber-Is' basic models, life control, residence, security, etc. (2) A general data management system has been developed for effectively collecting personal data from Web, social networks and various devices as well as their storage in both local machines and remote clouds. (3) Basic modeling approaches are studied for Cyber-I birth, growth and death. The core in this study is to find out the proper mechanisms and controls that enable Cyber-I growth.

４．研究成果

In this research, we have had many findings about Cyber-I and made a lot of outputs, which are described in the following.

(1) We have a user-oriented Cyber-I system for Cyber-Is' residence with a set of Cyber-I life control functions, by which a Cyber-I is able to be born up to its Real-I's request, grow up with the aggregation of personal data, and be terminated on its Real-I's demand in various ways. The developed system serves as a common place for Cyber-Is' residence, and is based on the Browser/Server architecture where Tomcat acts as the server. The Mongo DB is selected as the database for the persistence of data since it usually gains higher performance in dealing with the big personal data than the conventional RDBMS. Furthermore, with the schema-less property, large heterogeneous personal data could be managed in a scalable and flexible way.

(2) A Cyber-I is expected to gradually approximate to its Real-I by continuously collecting, processing and utilizing Real-I's personal data. We have made a study on the three mechanisms for Cyber-I modeling to enable the models growing bigger, higher and closer to its Real-I. We have further studied corresponding modules to arrange the schedule of Cyber-I's growth according to data and time, to manage the quantity of raw data involved in a specific growth process, to select a corresponding processor to handle raw data, and to generate Cyber-I model data with one or more growth forms. As a case study, a specific personal data gathered from Twitter is used to demonstrate the model growth.

(3) Personal data is very sensitive. To provide a generic and user-centric privacy protection mechanism, we have propose a Cyber-I privacy model (CIPM) that is a systematic description about a user's privacy preference, policy and rules, which are generated semi-automatically according to each user's characteristics. Advantages of the user-centric CIPM are twofold: one is able to reflect a user's privacy needs to different applications; the other is to continuously adapt to a user's privacy demand changes. Moreover, a basic platform for CIPM initialization and update is developed, and the privacy protection of personal data is realized through not only control but also awareness based on the CIPM.

(4) Cyber-I is expected to also be used for personalized services. Therefore, we have done research on privacy-preserved and best-effort provisions of Cyber-I information to personalized services by constructing a system prototype of Cyber-I Information Provision System (CIPS). This system is capable of providing Cyber-I

information by using a two-level privacy protection strategy and providing three best-effort provisions, i.e., existing data provision, related data provision and predicting data preservation. Message formats including request and response was defined to support communications between systems. And cases study was carried out to verify functions of the CIPS.

(5) For personal data management and personality analysis, we have developed a smartphone based client-server system. The smartphone is functioned as not only a source of personal data but also a gateway to manage other wearables and communicate with a server that keeps personal data in a larger amount and a longer period. A multi-security mechanism is implemented to ensure data security in collection, transmission and storage. We have further proposed a context-aware scheduling mechanism that is able to dynamically adjust the data collection schedule based on varying situations of wearable condition, network availability, computing resource and user state. This context-aware scheduling mechanism has implemented in a smartphone-based system to collect personal data from multiple wearables and upload the gathered data to a server/cloud. The efficiency and effectiveness of the proposed scheduling mechanism have been verified by the actual data collection using the developed system.

(6) Because different datasets were from various sensing sources, we did a lot of experiments and stochastic analyses on the data quality from multiple devices including smartphone and wearables. By taking into account temporal features, we propose two typical models, which provide statistical methods for describing time discrepancy and its distribution. The proposed models can be used to not only guarantee the completeness of the data, but also reduce redundancy for further research on the time synchronization of data from multiple wearable devices.

(7) Wearable devices have been widely used for personal date collection. Due to the high heterogeneity of these devices and data attributes, it is necessary to provide a unified mechanism to manage the devices and data. So, we have adopted the NoSQL database using JSON. To make the system scalable to support various devices and many users, we has used a cloud-fog combined computing architecture for securing large and scalable database storage. A cloud-fog based database system using smartphones as gateways has been implemented, and evaluated in a series of experiments in device and data management.

(8) The precision and integrity of current automatic personality perception is very important for the elaborate modeling in Cyber-I. Due to the heterogeneity of personal data, it is critical to classify the mass of personal data to valuable knowledge for sufficient personality perception. Therefore, we have focused on designing scenario-based ontic personae as various individuals' facets in different situations for automatic personality perception. By effectively fusing personal data from various sources, we further studied how to compute human personality. Instead of calculating personality traits from personal data directly, an approach to a personality model derived from the theories of Carl Gustav Jung was used to measure a human subject's persona.

(9) The affective features of Cyber-I may also be augmented into computers, robots and other applications. We further studied how personality traits, behaviors and emotions are associated with each other states based on physiological data collected from various wearable devices including Emotive Insight, Spire Stone and Huawei Fit Watch. In experiments, each of participants first completed a Big Five Inventory (BFI) questionnaire to get one's personality traits, and then each of their behaviors, e.g. blink, wink, surprise, furrow, smile and clench, are analyzed correlatively with their personality traits under emotion states of excitement, interest, relaxation, stress, engagement, and focus. It has been found that correlations between the personality traits and the personal behaviors are greatly depended up the emotional states.

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６．研究組織

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