

UDuctor: Enhanced Assistance and Monitoring of Noncommunicable Diseases using Pervasive Computing

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Abstract— The world's main causes of death are noncommunicable diseases (NCDs), which include diabetes, heart disease, and long-term respiratory disorders. Personalized healthcare support, prompt interventions, and ongoing monitoring are necessary for managing these disorders. Correspondence is done in pervasive wellbeing for disease care; however, the administration of assets is not bolstered. In order to improve support for patients with noncommunicable diseases, this paper presents UDuctor, a ubiquitous computing-based platform to help incessant infections patients for self-administration exercises and correspondence support among wellbeing association and group whenever, anyplace. It likewise gives constant correspondence to the patients to offer valuable assets for their self-administration exercises. The proposed model called UDuctor center the asset offering, without losing self-administration and correspondence supports. The executed framework is tried for couple of patients; the outcomes are fascinating and extremely helpful for genuine circumstances, and it can be utilized frequently by the incessant patients. The noncommunicable diseases patients are going to fill the inquiries to the UDuctor model to get the helpful assets for their consideration.

Index Terms— UDuctor, Pervasive Computing/Ubiquitous Computing, Patient, Non-Communicable Diseases (NCD).

I. INTRODUCTION

Health is an important thing for human beings. But the cause of the diseases is increasing the burden on the poor countries by the global status report of the World Health Organization (WHO). The examples of NCD are obesity, high blood pressure and overweight.

The causes for these diseases are the smoking and sedentary life style, which will lead to the changes in the metabolic or physiological conditions [1].

Chronic diseases are the disease which does not transfer from person to person [1]. This disease leads to deaths across the global then the combination of all other diseases. Especially these diseases cause is difficult to identify in the poor and developing countries.

The deaths of these diseases and suffers of these diseases are dramatically increasing; hence the reduction of this can be done through the early detection and timely treatments. For the non-communicable ailments, the WHO given a global status report having 74% of death due to NCDs globally. Low- and middle-income nations account for 86% of the 17 million premature deaths, or deaths before the age of 70, and more than three-quarters of all deaths from NCDs.

The flow condition of advancement nations is making to address these illnesses as far as strategies and arrangements, base, observation and population wide and singular intercessions for the associations. It likewise gives a dream and guide for NCD avoidance and control. The benefiter of this incorporate approach creators, wellbeing authorities, nongovernmental associations, the scholarly world, significant non-wellbeing divisions, advancement offices and common society. The different causes for the non-communicable diseases are shown in the figure 1.



Figure1: The causes for the non-communicable diseases

Doctor's facility focused intense consideration is the fundamental centre of human services for NCDs in some low- and centre pay nations. Cardiovascular infection, malignancy, diabetes and perpetual respiratory disease have come to the point of intense occasions or long-haul inconveniences of the NCDs in the clinics. This is weight with an extremely extravagant methodology that won't add to a critical diminishment of the NCDs. It additionally brings down the individuals' medical advantages of dealing with their conditions at an early stage. It is incorporated to an essential social insurance for right on time identification and auspicious treatment of NCDs. The bundle of essential human services administrations to NCD intercessions is vital to any wellbeing framework reinforcing activity. The death rate diminishes from high-pay nations demonstrates that a thorough concentrate on avoidance and enhanced treatment taking after cardiovascular occasions. Malignancy treatment joined with ahead of schedule discovery and screening mediations have enhanced advance in survival rates for some growths in high-salary nations. Yet at the same time the survival rates in low and centre pay nations are staying low. The general wellbeing frameworks can be reinforcing by a blend of public wide and individual intercessions to repeat successes in numerous more nations through understanding activities [2].

Currently, there is no much focus on finding local resources or services, or on finding caregivers who can assist chronic patients with their daily tasks. Hence the proposed system offers the features like self-management, communication support and search of nearby resources.

The Motivation for this article is, so many people suffering from the chronic diseases, at least they required the medical care, because most of these diseases requires continuous treatment and some diseases are not curable. Patients are not getting any effective clinical management, psychological support and the information required for patients are mismatch between their needs and care activities from where they are getting. This won't suit for all the patients because each of the patients will have different conditions [3]. At the present world the maximum people will be having the smart phones with the internet access therefore patients must understand their condition and adhere to the treatment regimen prescribed by the attending physician. With the help of ubiquitous computing the patients require continuous management and the patients will also get the required confidence to perform their care activities.

Hence the problem has to design uductor model to reduce the deaths of NCDs. The system should be helpful for the patients to continuously monitor their conditions along with the resource and context information. The patients can be aware of their body conditions like blood pressure, heart rate and body temperature etc. The patients are also getting the search option to retrieve nearby hotels and pharmacies information for their care activities [4].

The main objectives of this paper are:

- Uductor model offers the resource and context information for the patient care along with self-management support for the patient's activities.
- Manual and automatic alert message transmission facilitates communication between patients, community members, and healthcare organizations.
- Uductor model creates the awareness among the patients for their self-activities and continuous monitoring.
- The patients are treated through specified doctor id that is specified and informed about the remaining of the medicines to be consumed at the specified time through the automatic alert sending.

II. RELATED WORKS

There are several existing systems which will be described under the following features and which are also based on the ubiquitous health:

Self –management support: This allows patients to take care of their food, medications, and health issues on their own by managing these tasks independently. The patients are performing their own activities; they are taking food in the timely manner as specified, taking the medications as prescribed by the medical team and checking their body conditions like blood pressure, heart rate, weight etc. In some of the systems if the patients are not able to take care of their care activities, the patient's relatives or the medical team will be performing management of patients.

Interactions between community members, patients, and health organizations: it is a way of communication support so that a patient needs an alert that what are the drugs or medicines to be consumed and when they need to be taken. There are different ways of communications exists in the systems. It can be either through manual or automatic alert sending of messages. The patients can be communicated with the health organization or to the members of the community if they required help during their emergency conditions like the medicines or their body conditions. The health organization will be communicating to patients or their relatives if there are any left out medicines that need to be consumed. It will give an alert to the patients if they forget to have the medicines prescribed.

Resource and context notification: It is a method for assisting patients in finding local resources, services, or individuals that might be needed for their well-being and care. The different resources are the nearby pharmacy, hotels, medical team, the care givers and the equipment's available for their physical activities. The context notifications like the temperature, humidity etc. of the location and the blood pressure, heart rate, weight of a person etc.

[5] identifies the use of ubicomp in the medical field as "u-Health" or "pervasive health." Hospital management and patient monitoring systems comprise the bulk of u-Health's applications. Among the many U-Health hospital apps are hospital supervise routines like as drug management and treatment, health team coordination, and conference, surgery, and emergency department management. The various patient monitoring apps are frequently utilized to support elder and chronic patient care from a distance. A variety of application classes offer tools for managing one's own health, including nutrition plans, personal trainers, and games that encourage physical activity.

The concept is mostly applied to the management of chronic care in [6]. The interactions between patients and healthcare providers are provided by this paradigm. It provides the tools patients need to develop the abilities and self-assurance needed to take care of their ailments. When it comes to care activities, patients and caregivers must work together. It provides patients with self-management support and facilitates contact between patients, community members, and health organizations; nevertheless, this approach did not enable patients to search for nearby services. The properties of the model are:

- self-administration
- guidelines for patient decisions
- for the patients advise has delivered system

In [7], the Innovative chronic care model is mainly used for the chronic care management. This model provides a strong integration between the communities and health organization, so that the patients can take care of their chronic conditions. This model contains components that are divided into trio levels.

They are macro, meso, and micro. The problem with this model is it should be compromised between every level from patients to government. This model does not offer the search of nearby help. The key components in this model focus on:

- the quality of patient interactions is improved
- health care improvements for health organization
- involvement of the health care community
- It has the Policy and financing systems.

In [8] and [9], the patients performing self-management through the wellness dairy or mobile dairy, it is an application in the mobile phone. It was in Kanfer's cognitive behavioral therapy (CBT)-based self-management model. The patients perform self-management through the self-observations as an input to the system. They are going to get the self-observation output which is embedded in the calendar of the mobile phone. The wellness dairy's primary goal is to encourage longer-term self-monitoring of health and wellbeing. Additionally, it offers users feedback in their account to assess the state and direction of their own well-being and assist them in making decisions pertaining to their health.

Mobile is the key concept in the wellness dairy, because of the mobility feature. It provides patient well-being management continuously and integrated to everyday life. At the present world almost all people having and carrying mobile phone, hence the application is always on hand. It provides users with tasks linked to health management that they can complete whenever and wherever they choose, whether they are idling or making lifestyle decisions. In order to choose individualized health-related variables, users create personal goals in the WD. They also want to self-monitor before being allowed to use the dairy. As a result, WD can be used to track several planes of personal wellbeing and can be modified over time to accommodate evolving demands.

In [10], the Koutkias framework will be having monitoring sensors to identify the activities of the patients. This gives the descriptions about the drug use, its adverse effects and gives alerts to the patients. It also gives an alert for the situations that patients need a help. The framework contains the different functional units called mobile base unit (MBU) and the clinical subsystem. The functions of MBU are physically distributed and the functions of clinical subsystem are partially distributed. The mobile base unit (MBU) is called the patient monitoring hub.

The E. Paganelli and Giuli System fails to allow patients to self-manage in [11] and [12]. In their caregiving duties, the members of the health organization and the patient's relatives share obligations. In agreement with the rules established forth in the system, it offers a setting for home-grown monitoring and alarm production for the assistance system.

III. UDUCTOR: PROPOSED SYSTEM

In addition to self-assistance and message between patients, community members, and health organizations, the UDuctor model provides the ability to search for nearby assistance. The conceptual model and middleware architecture make up the whole UDuctor model architecture, which is depicted in figure 2. The middleware architecture is implemented in the conceptual model's nodes, and the model's elements' organization and interactions are discussed. The conceptual model will primarily address five uductor aspects. The nine components that make up the uductor middleware construction will be executed in the personal and local nodes.

A. UDuctor Conceptual Model

The UDuctor conceptual model consists of mainly five elements, Figure 3 shows the example for UDuctor elements. The user or patients will send the request to the uductor model; this model will process the request and gets the required resource and context information from the nodes. Then the uductor model will be giving response to the users.

The nodes in the UDuctor system are the objects providing a shared properties and context data. They are two types of nodes; they are local nodes (LN) and personal nodes (PN).

Local Node (LN)

LNs are like a place or any other type of site which is having people and other places has references to share resources and context notifications, hence which represents a residence in a geographic region.

For example: where, the pharmacist as a person called personal node, the pharmacy, which contains a drugs or medicines as resources, and the local thermometer used to check the temperature change notifications called the context.

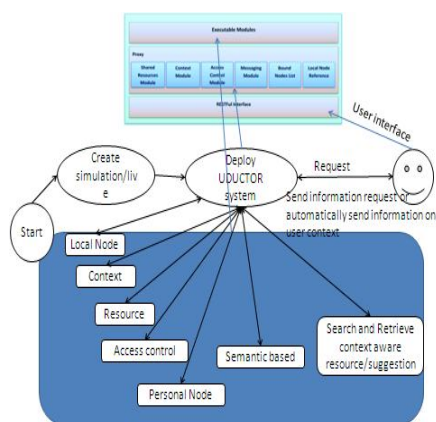


Figure 2: Architecture of Uductor Mode

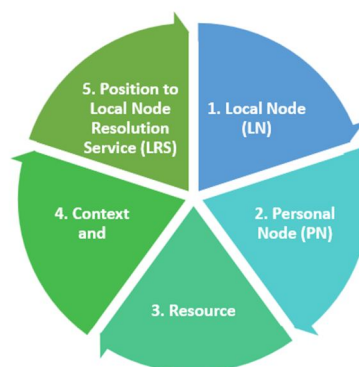


Figure 3: UDuctor elements

Personal Node (PN)

These are also nodes which are moving between the places and which are associated and bind to LNs based on the locations. This is a movable device like a tablet or smart phone. PNs will search for LNs to help for handlers in their care activities. Hence the PNs can bind or unbind to the local nodes, because when a position modification occurs the PNs will receive an LN reference dissimilar from its existing reference. These entities are also a person who has a knowledge in their care activities which provides a resources and context information. The PNs also share the resources and context information similar to LNs hence these are used for real time patient monitoring.

Resource

The resources can be physical or electronic; for example, scale and medicines in the pharmacy are physical resources similarly the image of food guide chart stored in the nodes is an electronic resource. Hence it is an information or content that is shared by the nodes, which will be use full for the users in their maintenance activities.

Context

The attribute or the property of an entity which can be used to identify the situation of the entity. Example: temperature of place and BP of a person.

Position to Local Node Resolution Service (LRS)

LRS is used by the PNs and LNs to shift across themselves and it can perform the conversion of the geopositioned data of the PN in the LN references. The following table1 shows examples for these elements.

TABLE 1: THE UDUCTOR ELEMENTS

Item Number	Description	UDuctor element type
1	Neighborhood	Local node
2	Drinking fountain	Resource
3	Temperature	Context
4	Pharmacy	Local node
5	Local resident	Personal node
6	Heart rate	Context
7	Pharmacist	Personal node
8	Medicine	Resource

The local node neighborhood is linked to the resource drinking fountain, context called temperature and the LN called pharmacy, the pharmacy is further linked to personal node-pharmacist, resource-medicine, next the LN neighborhood is further linked to PN local resident and which is linked to context heart rate. Figure4 shows the UML hierarchy object diagram where the UDuctor elements are connected.

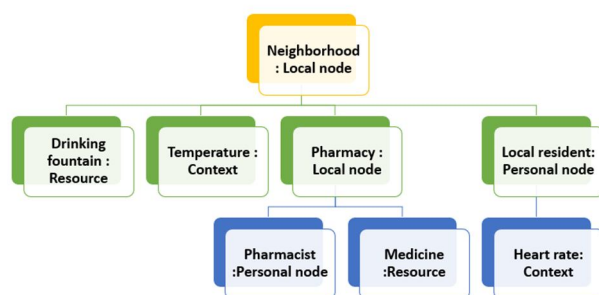


Figure 4: Hierarchical link of the UDuctor Elements

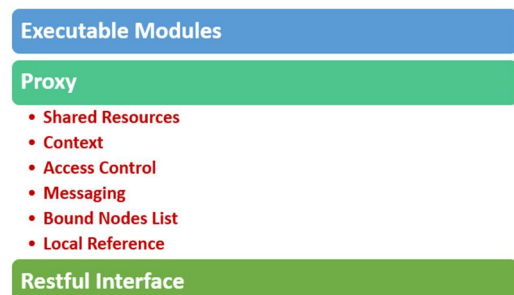


Figure 5: UDuctor Middleware Architecture

Each of the nodes in the conceptual model will be having the UDuctor middleware architecture. Hence the UDuctor middleware is executed in the nodes, which offers pervasive software infrastructure for the UDuctor model.

B. UDUCTOR Middleware Architecture

The architecture is providing features like resource sharing, context notification, messaging, and access control. Figure 5 shows the UDUCTOR Middleware Architecture. This middleware architecture contains the following nine components.

Executable Modules

To accomplish the various objectives, this component uses the apps to access the various middleware functions. These software programs, which are created by software developers, ought to be listed in the middleware. This provides the ability to access several middleware capabilities, including messaging, bound nodes, shared resources, context information, access control, and LN reference.

Proxy

By using access control module, proxy module grants access authorization. Additionally, it is employed to verify if the executable module or node is authorized to access a requested middleware function.

Shared Resources

The shared resource module is in charge of giving the nodes the ability to create, edit, query, and find resources. It controls the resources that a node shares, as the name suggests. Additionally, it notifies the workable modules whenever a resource is added, removed, or modified.

Context

Examples of the context include the air quality index, relative humidity, UV radiation index, and so on, if the node represents a location. The properties include blood pressure, glucose, body temperature, and so on if the node is a human. In order for the applications running on the middleware to get context notifications, the node keeps a context history or trail. The context module's primary duty is to ensure that executable modules or user nodes are registered with it in order to receive alerts of changes to the attributes that determine the state of the node that operates on it.

Access Control

This module provides a security over the unauthorized of other uductor nodes or executable modules, so which manages only the authorized nodes to access the middleware features. For example: the personal node has to receive the temperature updates from a local node, or any other information.

Messaging

The protocols can be used for the messaging in the applications. There is no any specific format for the messages; hence this module can be used to exchange the messages.

Bound Nodes List

A list of other nodes is included, which allows a node binding and unbinding to the active middleware instance.

Local Reference

The references are used by the PN or LN nodes to access the resource and context information. The LN can provide a reference to the nodes connected to it, that is, either PNs or LNs.

RESTful Interface

This interface is implemented using Representational State transfer architectural style. These are the kind of interfaces which provides a remote accessing to the nodes. In other words, nodes can remotely access middleware features including messaging, shared resources, context, access control, local references, and bound node lists.

IV. RESULTS AND DISCUSSION

The system is executed using Microsoft visual studio with C# programming. The system contains mainly two modules: UDUCTOR module (Server) and Patient module (Client)

The communication between this client and server is implemented through the TCP/IP sockets

A. TCP/IP Sockets

A socket is the network Inter process communication, can be used on a single machine or two machines. The socket system call is used to create sockets on both sides for the communication. On the server side the set of

system calls used are bind, listen, accept, read, write and close and on the client side the set of system calls used are connect, read, write and close.

Bind is used to bind the particular address to the socket. Listen is used by the server to wait for the client connection. Accept is the connection acceptance from the particular client. On the client side the connect system call is used to establish between the client and server. After the connection establishment is made between the client and server, the communications are performed through read and write system calls.

B. Uductor Module (Server)

Uductor module will be continuously monitoring the patient body conditions to achieve the proposed goals. It consists of IP address button, start, stop and exit buttons for the operations of the uductor module. It mainly consists of the message box to keep on displaying the patient body conditions for every sixteen seconds in the form of messages. It is possible once the patient is get connected to this uductor module by specifying the current values of heart rate (ECG), Blood Pressure (BP), and body temperature of the patient.

C. Patient Module (Client)

The patient module will be connected to the uductor module once the uductor is accepted the connection by the patient, then the continuous monitoring of patient will be started. There is no any specific format for the message displaying. The messages of patient body conditions will be displayed in the format that is specified in the program.

The chronic disease patient can use the ubiquitous health care system for their care and wellness management. These system users are called ubiquitous patient. The patients should be connected to the ubiquitous doctor called uductor through the TCP/IP sockets using IP address of the server. The connection is established between server and client through the connect system call of sockets.

The results of the uductor model are discussed with the few output screens. Figure 6 shows the monitoring screen for the patients with the different parameters like BP, Heart rate, weight and temperature of a patient entered with a particular doctor id for treatment. The figure 7 shows the uductor monitoring the patient with the proposed parameters and the proposed system provides the assistance with the near by pharmacy for medicines, hotels for food and also near by parks for the excercises which are shown in the figure 8 and figure 9. The results are also analysed with graphs with the ECG and blood pressure values shown in the figure 10.



Figure 6: patient monitoring screen

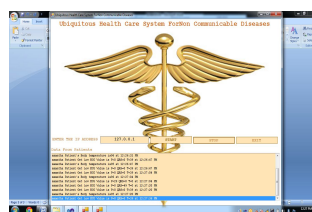


Figure 7 : uductor monitoring proposed parameters

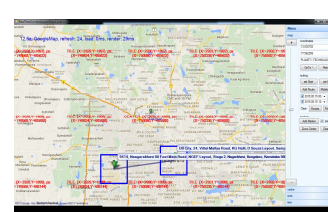


Figure 8: Resource and context notification

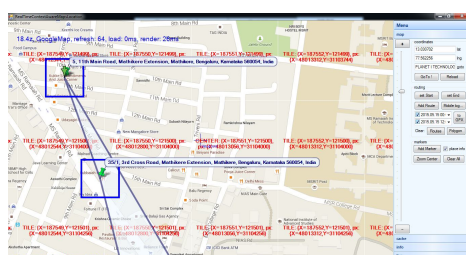


Figure 9: showing pharmacy and hotels using maps

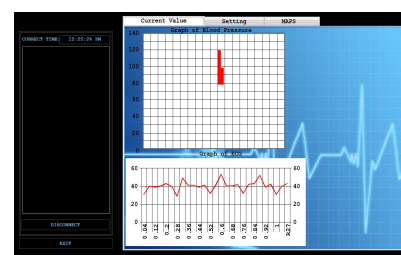


Figure10: the graph of BP and ECG(curent values of patient)

V. CONCLUSIONS

In order to improve the patient's support for treatment, the uductor model will primarily assist local resources, services, and people search. Additionally, it emphasizes the integration of communication and self-management assistance for universal NCD care. A software development kit implemented as a model enables patient monitoring with the two simple requirements internet access and the uductor model application. Since the majority of phones today confirm to these establishments, governments may find that using this strategy will improve local health and reduce the amount of money spent on hospitalizations due to untreated NCD illnesses.

Because it uses the distributed REST architectural style, which makes resources and context information accessible, it offers complete scalability. This is made possible by the PNs' connections to LNs, which stand in for the actual location of the PNs.

The future enhancements are, the uductor system will be able to achieve goals on the parameters like blood pressure, heart rate and body temperature of a patient, hence it can be enhanced for still more parameters. It can also be enhanced to connect the real patient for monitoring instead of simulation. The communication between the patients and the uductor can also be done through mobile phone messages.

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