Proposal of A Sustainable System Based on Harmony between Human and Information Technology

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***Abstract*—As online life and behavior progress rapidly, the limits are gradually becoming clear. So far, we have taken an approach to overcome that limitation with new IT technologies. We consider that people can move in a real way, and that people can only get together and meet, as a function that people can realize, and propose to aim for a more advanced system by integrating with IT technology. This system is called a sustainable system (SHONAN) that coexists with humans and IT technology, and this paper shows the concept and how to realize a neighborhood communication system (NAMI) as a concrete example of SHONAN.**

***Index Terms*—Harmony between people and IT technology, IoT, mobile IoT system, sustainable system.**

I. Introduction

A. Coexistence of People and IT Technology

The epidemic of the new coronavirus has changed our lives. The office workers have to work from home. College students are now taking classes online. The online society via networks, which has been talked about as the future ICT society, has become a reality at once. The mid-force of the online society has, on the contrary, attracted attention to the importance of meeting people in person. Sometimes you can do it online, and sometimes you can only tell by meeting in person. For example, a person in front of you may be more credible in some cases because the amount of information about that person is greater than that of a stranger on the Internet, even if you do not know his real name. It has been reaffirmed that by meeting people in person and sharing the same situation by being present at the same time, it is possible to have an experience that cannot be achieved by online alone.

So far, network technology and Internet technology have contributed to shortening the distance of space. It is now possible to have face-to-face conversations with people on the other side of the globe. However, there are few services that mainly focus on people who are close to each other.

If people can experience things that cannot be achieved with network technology by being in the immediate vicinity, it will be possible to complement the functions of network technology in such situations. For example, the authentication mechanism can be simplified or eliminated. In this way, by grasping the entire system as a whole, including not only ICT technology but also the functions provided by the people who use it, it may be possible to provide new services that go beyond the conventional framework.

In this research, we propose a system that aims to integrate humans and IT technology at a more advanced level by actively utilizing functions that depend on the participants. We name the proposed system as Sustainable system based on HarmONy between humAn and informatioN technology (SHONAN, Fig. 1).

Fig. 1. Sustainable System based on Harmony between Human and Information Technology (SHONAN).

B. Examples That Can be Realized with SHONAN

SHONAN makes it possible to realize a wider level of functions by fusing people and IT.

1) Message system

In a normal message system, in order to ensure security, one system strictly verifies the user identity. On the other hand, you can easily obtain an account anonymously for another system. The former has the disadvantage that it has a high threshold due to its rigor, and the latter has the disadvantage that it is prone to slander because of its anonymity. In SHONAN, by limiting the range of message transmission to only users in close proximity, it is possible to leave user authentication to a human and achieve the same level of security like a normal person-to-person conversation.

2) Disaster/accident prediction system

The meteorological disasters have been increasing in recent years. Those incidents can often be found in advance by people who were at the scene. SHONAN makes it possible to build a system that can easily transmit the signals detected by such a person.

3) Support for lost children and the elderly

It is possible to find people who need support but cannot seek support due to language barriers, such as lost children, the elderly, or those who are in poor physical condition by using SHONAN.

In this paper, as an example of SHONAN, we explain a system that increases the reliability that people can obtain by

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limiting services only to neighboring people. This system reduces the functions on the ICT system side and provides a system that is easier to use.

C. Problems and Solutions of Internet System

The Internet has used network technology to significantly reduce space-time and greatly improve people's daily lives. On the other hand, various issues have become clear as the world is instantly connected by a network. Some of them are shown below.

1) Authentication

You must uniquely identify the machine and the user to connect to. It is necessary to have a mechanism to guarantee whether the ID used is genuine or fake. Even if it is genuine, you can't say it is okay to trust the other party.

2) Diffusion

Information once transmitted is instantly spread all over the world. It is very difficult to correct or delete the spread information.

3) Security

There is concern that the information obtained is genuine, reliable, has not been eavesdropped by a third party, or has been tampered with.

With the expansion of Internet technology, many technological developments have been carried out so far, and various solutions have been proposed for these problems. However, it is not 100% reliable and new problems are emerging.

On the other hand, there are applications that do not necessarily have to expand time and space indefinitely. In such a system, it is possible to impose restrictions on time and space to avoid the technical problems of the Internet system as described above.

We propose a new approach to these problems by sacrificing the convenience of the Internet.

D. Proposal

In this paper, as an example of SHONAN, we propose a neighborhood communication system that can be provided by connecting only people and things that exist in the vicinity. We will explain the network infrastructure for that system. The followings are considered as the services that can be provided by this system.

・Information sharing in a small area (classroom, conference room, exhibition hall, concert hall, etc.)

・Friend search, lost property search

・Alerts to people on the spot (disaster, congestion / close detection, etc.)

The following chapters provide an overview of the proposed system and how to implement it.

II. Overview of SHONAN

A. Concept of SHONAN

As mentioned in the previous chapter, SHONAN aims to complement Internet technology and realize a more advanced system as a whole by utilizing the functions of people. In this paper, as an example of SHONAN, we will build a message exchange system that utilizes the fact that we can obtain more information about the person in front of us. Specifically, we will realize a system (narrow area communication system, NAMI). Using this system, people can exchange information only between nearby people by small mobile devices. We use the short-range wireless communication function of the devices. At the moment, the system can be easily implemented on the smartphone with BLE function. By limiting the distribution range of information to people in the vicinity, we aim to create a simple and ready-to-use system that eliminates the need for ID registration and authentication.

B. Usage Example

NAMI is supposed to be used to exchange information between people nearby at the time when people gather directly, such as in a school classroom, a meeting at a community center, an exhibition etc. In order to avoid the hassle of registering an ID in advance and the anxiety of accessing personal information, the system will be able to exchange information only by the fact that people are "on the spot". In addition, to prevent information from being spread all over the world, the system will provide information only in a narrow range for a short period of time. NAMI can be used with peace of mind.

C. Target User

This system NAMI targets people who move at low speed with a smartphone or wearable device. Hereinafter, smartphones, wearable devices, sensor-equipped devices, and the like are all referred to as devices. People carry devices and move at low speeds such as walking that the other person can easily recognize. Vehicles that move at high speed, such as cars and trains, are not targeted because people cannot recognize each other. Devices on the same car or train are targeted.

D. Communication Infrastructure

NAMI does not depend on the type of device or short-range communication method, but when considering a specific implementation, we will start by implementing it on a smartphone capable of BLE communication. For device-to-device communication, only the short-range communication function is used, and communication with the base station is not used. We assumed that there is no fixed management node. Nami consists only of individual devices that move. Participation of supplementary devices that provide sensor information such as temperature, humidity, and CO2 concentration is possible.

E. User ID and Reliability

NAMI does not register user or device IDs. All the functions are the same as anonymous networks. However, it is guaranteed that the user who sent the message is a person close to him / her and the message is a recent message in terms of time.

A node with certain malicious intent can spoof the time and place. Since message forwarding is one-to-one communication with a nearby device, if the next node is a legitimate node, spoofed data will not be transferred any more. Therefore, the spoofed message does not spread over a wide area.

The state in which the user ID cannot be recognized is, in a real situation, almost the same event as some stranger shouts at a venue where people gather. At least those around him can recognize who shouted. It's up to the listener to believe the message or not. The contents will not be instantly spread all over the world.

Since it is possible to block other people's conversations by continuing to speak loudly, this is also the case with this system, which is an issue to be considered.

F. *Proximity*

As already explained, NAMI eliminates ID registration by transmitting only the latest message from neighbors. By using the information obtained by the person in front of him, we are reducing the unfamiliarity about anonymous users. However, if there are multiple people on the spot, one of them cannot be identified by the message alone. It is the disadvantage that it does not provide the same information as face-to-face communication.

On the other hand, it is expected that the self-cleaning effect on the message will work by making the message visible to all the people in the neighborhood, not to one individual, and not spreading it over a wider range than necessary. No encryption is used so that the message can be read by anyone.

Also, since we know that participants share time and space, we can simply convey real information such as "I agree with the current opinion" or "The exit here will close in 5 minutes".

Since the message is transmitted only to the nodes that exist in the vicinity, the message can be received when it is near, and cannot be received when it is far away. There is no need to dynamically reconfigure the network as nodes join or leave.

G. *Message Exchange*

With NAMI, you can share the information you want to convey to people near you among those near you. Possible uses include communication to attendees in a classroom, information transmission at a concert hall, special sale information at a store, information sharing at an evacuation center, and an alarm saying that people are too crowded etc. The purpose is to convey a common message to people who are in a specific place at a specific time, and do not send a message by specifying one individual.

Since the recipients of the message are people nearby and it is not necessary to identify an individual, the user ID of the receiver is not registered. For the same reason, the user ID of the sender is not registered either.

H. *Operation Overview*

The message is transferred by one-to-one communication between neighboring devices. Each device searches for nearby devices and exchanges one-to-one messages with the discovered devices. The message includes not only the message issued from the own device but also the message transferred and accumulated from the other devices. The message will be relayed via multiple devices.

At the application layer of this system, the ID that identifies the device is not registered. Therefore, it is not possible to send a message to a specific device or receive only a message from a specific device.

A message ID is added on the message creation device to prevent the same message from being transmitted repeatedly. The message ID includes the message creation time and the number of hops, and prevents the message from being transmitted to a range (time, number of hops) that is more than necessary. The message is never forwarded around the world in NAMI.

I. *Message Centered System*

NAMI does not configure a newly network with multiple neighboring devices. Each device aims to efficiently transmit a message to a device existing in the vicinity by exchanging a message with as many different devices as possible on a one-to-one basis. We do not necessarily guarantee that the message will be delivered to all nearby devices.

This system does not use user ID at the application level. On the other hand, in the lower layer, in order to exchange messages with as many different devices as possible, an ID for storing the most recently connected device is required. At the lower level of the communication layer, an ID that identifies the device will be used. How to implement this function depends on the platform on which it is implemented.

III. NAMI System Implementation

In this chapter, we will examine the details to implement NAMI using smartphones equipped with BLE.

A. *Overall Scenario*

In order to keep the system flow as simple as possible, we define one-to-one message exchange between devices as the basis. All processing is basically completed only by this message exchange.

The device periodically searches for nearby communicable devices and repeatedly exchanges messages with the discovered device. Between devices, it receives messages that it does not hold from the other party and sends messages that the other party does not have to the other party. When a series of message exchanges is completed, the connection is disconnected and the search for different devices is started. We need a mechanism to avoid repeated connections between the same devices.

The message is not propagated indefinitely. It is achieved by setting the number of hops, effective time, effective location, and the like.

There is no concept of network configuration by a set of nodes. Message expansion to neighboring devices is performed by relaying messages continuously between nearby devices. We do not guarantee message forwarding to all devices.

The details of each step will be described below.

B. *Processing Flow*

A new message is registered by the user or some application on his device. At this time, the message ID is added.

The device periodically repeats the discovery of the other device and the exchange of messages, apart from the registration of the message by the user. By repeating the process of exchanging messages while each device changes the other party, the messages are sequentially transferred to nearby devices (Fig. 2).

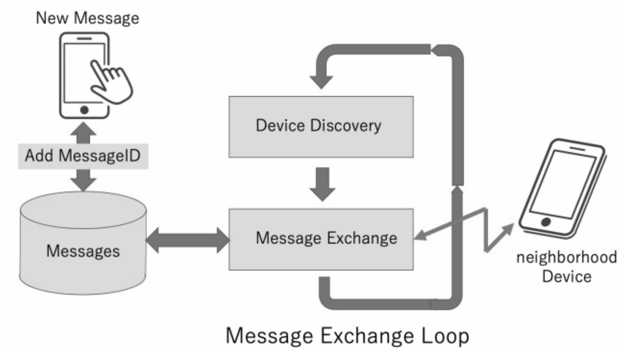

Fig. 2. Processing flow.

After the other device is discovered, the devices move to a bi-directional communication state. After the message exchange is completed, the connection is terminated and the discovery of the next device is started.

C. Device Discovery

Each device needs to find a communication partner in order to perform one-to-one communication. We assume that there is no management node like a base station and each device is in the same position.

In general, the device discovery protocol is often divided into a master node that sends a request to search for a device and a slave node that responds to the request. In BLE, it corresponds to Central node and Peripheral node.

In this system, devices should be discovered while handling all nodes in a unified manner. It is assumed that the same device discovers the other device while alternately switching the roles of master and slave without fixing the division of roles. The timing of switching will be examined separately (Fig. 3).

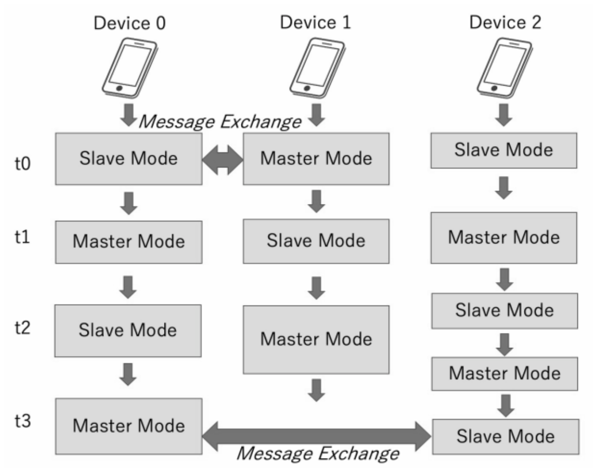

Fig. 3. Device discovery and message exchange.

D. Message Exchange

When the devices can find a partner for one-to-one communication, message exchange is started. The devices are on an equal footing, but at the time of device discovery, the roles have been divided between the master node and the slave node. In the message stage, these roles will continue.

The message exchange consists of phase 0 of message transmission from the master to the slave, and conversely, phase 1 of the slave to the master. Each performs the same processing except that the message transmission direction is different (Fig. 4).

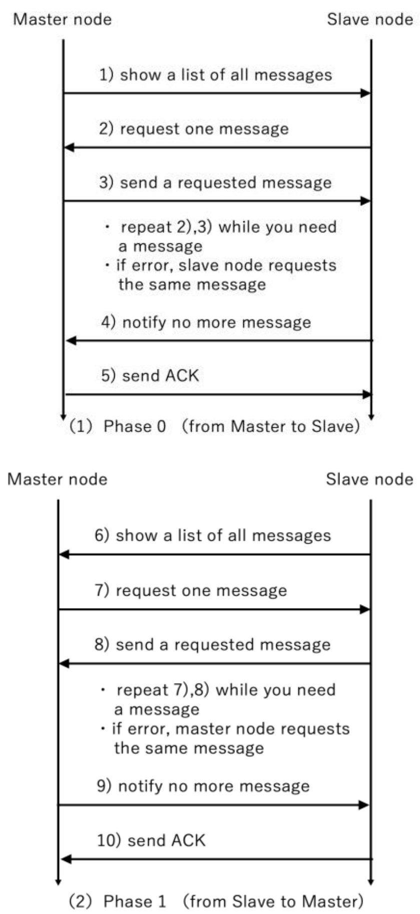

Fig. 4. Message exchange protocol.

1) The master node informs the other party of the list of message IDs it has. At this time, messages that exceed the transfer range from the time information, location information, etc. are not included in the list, so that no further transfer is performed.

2) The slave node sequentially requests messages that are not in its own node from the list of received message IDs.

3) The master node sends the requested message.

4) Repeat steps 2) and 3) until the required message has been transferred.

5) When all the necessary message transfers have been completed, we will notify you and end this phase.

After the end of Phase 0, the roles are exchanged and Phase 1 is executed. When Phase 1 ends, the entire message exchange ends.

If processing cannot be continued due to an error or connection disconnection, the message exchange itself ends at that point. Messages that can be transferred normally up to that point are imported to the local node.

The latest smartphones can execute both Peripheral and Central functions at the same time. But assuming that low-performance devices are included in this system, the basic message exchange function will be performed alternately like just explained.

E. Message Format

The message contains the followings.

a) Message ID
b) TTL (Time To Live)
c) Message Body

1) Message ID

In this system, when issuing a message, an ID for identifying the message is created. The message ID uses time (up to mS) + random number. The time alone does not guarantee that the message ID will be the unique ID, but since the random numbers are added and the message itself does not spread over a wide area, it is unlikely that the IDs will overlap in a real situation.

2) TTL

We use TTL to prevent messages from spreading beyond what is needed. It is decremented by 1 for each transfer, and when it becomes 0, no further transfer is performed. The initial value of TTL will be examined in the experiment system in the future.

3) Message body

The message body is sent with the message length. The message length has a maximum value determined by the restrictions of the lower communication layer. If the maximum length is exceeded, multiple message exchanges are required. With the latest iOS, 512 Octet data can be sent, and the experimental system will check within this range.

F. Application Examples

In the experimental system, in addition to the manually input message exchange application, the following applications are planned to be implemented as application examples.

G. Crowded and Close Warning System

Corona virus is said to increase the risk of infection due to the close presence of people. It is conceivable that not only places such as restaurants that are expected to be crowded and close in advance, but also streets and aisles may be unintentionally crowded and close due to poor flow of people. By warning people in the vicinity that a crowded or close condition has occurred in such a case, it becomes possible to take evasive actions such as leaving the place promptly. This time, we will implement this system using the BLE function of the smartphone, and at the same time, we can estimate the crowded and close situation from the signal strength of BLE and the number of devices, and it will be possible to transmit it as an alarm. Currently, this application system is being implemented on iOS devices (Fig. 5).

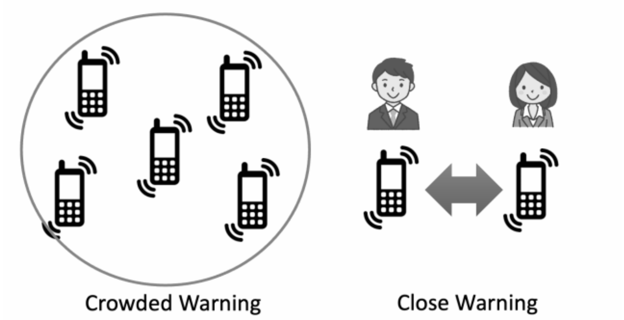

Fig. 5. Crowded and close warning system.

IV. RELATED RESEARCHES

Suzuki et al. [1] have obtained the result that the gender, age, etc. can be inferred from the appearance of the other person in face-to-face by hearing with the subject, and a feeling of intimacy is created. Blenke [2] shows that face-to-face dialogue creates trust in others in development projects. From our experience of working online and giving lectures under Covid-19 pandemic, we recognize that the feeling that there is information that cannot be obtained non-face-to-face is somewhat convincing.

Nagahara et al. [3] argue for the importance of a robust and flexible human-centered social system in their proposals for science and technology in the post-corona era. Saito [4] emphasizes the need to transform business processes from a "Thing-centric perspective" to a "Human-centric perspective." The SHONAN we propose is a system that aims to integrate IT technology with humans, and is a concept that follows these people-centered trends.

Many services using the proximity of IoT devices have been proposed in recent years. Fujihara [5] proposes a route guidance system using multiple Beacons. MSNP (Mobile Social Networking in Proximity) has been proposed as a service in the proximity area by mobile devices [6]. MSNP is a service that complements the Social Network through D2D communication between neighboring devices. Regarding the technical elements to be used, there are some overlaps with this system, but the functions that can be realized differ depending on the fusion with human functions and the difference in concept such as not using ID.

V. CONCLUSION

In this paper, we proposed the concept of a sustainable system based on harmony between human and Information technology (SHONAN). With SHONAN, we propose a new approach to solve some problems caused by too many functions expanded more than necessary. As an example of SHONAN, we introduced a neighborhood communication system (NAMI). NAMI has solved some of the problems with conventional communication systems by using human ability. In the next step, we plan to implement the experimental NAMI system. Detailed parameters will be confirmed in this experimental system. In addition, a crowded and close warning system to counter the Covid-19 virus is now implemented as a more practical version of NAMI. It is important for a system that warns people to prevent infectious diseases to detect the condition that people are in close proximity. This crowded and close warning system is a more realistic application because of its importance to proximity detection using BLE, rather than just a short-range message exchange system NAMI.

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHOR CONTRIBUTIONS

Tadashi Ogino as a single author contributes this paper.

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