DESIGNING SECURITY FRAMEWORK IN PET-CARE MEDICAL ENVIRONMENT

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Abstract. *Demographic structure and income increase led to incline of households with companion animals. Personal information security is changing from security of single information to security of multiple information. And the security methodologies are changing from technical information security to convergence security. Since most of the information handled by vets is a pet, it is outside the scope of personal information security in various small and medium medical institutions. Therefore, the security system is not equipped with the information of the person connected with the information of the pet. In this research, it is to be focused on a framework that can protect information related to a closed information management environment on pet-care medical small and medium medical institutions. Specifically, it identifies various types of information handled by veterinary clinics and designs a comprehensive protection scheme for technical, physical, and managerial purposes for data security.*
Keywords: Multi-modal data, Data security, Convergence security, Medical security, Pet-care, Medical environment

1. **Introduction.** Households with companion animals are increasing, along with a progress in population structure due to rapid increase of aging population and single-person household, income increase, etc. Accordingly, the market for pets, food, beauty, technology, play, and medical care is increasing rapidly. Meanwhile, utilization of new technology is rapidly increasing due to the development of 4th industrial revolution. Massive heterogeneous data produced due to technical and environmental IoT, cloud, mobile, etc. are reclassified or re-analyzed or used as basic data for AI through big data. Usage of massive and various data is playing a critical role in business process change of various industries. In these environments, domestic healthcare industry retains incalculable amount of data which involves domestic personal information, limitation exits in opening to public due to Personal Information Protection Act, Medical Service Act, etc. and compatibility, quality, etc. of medical devices equipment used internally is at a low level. In perspective of security, targeted industry can be specified, and especially healthcare industry simultaneously retains closed composition of institution for patient treatment and open composition of institution for recommendation of prevention and service, healthcare, etc. In these kinds of environment, concerns regarding the growth of social cost such as nurture, treatment costs regarding companion animals, etc. are growing due to the era of pet economy. Furthermore, since animal information retained by veterinary clinics does not belong to the classification of personal information, which makes information retained by institution partly has a characteristic of open composition of institution which makes protecting an information be in an unsatisfactory situation. Therefore, it is in need of introduction of preventive healthcare service system based on lifecycle by security of high-quality big data

through collection standardization of heterogeneous healthcare data between veterinary clinics.

This paper intends to study a framework that can protect information related to a closed information management environment. Specifically, it identifies various types of information handled by veterinary clinics and designs a comprehensive protection scheme for technical, physical, and managerial purposes for data security.

2. **Recent Study.** Sections 2.1 and 2.2 improve the justification for the necessity of this study by analyzing the current status of pet-care related systems and markets in Korea and the world. Section 2.3 introduces the clustering method of core data in a general multi-modal data environment and applies to the study. Then the requirements for designing a security framework are discussed, which is the core of this paper. Section 2.4 introduces the main systems that operate in the medical environment to handle data. These systems produce a variety of data that can be handled in a pet-care environment. It provides a preliminary identification of the subjects to be addressed in the security framework of this study.

2.1. **Korea domestic technology and market status.** Domestic companion animal healthcare related services are being developed with telecommunications companies as the center and 'StarWalk' of LG UPlus and 'T Pet' from SKT is a representative example. 'IntoVet GE' which is an EMR targeting local veterinary clinics is a program composed for information exchange and sharing of chart to be enabled by accessing a network with own business-use program, and has developed a program that can effectively manage chart and medical history by interlocking all kinds of medical equipment such as blood equipment of companion animals, and video equipment. Domestic Petdoc company has developed an application which provides one-to-one correspondence from local veterinary, space where user and agency can communicate, check local pet store and veterinary clinics, notify sale information, etc. GURU company has developed a system which enables communication with companion animals by utilizing a smartphone and motion control platform and detects unusual situation, etc. through sensor.

Domestic household with companion animals took up 30.9% in 2017 and is estimated for about 5.9 million households to have companion animals. Market size regarding a companion animal has reached $ 1.5 billion in 2015, which has doubled from $ 700 million in 2012. It is expected to reach $ 5 billion in 2020 with rapid growth of market size [1].

2.2. **Global technology and market status.** In case of overseas, various IoT/Big Data services are being released due to the spread of positive awareness of companion animals and strength of customers' needs. Fujitsu from Japan uses the 3D accelerometer to calculate walking data by algorithm analysis, and based on it, it can be used as a health status checking and checkup data for dogs. It is planning to provide a service by applying a solution and cloud capability to animal medicine field, and provide to hospitals, pharmaceutical companies, insurance companies, etc. Also, 'NTT' in Japan has C-control pet healthcare service which can provide precise prescription and treatment method by implementing a healthcare service which conducts health care and prevents illness, supports health maintenance in joint service in conjunction of companion animals' health care and medical consultation. 'FitBark' from the United Kingdom, has developed a product which can figure out health status by comparing a play status of companion animals to identical species. 'Whistle' from US has developed a mobile application which helps a status measurement of companion animals and comprehends the level of treatment by setting a daily goal of companion animals' health status. In addition, 'Pebby' from US has developed a smartball which can monitor companion animals through smartphone. 'Tractive' from Austria has come up with a monitoring system which checks on health

status by comprehending a walking or activity level by establishing GPS and acceleration sensor in wearable leash device.

Foreign consumer markets regarding companion animals are expected to continue to grow, while investment and start-ups of technology-related companies, such as companion dog wearables, are taking place. ICT companies are creating business opportunities in the booming companion animal industry by combining innovative ideas with existing services.

2.3. **Data characteristic analysis and security.** Cluster analysis is a method of data mining by defining the data group (cluster *) by considering the characteristics of the given data and finding representative points of the data cluster. Deep clustering is the computation of changes in big deep vector and individual similarities, and clustering by the comparison of similarities of data using big deep vector.

Multi-factor analysis is a method of assuming that there is a common factor among the variables and aggregates the interrelationship between the variables into a small number of potential factors. For the characteristics of cluster, the level of influence by specific factor is to be found. With the method of data characteristic analysis as the center, clusters are formed by the type of representative breed, illness and by symptoms through the gathered data of companion animals. Then, as the updated data get added, the form of changed cluster is directly observed, and is able to apply on security system with the connectivity of personal information.

In order to establish an information security framework, the CIA triad, which is Confidentiality, Integrity and Availability is to be secured. Integrity is to prevent unauthorized users from tampering with or modifying important information so that the content is not altered. Confidentiality is the intentional intrusion into the information system to prevent sensitive information from being exposed or disclosed. Availability is a security design that considers the need to provide legitimate users with accurate and reliable information at the right time.

2.4. **Status of medical environment system.** HIS (Hospital Information System) is commonly called for system which conducts integrated management effectively and efficiently on various data created in the medical field in order to provide high quality of medical service. As representative example, it consists of detailed components such as video, nursing, financial information system including an EMR (Electronic Medical Record) system, OCS (Order Communication System), etc. Specifically, EMR is a system that manages every record created within hospitals by digitalizing, enabling an effective implement regarding creation, inquiry, storage, etc. OCS delivers various prescription-related medical information to a various related division through network which was created in the process of consultation, enabling an effective operation of hospitals, by reducing time and manpower.

3. **Security Framework Design for Pet-Care Medical Environment.**

3.1. **Data distinction and refinement.** When procedure of medical treatment of veterinary clinic is fundamentally analyzed, it was shown that it consists of 11 steps as shown in Figure 1. Specifically, it is divided into stages of reservation, visit, reception, waiting, medical examination, inspection, diagnosis, consulting, prescription, acceptance and payment (pharmacy). Data is created in almost every stage, which includes not only a general information but also heterogeneous data such as personal information, sensitive information along with video information.

Among these, process which can store data is shown in Table 1.

In order to draw a fundamental data distinction, we have gathered and analyzed 112,027 of medical treatment data set from August 2015 to October 2018. And we analyzed the classification and the characteristics. As the result of analyzation, core data variables
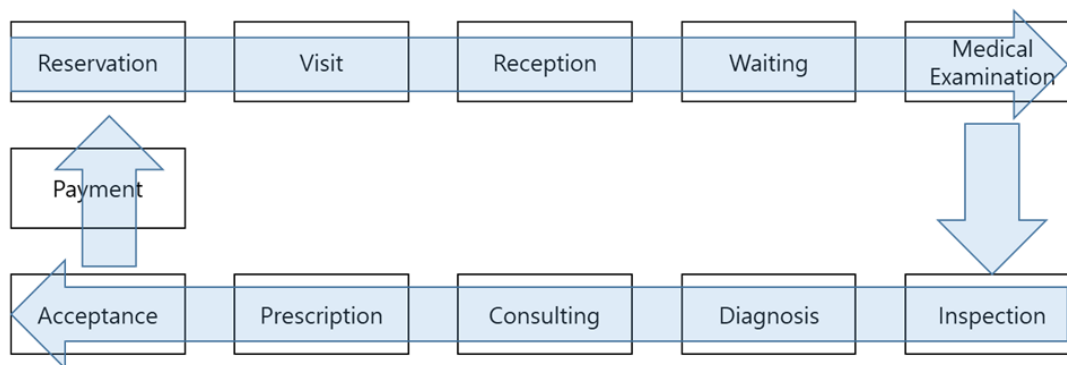
FIGURE 1. The procedure of medical treatment in veterinary clinic

TABLE 1. Distinction on data types followed by medical treatment of veterinary clinic

Process step	Types of data
Reservation	Name of reservation, contact information, types of animal, name of animal
Visit	—
Reception	Name of reservation, contact information, types of animal, name of animal
Waiting	Name of reservation and animal
Medical examination	Medical examination by animal
Inspection	Inspection information of animal (external, internal condition diagnosis information, etc.)
Diagnosis	Diagnosis information (disease information, external, internal condition diagnosis information, etc.)
Consulting	Massive information of unstructured data such as diagnosis regarding animals' condition and owners' opinions
Prescription	Pharmacy information (types of medicine, usage of medicine)
Acceptance	Card information (number, expiration date, etc.)
Payment	Card information (number, expiration date, etc.)

were distinguished which include personal information set of owners of companion animal, serial number of companion animals, types of medical treatment, main symptoms, medical treatment and prescription, etc.

As shown in Table 1, medical treatment of veterinary clinic produces various data. In Figure 2 DB table shows various data partially. Information regarding a human is related to separate table, resulting it to exist as a form of personal number. Forms are presented as 'General' which shows one-time diagnosis as the result of conducting diagnosis result, 'Second-visit diagnosis' which is to visit again, 'Hospitalization' and 'Discharge' which is to stay at hospital, immediate prescription, etc. Also, 'Consulting contents' exists as an atypical data which is to be a core data. This data includes a diverse data such as telephone conversation with owner of patient (animal), consulting data regarding visiting, status data of surgery, etc. Lastly, a complex data represents a data such as 'Inspection type' which is a regular diagnosis, connection with other diagnosis, CT (Computed Tomography) room, etc.

3.2. **Establishment of security framework.** The form of security framework which is to be set in veterinary clinic was established based on the collected and analyzed data forms, as shown in Figure 3.
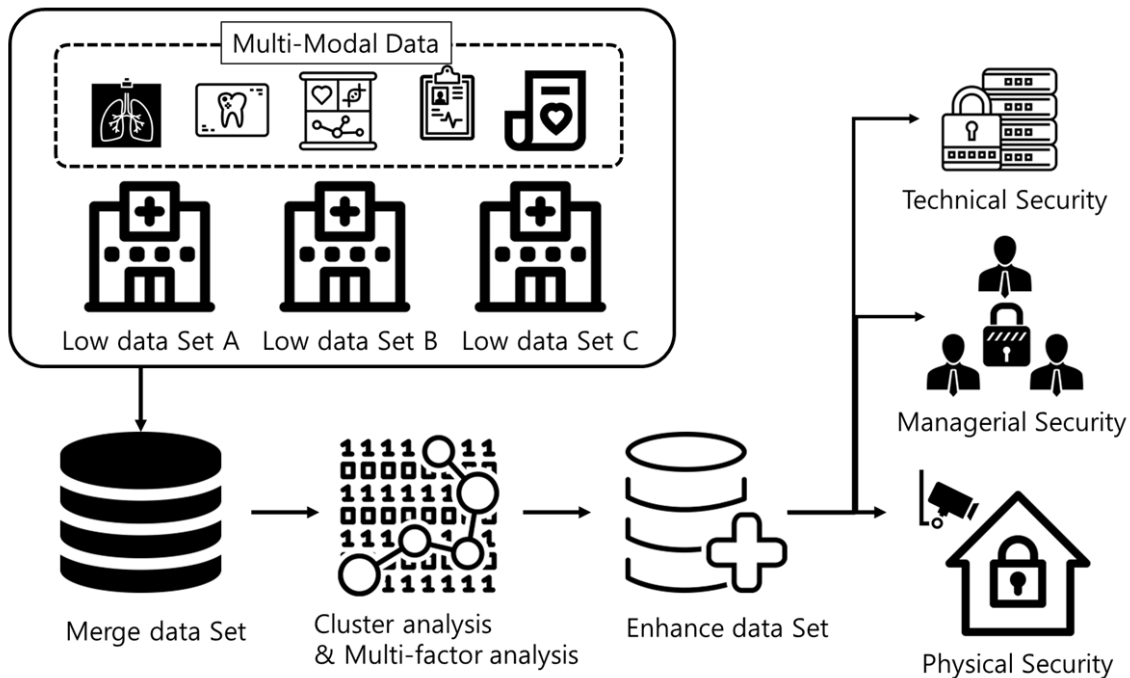
FIGURE 2. Analyzed data set (partial)

FIGURE 3. Establishment of security framework of companion animal veterinary clinic

It basically includes security system establishment frame followed by collection, integration, classification, characteristic of data collected from various veterinary clinics.

In various companion clinics, video charts, text data, individual data, atypical consultation data, personal information, recipience information, etc. are retained in different forms. These data are called multi-modal data, and fundamental merge regarding these data since standardized classification is insufficient by veterinary clinics. Data of general diagnosis which is represented in Figure 2 is subordinated in types of EMR system which is used in corresponding veterinary clinic.

In addition, it was shown that merged data has a lot of changes in notation of companion animal according to tendency of recording such as using abbreviation, full name. Cluster analysis is performed to standardize the integrated data. Cluster analysis is a method of finding representative points by grouping data with similar characteristics. A standardized dataset is created through this method by deriving a standardized naming.

If standardization of data is conducted, security system is to be established according to 3 stages of procedure as presented below.

1) Technical security system is to be prepared a collected heterogeneous data.

2) Managerial security system is to be made regarding a collection and management of data.

3) Security system is to be installed regarding the entire veterinary clinic.

Detailed application method of corresponding 3 stages establishment method is as follows.

Firstly, contents below must be prepared for the establishment of technical security system. According to a form of classified data, general information is stored, managed and utilized based on DB encryption. Data classified as personal information and sensitive information is set to be not directly identified and distinguished by using a data masking technology for certain names, when putting up for consultation. Also, when using a data regarding personal information and sensitive information, de-identification technology such as processing of false name, totalize, data removal, data categorization is to be applied for identification, and distinction is not to be done by connection of complex data classification.

Secondly, for the establishment of managerial security system, systematic procedure is to be done by changing steps of data collection, storage, utilization and discard centrally on identified data. Security oath is to be requested to medical personnel who handles personal, sensitive information. Regarding a personal information required excessively when submitting a receipt, minimal data collection procedure is to be made. When in need of collecting a massive, varied kind of data, procedure of applying an electronic signature technology is to be made. Plan for basically applying DB encryption on every collected data. For disuse data, procedure for writing a register (ledger) is to be made.

Lastly, in order to construct physical security system, control device for space is to be arranged. For the storage of printed output, security device-installed cabinet is to be prepared. To prevent theft of vital information and printed material by human, security system such as CCTV is to be installed based on the place with core information.

4. **Conclusions.** Demands on companion animals are increasing around the globe. Accordingly, market centered on companion animals is being activating and showing a rapid growth rate. Also, the concern on security management and utilization of massive heterogeneous data is increasing for a utilization of 4th industrial industry technology and development of the medical industry.

However, health management which takes huge part of companion animal market, is in limited situation where security management does not take place regarding information of companion animals and up to personal information that is related. It is in difficult situation where massive heterogenous data is hard to be distinguished and managed due to separate usage of system.

In this research, two solutions are suggested as below in order to solve a problem.

1) The characteristics for information security are analyzed by analyzing a collectable data from veterinary clinics.

2) Technical, physical and managerial security framework is designed by considering an industrial convergence environment.

Data management in veterinary clinic has a tendency of breaking bounds from personal information security activity since animal-related information takes up most part, apart from visitors' information. With all those said, it is still possible for personal information to be distinguished or leaked due to various data integration, systematic security management is an essential in these environments. It is anticipated to establish the convergence security system by utilizing it in companion animal related industries through this study.

For future research, comparative analysis on the effectiveness of the animal veterinary security framework and the qualitative satisfaction with the existing general security framework is to be conducted.

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