Contempo: A Home Care Model to Enhance the Wellbeing of Elderly People

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***Abstract*— Fast growing population of elderly people has recently been a serious issue in many countries and becomes a global concern in the world. Most elderly people require assistance in their daily life, including in maintaining their wellbeing, taking care of their health, or responding to emergency medical situations. The need for caring for elderly people, particularly to maintain their wellbeing, has been growing significantly.**

The objective of this research is to seek improvements in quality of life that can enhance the wellbeing of elderly people through innovations in information technology. This research is also expected to be a significant contribution for dealing with ageing population as a common issue in many countries. This paper deals with a pervasive health care technologies and ambient environment, which propose a model of Connected Technologies for Home Care for Elderly People (Contempo) to enhance the wellbeing of elderly people. A model of wellbeing assessment is also proposed to examine the proposed Contempo.

I. INTRODUCTION

The population of aging people has recently been gaining attention from many countries in the world. United Nations reported similar trend in many countries about rising of elderly ratio from 7% to 14% in East Asia [1]. This research project deals with elderly people relevant to regional common issues of population ageing [1]. The issue of rapidly aging population in many countries has been published by JICA on a Japanese study report [2, 3]. In response to the aging population, Indonesia has adopted a National Action Plan [4], which focuses on establishing and ensuring necessary support for the elderly.

A major concern for elderly people is their health care. Health care for elderly becomes a very crucial issue in many countries, because if it is neglected, poor and sick old people will indeed become burdens to their families and the government. Continuous urbanization, in which people from rural move to urban area, has made most elderly people eventually live in urban areas. Elderly people are at high risk for disease and disability. Difficulties in accessing health professionals and public health services bring up a problem in their medical care. Additionally, most elderly people are still unwilling to enter nursing homes. They prefer to have the convenience and comfort of staying at home. We present Contempo, a home care model, which is equipped with an automated stand-alone surveillance method and is fully integrated with the environment. Contempo, which implements the concepts of pervasive computing technologies and ambient environments, is a solution to deal with this problem. Contempo can be defined as a dwelling that connects the residents, household appliances, environments, sensor and services, medical care givers, family member and allow them to be remotely monitored or accessed. Its automated stand-alone surveillance method, which is fully integrated with the environment, is an assistance to elderly people who live autonomously. Monitoring of the elderly people can be performed remotely by health service providers such as doctors, care givers, and hospitals. Having the capability of remote health care services can reduce human resources and response time in critical situations and finally enhance the wellbeing of elderly people.

Enhancing the wellbeing of elderly people in this research project will be concerned on the technological perspective through Contempo, including metrics and evaluation criteria which can be tested by elderly people. We also aim at proposing a wellbeing assessment model as a tool to assess Contempo. Finally, this research project is also expected to be a significant contribution for dealing with ageing population as a common issue in many countries.

The structure of this paper is as follows. Section 2 gives description about related research work. Section 3 describes the proposed model. Section 4 presents challenges and future research.

II. RELATED RESEARCH WORK

It is necessary to assist elderly to deal with their health problems, such as chronic disease, disability, and the risk of falling. Many inventions [5, 6, 7] have been developed to overcome elderly health problems. Wireless Sensor Network (WSN) and Radio Frequency Identification (RFID) in health care system has become a tremendous effort as communication tools in health care [8, 9]. However, improving quality of life is one of the main concern for the pursuit of wellbeing of elderly people.

Vincent La Placa from University of Greenwich categorized the framework of wellbeing into four domains as individual, family, community, and societal wellbeing [10]. Hsinchun Chen from University of Arizona have developed smart health to improve wellness services based on patient-centered health [11]. Indicators such as satisfaction, anxiety

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978-1-4799-2131-7/14/$31.00 ©2014 IEEE

and happiness are used by UK government to measure people's individual and psychological status [12, 13].

Home is the best environment for elderly people to get convenience health care. By utilizing WSN, healthcare providers also can remotely constant monitor the elderly activities and physiological parameters. Elderly's disability to access public health services and elderly's preference to have the convenience and comfort of staying at home are a strong justification for developing Contempo. Due to incapabilities and preferences of elderly, Contempo offers a unique and new perspective in providing reflective sensing system for elderly, which concerns in human condition and position as well as surrounding environment that may affects the wellness of elderly. Automatically intelligent reflection of sensing will process data gathered from real time elderly's wearable body sensors and the surrounding environmental conditions to be sent reflectively to home appliances and personal health support appliances.

III. THE PROPOSED MODEL

A model of Contempo, as shown in Figure 1, is a pervasive system that is equipped with an automated stand-alone surveillance method and fully integrated within the environment. It can provide constant monitoring of the activities and physiological parameters of elderly person, recognizes changes in their health status, and has the capability to alert doctors, care givers, and family members.

The proposed model of Contempo consists of three main sub systems, namely Reflective Sensing System, Alert System, and Diagnostic Support System. These three main sub systems of Contempo will work in harmony simultaneously in order to enhance the wellbeing of elderly people, particularly elderly people with disabilities or/and elderly people with chronic diseases.

A. Reflective Sensing System (RSS)

RSS will provide automatically reflection of sensing gathered from vital sign sensors, activity daily sensors, fall detection and tracking sensors, and ambient environment sensors. Sensor will send data of the elderly in real time about health status and environment data surrounding the elderly as inputs to RSS. Output from this system will be sent automatically to home appliances or/and personal health appliances (particularly for elderly with chronic disease).

B. Alert System (AS)

AS will provide alert to care givers, doctors, emergency units, and family members related to elderly health status in alert condition.

C. Diagnostic Support System (DSS)

DSS will provide medical diagnostic to doctors to be monitored and analyzed. The result of analyzing, doctors will give resume of diagnostic as a feedback manually to the system to improve the elderly health status and treatment.

We define alert system of Contempo into five categories, such as:

- *Category 1: Wellness Improvement Condition*

Condition that elderly has significant improvement on wellness. We will define wellness of elderly by indexing based on physiological status of elderly and their activity.

- *Category 2: Critical Activity Condition*

Condition that elderly needs special attention because of doing critical activity. Critical activity leads to possibility of having accidents such as body position in bathroom, going to outside home.

- *Category 3: Minor Condition*

Condition that elderly needs more convenience from environment and some assistances.

- *Category 4: Major Condition*

Major condition is a condition in critical situation and needs some medical assistance, such as falls but elderly remains in consciousness.

- *Category 5 Emergency Condition*

Condition that elderly in emergency condition and need assistance from emergency units. Emergency conditions such as fall in the elderly that resulting serious injury.

Category 1 till category 3 of alert condition will be sent only to care givers and family members. Category 4 of alert condition will be sent to doctors, care givers, and family members. Category 5 of alert condition will be sent to emergency units, doctors, care givers, and family members.

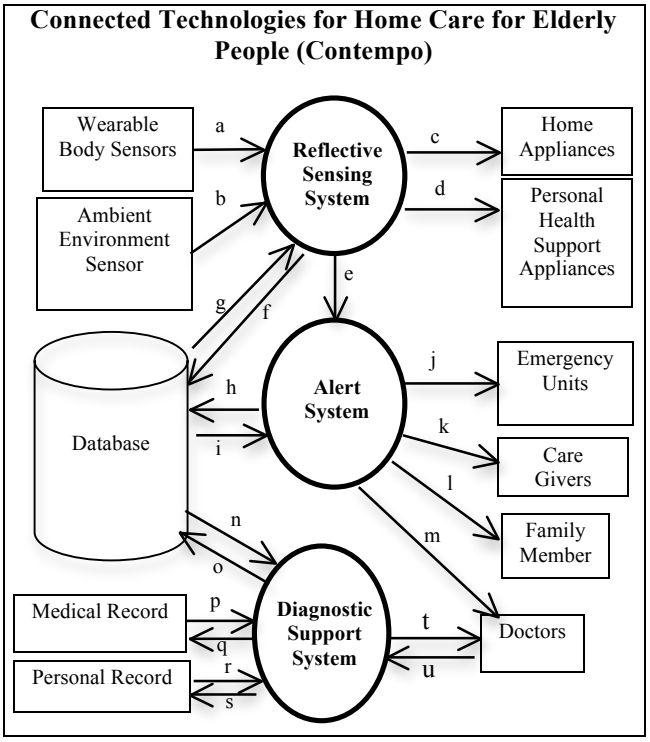

Figure 1. A proposed model of Contempo

The flows in Contempo, described as follow.

a. Wearable_Body_Sensor_Data

Wearable_Body_Sensor_Data consists of data from vital sign sensors, activity daily monitoring sensors, fall detection sensor, and tracking sensors. Vital sign will monitor physiological function of elderly, which includes data of body temperature in Celcius degree, respiratory rate in breaths/minutes, blood pressure in mmHg, and heart rate in pulse/minutes. Activity daily monitoring sensors will monitor elderly's activity, which includes sitting, lying, and standing. We will classify the state of activity into two categories namely active state and passive state. Active state is a state where the elderly in an active circumstance such as sitting position and standing position. Both sitting position and standing position are states where elderly is doing activities. Lying position will be defined as a passive circumstance where elderly is not doing activities. Elderly is at high risk of fall that can result injury and fatal damaged. Fall detection will be able to accurately predict a fall of elderly, so that some fast preventive measures can be taken to prevent any serious injury. Elderly tracking system will track the location of elderly when something happened to elderly in dangerous condition.

b. Ambient_Environment_Data

Context awareness of environment for Contempo is a crucial matter in the design of solutions for in-house safety. Context information related to elderly wellbeing such as location and health status will be obtained by sensor infrastructure such as lighting, temperature, and noise. The information can then be further processed and combined with wearable body sensor data to give appropriate condition of elderly health status.

c-e. Trigger_Data

The processing result of RSS will produce Trigger_Data reflectively to do some action related to alert condition of elderly to Home Appliances, Personal Health Support Appliances, and AS, as shown in flow c, d, e, respectively.

f. Sensing_Data

The processing result of RSS will produce Sensing_Data, which will be saved in database.

g. Sensing_Parameter

Sensing_Parameter is a historical data taken from database to be processed in RSS to trigger Home Appliances and Personal Health Support Appliances.

h. Historical_Alert

Historical_Alert is data as a result from AS processing and will be saved in database.

i. Historical_Data

Historical_Data is data taken from processed database as an input to AS.

j. Emergency_Alert

The output of AS will be sent as an alert to emergency units if elderly is in emergency condition only.

k-l. Alert

The output of AS will also be sent as an alert to care givers and family member, as shown in flow k and l, respectively, if elderly is in wellness improvement condition, critical activity condition, minor condition, major condition, and emergency condition.

m. High_Alert

The output of AS will also be sent as an alert to doctors if elderly is in major condition and emergency condition.

n. Historical_Data

Historical_Data is data taken from processed database as an input to DSS processing system.

o. Diagnostic_Data

Diagnostic_Data is the result of processed DSS that will be saved in Database. There are four inputs to DSS processing system: Medical_Record_Data, Personal_Health_Record_Data, Database, and Resume_of_Doctor_Diagnosis.

p-q. Medical_Record_Data

Medical Record (MR) contains information about elderly/patient's health compiled and maintained by each of health care providers. Medical_Record_Data consists of elderly health information including personal identification; anamneses; laboratory; radiological, and other test record; medication record. Data from MR will be sent as and input to DSS, as shown in flow p. Data that has been processed in DSS will be recorded back to MR, as shown in flow q.

r-s. Personal_Heatlh_Record_Data

Personal Health Record (PHR) contains information about elderly/patient's health compiled and maintained by elderly themselves. Personal_Health_Record_Data consists of medical record information, which comes from health care providers, and elderly/patient's additional information, which comes from individual such as preferences. Data from PHR will be sent as an input to DSS, as shown in flow r. Data that has been processed in DSS will be recorded back to PHR, as shown in flow s.

t. Diagnosis_Data

The result of DSS will be sent to doctors as a Diagnosis_Data. Doctors will login to the system to monitor and analyze elderly health status daily.

u. Resume_of_Doctor_Diagnosis

Doctor's analysis manually will be sent as a Resume_of_Doctor_Diagnosis to improve processing in DSS. The information related to elderly's health status will periodically update by system and doctor.

Before the implementation step, the Contempo model has been verified and validated. For verification of Contempo model, we ran simulation with various input scenarios and checked the output of simulation for reasonable results. For validation of Contempo model, we discussed with different types of user such as elderly, doctors, care givers, family members, and emergency units.

To test the implemented Contempo, we will use system testing and user acceptance test. For user acceptance test, we will involve all types of user.

To achieve the goal of this research project, we also proposed a wellbeing assessment model, as shown in Figure 2. Indicators for wellbeing assessment include satisfaction, anxiety, and happiness [12, 13]. Wellbeing assessment will be measured qualitatively through observation and interview to some elderly people. There are three components that effects wellbeing, namely physical health, behaviour, and environment. These three components will be measured quantitaively based on information gathered from wearable sensors and ambient environment sensor.

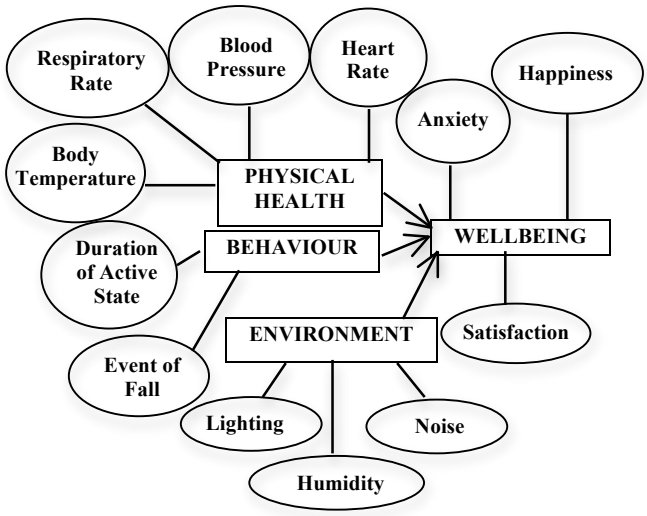

Figure 2. A proposed model of wellbeing assessment

A. Physical Health

There are four variables to measure physical health periodically such as body temperature that will be measured quantitatively in Celsius degree, blood pressure that will be measured quantitatively in mmHg, heart rate that will be measured quantitatively in pulse/minutes, and respiration that will be measured quantitatively in breaths/minutes.

B. Behaviour

There are two variables to measure behavior periodically such as duration of active state and event of fall. Active state will be defined as a sitting or standing position while doing activities. We will measure and analyze the duration of active state done by elderly in a day. Event of fall will be measured every day.

C. Environment

There are three variables to measure environment periodically such as lighting, temperature, and noise. Lighting will be measured quantitatively in lux. Temperature will be measured quantitatively in Celsius degree.

IV. Challenges and Future Works

Since health care for elderly is becoming an important issue in many countries due to rapid growth of elderly people population, development of Contempo to enhance the wellbeing of elderly people is of significant importance. There are some challenges, such as: (1) how to integrate three main sub systems of Contempo to become an effective and comprehensive system, (2) how to develop knowledge base and health information processing to determine the appropriate clinical decision support system, and (3) how to determine parameters for wellbeing index.

Our future work shortly will be focused on developing three main sub systems of Contempo, which consists of reflective sensing system, alert system, and diagnostic support system. Readiness of information gathered from wearable sensors, ambient environment sensors, medical record, and personal health record is really needed as input to Contempo. Developing knowledge base and health information processing accurately and real time are the main important things to provide appropriate clinical decision. Then, integrating three sub systems of Contempo will be our next project after development of each sub system has been done. Finally, Contempo will be assessed to measure level of wellbeing. Determining parameters for wellbeing index is really needed to assess the wellbeing. Wellbeing assessment will be our final future work.

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