International Journal of Digital Information and Wireless Communications (IJDIWC) 6(3): 163-172
The Society of Digital Information and Wireless Communications, 2016 ISSN: 2225-658X (Online); ISSN 2412-6551 (Print)

An e-Healthcare System for Ubiquitous and Life-long Health Management

Eiichi Miyazaki[*1] Hiroshi Kamano[*2] Kazuaki Ando[*3] Yoshiro Imai[*3]
{[*1] Faculty of Education, [*2] Health Center and [*3] Faculty of Engineering} Kagawa University
{[*1] 1-1 Saiwai-cho, [*2] 22-1 Saiwai-cho, [*3] 2217-20 Hayashi-cho} Takamatsu, Japan
{miya@ed, kamano@cc, {ando, imai}@eng}.kagawa-u.ac.jp

ABSTRACT

An e-Healthcare system with IC card authentication, automatic health screening sub-system and Web-based health information monitoring, has been designed and implemented for university health education. It looks like a prototype of private Cloud service of e-Healthcare for university students which can obtain their health records from physical measuring devices with their IC card-based authentication, manage their health data in suitable database, investigate the relevant data according to requests from doctors/nurses, and provide such data as necessary information for self-healthcare through Web-DB service. This paper presents an organization of the above e-Healthcare system, demonstrates its real usages in university health education and describes its trial quantitative evaluation, and describes expanding plan through practical applications.

KEYWORDS

e-Healthcare, IC card authentication, health information monitoring and retrieving, System evaluation.

1 INTRODUCTION

People of the world have own natural rights to live their healthy lives. They have been interesting in their situations of health and nowadays almost all of them are longing for their healthy environment more strongly than ever before. Doctors always point out that people need to keep their healthy lives if they do not want to be ill and sick. It is very important for everyone to maintain his/her living environment at the healthy level. In other words, everyone wants to have some facilities to monitor his/her healthy level and needs some visualizing tools to recognize whether his/her healthy level becomes good or not.

In every higher education and/or university, even in Japan, of course, its staffs and administration must provide health education and equip health managing environment for its students. Because it is important for current students to study in good condition during their university lives and for external society including their family to welcome the relevant students as its up-and-coming persons. Strictly speaking, however, universities have faced to some problems to be resolved in order to provide efficient health education and they are/have been suffering from the lack of staffs and facilities to manage health keeping environment for their students.

An approach of e-Healthcare seems to be one of the most effective and efficient solutions to improve such environment of health education with the above lack of staffs and facilities in universities as well as in general societies. This approach may be able to provide a powerful strategy to equip so-called “Ubiquitous Healthcare Service” where users can always connect to the information server, monitor their health information in it and obtain suitable advises and instructions for their health management(s).

This paper describes our e-Healthcare system for university students with IC card authentication, automatic health screening sub-system and Web-based health information monitoring. First of all, the next (second) section introduces some related works for the sake of comparison and coordination of our study with the state-of-the-art in the same domain. The third section shows configuration of a newly-developed e-Healthcare system and illustrates some details of the system and its facilities. The fourth section demonstrates its real application in our university, explains some brief evaluation of our e-Healthcare system and reports our challenge to expand our system to overground in the future market. Finally, the last (fifth) section

concludes our summaries for the perspective study and shows acknowledgements and some useful references.

2 RELATED WORKS

This section introduces some typical related works (papers) in order to compare and coordinate our study with the below the currently and/or previously published papers in the same domain.

2.1 e-Healthcare Related Works

B. W. Trevor Rohm of Brigham Young University and his son in [1] described "Abstract: A vision of the e-healthcare era is developed using scenarios from today and for the future. The future of e-healthcare is based on empowering individual patients with current information about diagnosis and treatment for personal decision-making about their health without ever visiting a healthcare facility. Empowering the patients is made possible with a futuristic personal medical device (PMD). " And they added "The PMD is a 'black box', which works in conjunction with the internet and locally stores expert system programs. The PMD has various accessories available to help with diagnosis besides voice and image capabilities. "

Patrick C. K. Hung of University of Ontario Institute of Technology (UOIT) described in [2] "Information privacy is usually concerned with the confidentiality of personal identifiable information (PII) and protected health information (PHI) such as electronic medical records. Thus, the information access control mechanism for e-Healthcare services must be embedded with privacy-enhancing technologies. "

A. Mukherjee and J. McGinnis of Montclair State University categorized and explained 'e-Healthcare' in paper article[3]. And they presented the state-of-the-art to identify key themes in research on e-healthcare. They pointed out "E-healthcare is contributing to the explosive growth within this industry by utilizing the internet and all its capabilities to support its stakeholders with information searches and communication processes. A review of the literature in the marketing and management of e-healthcare was conducted to determine the major themes pertinent to e-healthcare research as well as the commonalities and differences within these themes. Based on the literature review, the five major themes of e-healthcare research identified are: *cost savings*; *virtual networking*; *electronic medical records*; *source credibility and privacy concerns*; and *physician-patient relationships*. E-healthcare systems enable firms to improve efficiency, to reduce costs, and to facilitate the coordination of care across multiple facilities. "

2.2 Ubiquitous Services of e-Healthcare in Other Related Works

Nowadays, e-Healthcare has been tightly connected with ubiquitous computing services. Especially, mobile computing is a key technology to realize e-Healthcare system effectively and efficiently. The below papers are discussing about relations and connections between mobile computing and know-how of construction of e-Healthcare system.

Zhuoqun Li and his supervisors of University of Plymouth described at the relevant conference on Computational Intelligence in Medicine and Healthcare[4] "The growing availability of networked mobile devices has created a vast collective potential of unexploited resources. Grid computing with its model of coordinated resource sharing may provide a way to utilize such resources that are normally distributed throughout a mobile ad-hoc network." They also discussed the general challenges in implementing Grid functionalities (e.g. service discovery, job scheduling and Quality of Service (QoS) provisioning) in the mobile environment and the specific issues had arisen from realistic application scenarios, i.e. the e-healthcare emergency.

Min Chen and his co-researchers of Seoul National University described in [5] "Radio frequency identification technology has received an increasing amount of attention in the past few years as an important emerging technology. To address this challenging issue, we propose an evolution to second-generation RFID systems characterized by the introduction of encoded rules that are dynamically stored in RFID tags. This novel approach facilitates the systems' operation to perform actions on demand for different objects

in different situations, and enables improved scalability. Based on 2G-RFID-Sys, we propose a novel e-healthcare management system, and explain how it can be employed to leverage the effectiveness of existing ones. It is foreseeable that the flexibility and scalability of 2G-RFID-Sys will support more automatic and intelligent applications in the future."

2.3 Design Concept based on Previous Related Works

We have designed our new e-Healthcare system based on not only facing problems to be resolved in our university but also the above previously announced in the public journals and conference papers described in the above subsections. Our design concepts are summarized as follows, the former are our original design concepts introduced from existing problems at Routine Physical Examination for students in our university. Namely,

- Reduction of time-consuming tasks and frequently occurred human-errors.
- Avoidance of paper-oriented information exchanging and sharing.
- Applicability of newly designed system to Health Education in our university.
- Usage of IC card-based Student Identification for user authentication.

And the latter ones are added through investigation of previous related works in the public papers. Namely,

- Utilization of Mobile Computing technologies including Wireless LAN, 3G/GSM telephone communication and others for position-independent services.
- Employment of suitable “Electronic Medical Records” and/or “Personal Health(care) Records” for seamless healthcare services.
- Capability of newly designed system as so-called Ubiquitous Services or Cloud Services in order to provide effective healthcare environment.

3 e-HEALHCARE SYSTEM

This section shows configuration of our e-Healthcare system which is already annunciated in the paper[6] and illustrates some details of the system’s characteristics and its typical facilities.

3.1 Configuration of e-Healthcare System

Figure 1 shows a conceptual configuration of our e-Healthcare System in order to resolve existing problems at Routine Physical Examination for students in our university. Its characteristics are summarized as follows;

- User (Examinee) authentication with IC card-based student ID for simplification of Examinee checking.
- Automatic data obtaining of physical measuring devices into personal computers in order to reduce time-consuming tasks of paper-based data recording.
- Temporary data storage with IC card for Routine Physical Examination in not-networked environment.
- Equipment of database for individual healthcare record and health monitoring through campus network.
- Professional health education by university doctors and/or nurses through analysis of medical records from Routine Physical Examination.
- Information retrieval of medical records from Web-based monitoring with user authentication.

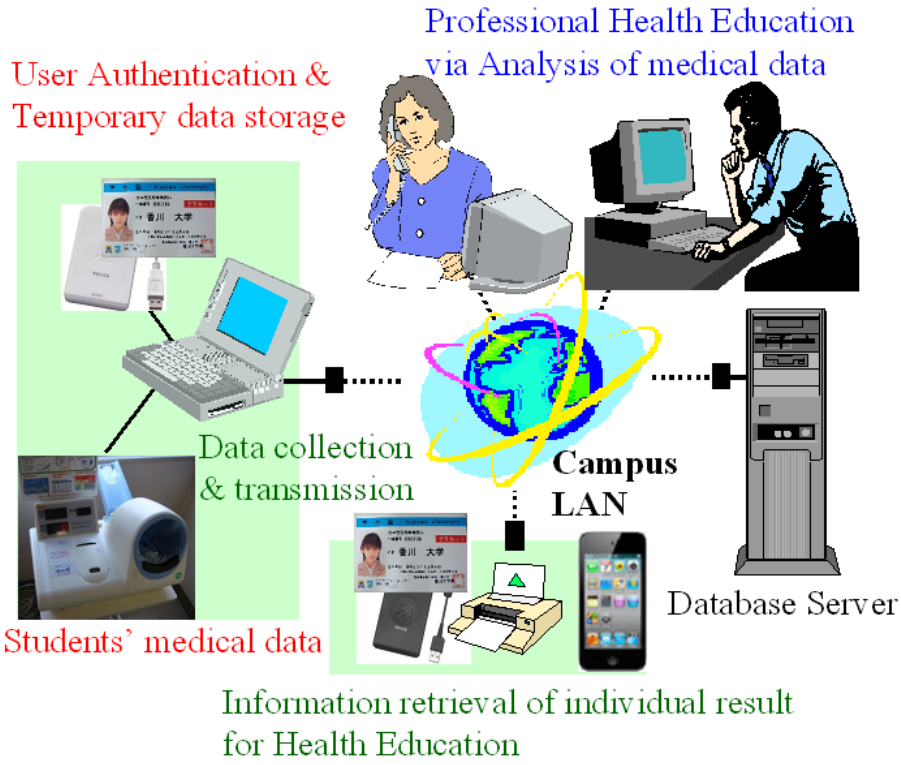

Figure 1. Conceptual Configuration of an e-Healthcare System (previously annunciated in [6])

At the IEEE International Conference on Services Computing (SCC2007)[7] held in Lisboa in 2007, F. Kart and co-researchers of University of California, Santa Barbara described "Large-scale distributed systems, such as e-healthcare systems, are difficult to develop due to their complex and decentralized nature. The service oriented architecture facilitates the development of such systems by supporting modular design, application integration and interoperation, and software reuse. With open standards, such as XML, SOAP, WSDL and UDDI, the service oriented architecture supports interoperability between services operating on different platforms and between applications implemented in different programming languages." They mentioned in other article [8] of *IT Professional* (March-April 2008) "Medical monitoring devices worn by the patient, and frequent electronic communication between the patient and a nurse, can ensure that the prescribed treatment is being followed and that the patient is making good progress. The e-healthcare system can be readily extended to other healthcare professionals, including medical technicians who perform and report tests and analyses requested by physicians."
Their studies and results have provided some good ideas and comprehensive strategy for us to develop and improve our e-Healthcare system and simultaneously taught us how to select several kinds of technologies for implementation of effective e-Healthcare system for our demand of university. We do not employ such open standards described in the above papers but we recognize that it is very important to design our system with modular system architecture / programming and utilize standards of protocols and data formats. So our system can have expandability not only to connect with other systems but also to adapt for several kinds of users with interoperability.

3.2 Sub-systems and Facilities of Our e-Healthcare System

For example, at first, we introduce a *dedicated sub-system* including physical measuring devices, IC card reader/ writer and personal computer (PC) for controlling. We had already developed these

sub-system as Automatic Health Screening System. And Figure 2 shows a typical *dedicated sub-system* with a blood pressure monitoring device and vision analyzer as physical measuring device. As you know, Figure 2 is a part of the left hand of Figure 1 and focuses on a scheme to equip note PC connected with IC card reader/writer and some kinds of physical measuring devices so that both of user authentication and data acquisition can be realized simultaneously in the following steps;

1. Placing IC card of Examinee on the IC card reader connected to PC.

2. Authenticating ID of Examinee from IC card and obtaining his/her relevant information.

3. Acquiring data from physical measuring device connected to PC.

4. Combining measured data and regarding information of Examinee into the formatted record with time-stamping.

5. Storing the above time-stamped record in IC card if the PC for physical examination is not connected with network environment.

Figure 2. *Dedicated Sub-system* of Physical Measuring Device, IC card Reader/Writer and Personal Computer

6. Database server can collect such records of PC or IC card into its storage through network environment.

We have already developed a mechanism to build *dedicated sub-systems* in order to interface several measuring devices such as a blood pressure monitoring device, vision analyzer and other devices to take height and weight [9]. So we will be able to expand the above samples into other types of dedicated sub-system relatively easily for other kinds of physical measuring devices.

Secondly, we explain another facility of our e-Healthcare system to realize health monitoring for database server through campus network in university. The right hand of Figure 1 illustrates a scheme of health monitoring or health information retrieval for database by university doctor through campus LAN.

The *dedicated sub-system* of our e-Healthcare system described above can accumulate the formatted record combined with measured data and regarding information of Examinee with time-stamping. So every student (i.e. Examinee) has his/her health records in database with when-where information about Routine Physical Examination or periodical health checking. Not only the relevant students themselves but also university doctors/nurses can investigate or trace the history/changes of health information in time series.

The relevant facility of our system can generate some kinds of graph based on time-series analysis in order to illustrate the history/changes of health information. Of course, university doctors/nurses can relatively easily perform their professional medical suggestions and/or judgments for some specified students by means of the above facility. Moreover, students will be able to retrieve their health information from database and understand the according history/changes of such information even by themselves.

One of the merits of employing graphical interface for retrieval of health information is to find out a specific change of health information with irregularity efficiently even at glance. Students can recognize such a case very easily through our e-Healthcare system by themselves and then consult their university doctors and/or nurses with

their evidences from our system. Doctors and/or nurses in university also can perform periodical monitoring for graphical retrieving results (shown in Figure 3). Whenever they notice any suspicious changes (phenomena) with the above mechanism, they will be able to send some e-mail and/or do other communication to the relevant student about his/her health situation.

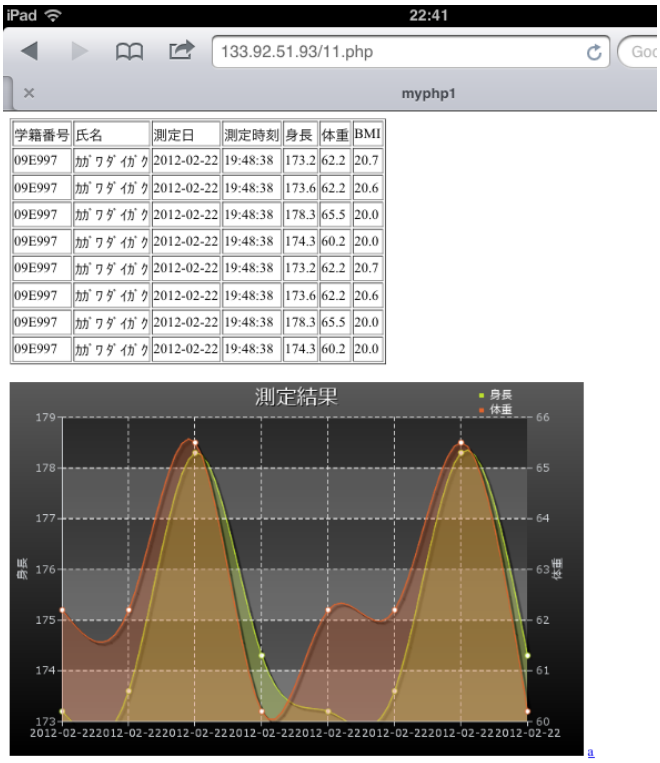

Figure 3. Ubiquitous health monitoring by doctors/nurses through smart devices (i.e. iPad)

With our e-Healthcare system, the above Health Education of university will be introduced and managed effectively and efficiently. The next section will demonstrates its real application in our university, explains some brief evaluation of our e-Healthcare system and reports our challenge to expand our system to overground in the future market.

4 APPLICATION of e-HEALTHCARE SYSTEM and ITS EVALUATION

This section demonstrates real application of our e-Healthcare system at Routine Physical Examination in our university at first. And then it explains brief evaluation of the system and mentions our new challenge to expand our system for potential market near future.

4.1 Quantitative Evaluation of System

It becomes an effective solution to reduce data collecting time and time-consuming error correction in order to obtain data from physical measuring devices. Our e-Healthcare system can achieve an expectable advantage for the above problem which had occurred in the past Routine Physical Examinations.
It can also recognize whether the relevant students have finished all the contents of their Routine Physical Examinations or not. Such a procedure is very useful and attractive for students themselves as well as staffs of Health Center. Because there occurred many problems and tasks when the staffs detected some students returned without finishing their menus of examinations after all the works of routine examination had been closed. And such students must receive the rest of examination in another date/schedule.
It is necessary and important to describe some problems which had occurred during Routine Physical Examination in 2011. Such problems are itemized as follows;

- There occurred many tasks and troubles for preparation of our e-Healthcare system at Routine Physical Examination in gymnasium where we suffered from lack of electricity and LAN connectivity.

- Routine Physical Examination needed technical staffs who can resolve computer-related tasks and troubles in a short time and moreover continue corrective working of computers/physical measuring devices.

- Gymnasium may be not a suitable space for physical examination because it is very much complicated and constrained environment to equip and restore e-Healthcare system for other usages in a short period. (*pre*-Routine Physical Examination can allow e-Healthcare system to work at the same place for a relatively long time)

Figure 4. Photo of utilization of our system for *pre*-Routine Physical Examination in 2012

Figure 4 shows a photo of real utilization of our health screening system for *pre*-Routine Physical Examination in 2012. Students of Sport Club wanted to receive *pre*-Routine Physical Examination because of their schedule in the case of Figure 4. Many other students had also received the *pre*-Routine Physical Examination during a few weeks in 2012 because the relevant students had their own reasons such as their convenience, dislike of crowded normal examination, and so on. As you know, our system can provide such pre or post-Routine Physical Examination for examinees. It can be considered that this evidence informs another effectiveness of our system as qualitative evaluation.

Frankly speaking, utilization of our system for *pre*-Routine Physical Examination is to be a solution for trial avoidance of problems occurred in the above routine examination in 2011. An idea of using system for *pre*-Routine Physical Examination is not only reduction of problems in routine examination but also improvement of consultation rate of students who want to receive physical examination as one of health education of university.

Our e-Healthcare system can generate warning alert when the measured blood pressure is out of the above allowance. So there had been 10 times of warning generation for measuring 300 numbers of students. That was very much useful for Health Center to detect misjudge of measuring blood pressure by means of real time warning and correcting (namely, retrial and rewriting at the same time).

Secondary, we report quantitative evaluation of our e-Healthcare system during the *pre*-Routine Physical Examination in 2012. Evaluation of our e-Healthcare system in 2012 is good and remarkable because it is confirmed that there has been "evident fact" about improvement of consultation rate from the previous situation to the current one. Figure 5 shows consultation rate of Routine Physical Examination in 2011 and 2012.

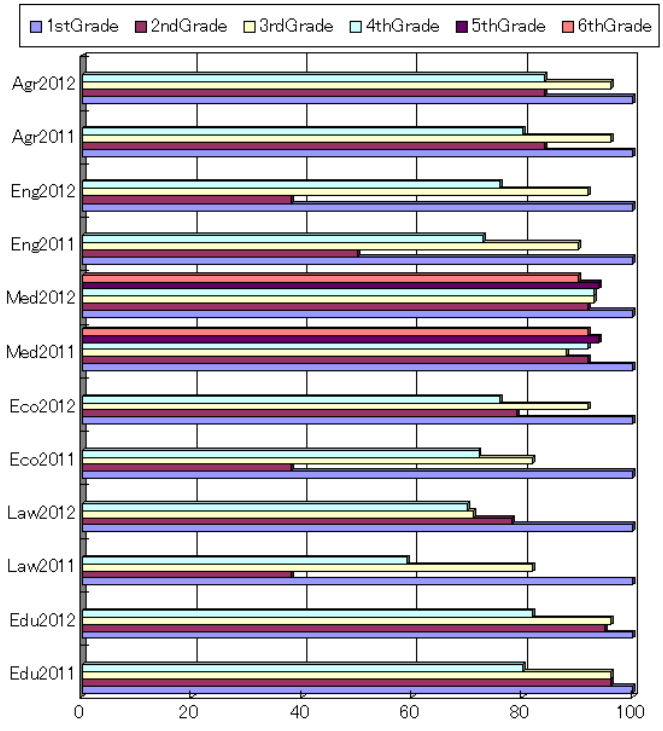

Figure 5. Comparison of Consultation Rates in 2011 and 2012

Our university has six faculties such as Education, Law, Economics, Medicine, Engineering and Agriculture. Only faculty of medicine has students from 1st grade to 6th one, others have students from 1st grade to 4th one.

For example, in the Y-axis of the Figure 5, "Edu2011" specifies consultation rate for faculty of Education in 2011, and "Agr2012" also specifies consultation rate for faculty of Agriculture in 2012. On the other hand, the X-axis of the figure means percentage (max. 100%) of consultation rate. Naturally, in Figure 5, 100% of consultation rate (namely bar chart indicates 100) means that all the students of the relevant grade of the specific faculty have participated in Routine Physical Examination in 2011 or 2012. Consultation rate for students of some faculty has become increased in more 20.0% than the previous one.

Table 1 shows Improvement of Consultation Rate from 2011 to 2012.

Table 1. Improvement of Consultation Rate from 2011 to 2012

Faculty(yr)	1st	2nd	3rd	4th	5th	6th
Agr(2012/11)	1.00	1.00	1.00	1.05	-	-
Eng(2012/11)	1.00	0.76	1.02	1.04	-	-
Med(2012/11)	1.00	1.00	1.06	1.01	1.00	0.96
Eco(2012/11)	1.00	2.08	1.12	1.06	-	-
Law(2012/11)	1.00	2.05	0.87	1.19	-	-
Edu(2012/11)	1.00	0.99	1.00	1.05	-	-

(NB) only faculty of Medicine has 5th and 6th grade of students.

For example, the row of "Eco (2012/11)" means improvement of consultation rate for Faculty of Economics from 2011 to 2012. And in such a row: "Eco (2012/11)" there are 1.00, 2.08, 1.12 and 1.06 of improvement from 2011 to 2012 for 1st grade, 2nd one, 3rd one and 4th one, respectively. Strictly speaking, it cannot be confirmed that there are pure improvements (namely more than 1.00) for all the grades and faculties. The first comers, namely all the students of the 1st grade of all the faculties *must participate in the relevant Routine Physical Examination* based on our university's regulation, so that every 1st grade improvement is exactly 1.00.

As shown in Figure 5, usual average of Consultation Rate of Routine Physical Examination becomes about 80% in a recent few years. So we probably cannot expect a drastic improvement of consultation rate now and in near future, but it can be confirmed that there occurs some remarkable improvements of consultation rate in the 2nd grade of faculties of Law and Economics from 2011 to 2012. Indeed, we can recognize that these improvements are ones of the effects based on utilization of our e-Healthcare system for *pre*-Routine Physical Examination in 2012. Because Health Center has already investigated how many students of each grade of each faculty participate in such an examination, more students of 2nd grade of Law and Economics than others receive health screening in *pre*-Routine Physical Examination.

At the same time, we must recognize that there occur specific exchanges from 2011 to 2012 in 2nd grade of Faculty of Engineering (namely, 0.76) and 3rd of faculty of Law (namely, 0.87). Health Center has also reported that the relevant students have hardly participated in *pre*-Routine Physical Examination, because they probably did not know such an examination in 2012.

4.2 Statistical Testing for Improvement of Consultation Rate from 2011 to 2012

Statistical testing such as *t-test* has been applied for Improvement of Consultation Rate from 2011 to 2012 as follows;

1. All the students of 1st grade of each faculty always participate in Routine Physical Examination, so we can exclude all the cases about 1st grade in Figure 5, namely the targets are focused from 2nd grade to 6th one only.

2. Student's *t-statistic* (*t*) can be calculated as follows:

$$t = \frac{\overline{X} - \mu}{\sqrt{s^2/n}}$$

, where $\overline{X}$ is average of samples, μ is target expectation, s^2 is sample variance and n is number of samples.

3. From Table 1, $\overline{X}$ = 1.11, standard deviation: $s = \sqrt{s^2} = 0.3361$, and n = 3 * 6 + 2 = 20, $\sqrt{n} = 4.47214$.

$$t = \frac{\overline{X} - \mu}{\sqrt{s^2/n}} = \frac{1.11 - \mu}{0.3361/4.47214}$$

If target expectation: μ is assumed to be 1.00, value of Student's *t-statistic* can be calculated as t = 1.52701.

4. Number of samples is *n*, so degree of freedom is $n-1$. $n-1 = 20-1 = 19$.
From Statistical Tables of Student's *t-statistic* distribution, we can obtain the following values for two-sided 5% point ($\alpha = 0.025$), two-sided 10% point ($\alpha = 0.05$) and two-sided 20% point ($\alpha = 0.1$) respectively;
$t_{\alpha=0.025}(19) = 2.093$,
$t_{\alpha=0.05}(19) = 1.729$and
$t_{\alpha=0.1}(19) = 1.328$.
, where α is Significance level of probability.

5. Two-sided *t-test* has been performed as follows;
Null hypothesis H_0 is assumed that Consultation Rate has been significantly improved from 2011 to 2012 by means of utilizing our e-Healthcare system for *pre*-Routine Physical Examination. In other words, "Improvement of Consultation Rate from 2011 to 2012 has been remarkably achieved in the statistical meaning."

Concerning two-sided 5% point
(Significance level: $\alpha = 0.025$),
$|t| = |1.52701| < t_{\alpha=0.025}(19) = 2.093$, so Null hypothesis H_0 cannot be rejected.

Concerning two-sided 10% point
(Significance level: $\alpha = 0.05$),
$|t| = |1.52701| < t_{\alpha=0.05}(19) = 1.729$, so Null hypothesis H_0 cannot be rejected.

Concerning two-sided 20% point
(Significance level: $\alpha = 0.1$),
$|t| = |1.52701| > t_{\alpha=0.1}(19) = 1.328$, so Null hypothesis H_0 can be rejected.

Therefore, we cannot confirm that Consultation rate has been improved statistically concerning Significance Level $\alpha = 0.025$ nor $\alpha = 0.05$. Meanwhile, we may confirm that Improvement of Consultation rate from 2011 to 2012 has been significantly achieved in a statistical meaning of Significance Level: 20%.

As a result, we can recognize that many of the relevant students have participated in the specified *pre*-Routine Physical Examination in order to bypass the crowded "normal (= regular)" Routine Physical Examination. So we have confirmed that it can be statistically effective to utilize our e-Healthcare system for Routine Physical Examination, especially for health screening in *pre*-Routine Physical Examination.

5 CONCLUSION

This paper describes our e-Healthcare system for Student Health Education in Kagawa University. With our system, not only students can receive efficient Health Education but also doctors/nurses can provide fruitful medical suggestion and/or judgment through health monitoring. Routine Physical Examination can be improved into reduction of time-consuming tasks as well as avoidance of frequently-occurred human errors.
Characteristics of our e-Healthcare system are summarized as follows;

- Employment of modular system architecture for easy maintenance, effective interoperability and system expandability:
Our e-Healthcare system includes a *dedicated sub-system* with some kinds of physical measuring devices, IC card reader/writer and controlling PC(s), a Database information

server and some facilities for user-side health monitoring and retrieving. Each *dedicated sub-system* can be relatively easily tailored for other kinds of physical measuring devices. An additional facility can be built into the system for the sake of system expansion.

- Utilization of student IC card for user identification:
  It is a good idea to employ student IC card for user (i.e. examinee) identification during physical examination. With such IC card-based identification, our e-healthcare system can reduce and shorten total amount of time to register and authenticate examinees for physical screening test.

- Realization of mechanism to interface between measuring devices and computers:
  In order to build some kinds of interfaces between physical measuring devices and controlling PC in *dedicated sub-system*, it must be done to connect device into computer's IO ports such as USB, write specific software for interrupts just like drivers and manipulate such devices by the controlling PC. With automatic control of measuring devices by such PC, our e-Healthcare system can avoid probabilistically happened human errors as well as writing mistake of measured data.

- Visualization of history/changes of health information in time series:
  The specific facility of our system can generate graphic information based on time-series analysis in order to illustrate the history/changes of health information. Doctors/nurses of university can relatively easily perform their professional medical suggestions and/or judgments by means of such a facility. Students can also recognize graphical history/changes of their health information.

REFERENCES

1. B. W. T. Rohm and C. E. T. Rohm (Jr): A vision of the e-healthcare era. International Journal of Healthcare Technology and Management, Vol.4, No.1-2, 87--92 (2002).
2. P. C. K. Hung: Towards a Privacy Access Control Model for e-Healthcare Services. In: Third Annual Conference on Privacy, Security and Trust (PST2005), 4 pages, (2005).
3. A. Mukherjee and J. McGinnis: E-healthcare: an analysis of key themes in research. International Journal of Pharmaceutical and Healthcare Marketing, Vol.1, No.4, 349--363, (2007).
4. Z. Li., L. Sun and E. C. Ifeachor: Challenges of Mobile ad-hoc Grids and their Applications in e-Healthcare. In: 2nd International Conference on Computational Intelligence in Medicine and Healthcare (CIMED2005), 8 pages, (2005).
5. Min Chen, Sergio Gonzalez, Victor Leung, Qian Zhang and Ming Li: A 2G-RFID-based e-healthcare system. IEEE Wireless Communications, Vol.17, No.1, 37--43, (2010).
6. Y. Imai, Y. Hori, H. Kamano, E. Miyazaki and T. Takai: A Trial Design of e-Healthcare Management Scheme with IC-Based Student ID Card, Automatic Health Examination System and Campus Information Network. In: H. Cherifi, J. M. Zain, and E. El-Qawasmeh (Eds.) The International Conference on Digital Information and Communication Technology and its Applications (DICTAP2011), Part I, CCIS 166, pp.728--740 (2011).
7. Firat Kart, Gengxin Miao, L. E. Moser and P. M. Melliar-Smith: A Distributed e-Healthcare System Based on the Service Oriented Architecture. In: IEEE International Conference on Services Computing (SCC 2007), pp.652--659 (2007).
8. Firat Kart, Louise E. Moser and P. Michael Melliar-Smith: Building a Distributed E-Healthcare System Using SOA. IT Professional, Vol.10, No.2, 24--30 (2008).
9. E. Miyazaki, H. Kamano, D. Yamakata, Y. Imai and Y. Hori: Development of an Automatic Health Screening System for Student Health Education of University. In: W. V. Siricharoen, M. Toahchoodee, and H. Cherifi (Eds.) 2nd International Conference on Digital Information and Communication Technology and its Applications (DICTAP2012), pp.421--427 (2012).