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Exploring the Feasibility Assessment of Sensor Applications for Artificial Intelligence of Things Technology

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With the widespread adoption of the Internet and 5G technology, the development of the Internet of Things (IoT) has rapidly expanded from industrial applications to smart homes. IoT technologies and sensors can be widely deployed in factories, warehouses, schools, hospitals, and households to improve quality of life and provide early disaster warnings. In this study, we aim to analyze IoT technologies and assess the feasibility of sensor applications, including the use of Power over Ethernet (PoE) cameras, electronic fencing systems, and environmental monitoring networks based on optical fiber. A quantitative research approach employing SPSS 20.0 and AMOS software is used to examine the impact relationships and evaluate the feasibility of integrating sensor data into smart regional monitoring systems.

1. Introduction

In recent years, Internet of Things (IoT) technology has been promoted in a wide range of areas from industry to smart homes. It has been used in applications such as smart home appliances and monitoring systems, all of which use networks and sensors to improve the convenience of life. By implementing electronic fencing via monitors, traditional security can be upgraded to a smart surveillance system that can detect intrusions and issue alarms. If combined with license plate recognition, face recognition or object recognition technology, access control management can be optimized, identification time can be shortened, human resources attendance management performance can be improved, security and environmental safety can be enhanced, and more rigorous security control management can be achieved. Object identification in IoT technology can effectively improve warehouse management, such as incoming goods notifications, outbound operations, and storage location adjustments, saving manpower and efficiently controlling materials. License plate recognition technology can monitor vehicles entering and exiting electronic fences, residence time, and work efficiency. In smart home applications, devices can be connected through wireless networks to enable remote

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control and monitoring of the home environment. AI smart homes integrate sensors (such as temperature and humidity meters and smoke detectors) to collect environmental data in real time, improve fire response capabilities, and manage equipment through environmental controllers to extend service life and reduce damage and risks.

The sensor can monitor abnormal conditions such as the presence of flames and smoke, flooding, temperature, and humidity around the clock and issue immediate warning notifications. It can be used in gas and fire sensing, power load monitoring, smart switches, and air quality functions to effectively improve safety. However, traditional monitoring systems are often complex, costly, and difficult to maintain. With technological advancements, optoelectronic systems have transitioned to optical fiber transmission, which provides long-distance, high-efficiency, and energy-saving benefits, as well as durability in harsh environments. By integrating intelligent data processing and storage, these technologies enable smart regional surveillance and alert systems. In this study, we aim to analyze IoT technologies and evaluate the feasibility of integrating sensor applications, such as Power over Ethernet (PoE) cameras, electronic fencing, and fiber-optic environmental monitoring, using quantitative methods to support safer and smarter environments.

In this study, we use purposive sampling to target smart policing construction units, supervisory units, and users, and explore the evaluation and opinions of different fields (such as factories, schools, and public institutions) to study its relevance and feasibility.

On the basis of the above research background and motivation, a study was conducted on the relevance of using IoT technology to explore the feasibility of sensor application. The purpose of this research is as follows.

(1) Discuss the impact of IoT technology on sensor applications.

(2) Explore the relationship between sensor application and feasibility assessment.

2. Theoretical Background

2.1 Discussion on IoT and sensor applications

With the advancement of technology, technologies such as IoT, big data, and AI are being applied in buildings, enabling smart access control, security monitoring, health care, and energy-saving management services of, for example, air conditioning and lighting. Data is collected through sensors to improve related services. Environmental, social, and governance principles emphasize four key areas, aiming to foster sustainable development, corporate responsibility, and ethical governance. In this context, smart cities leverage information and communication technologies to build sustainable infrastructure, enhance urban operational efficiency, and promote industrial development.(1) AI is the core of IoT. The International Consumer Electronics Show highlights innovations in autonomous driving, smart vehicles, AI voice assistants, smart homes, and security technologies. According to Lin,(2) with the improvement of network quality and the widespread adoption of open-source architecture, edge computing combined with cloud resources can handle exceptions and deliver real-time information services through intelligent decision-making mechanisms. Furthermore, as noted by

Chen *et al.*[3] cloud information systems can present home environment data in a visualized format, thereby enhancing the convenience of information delivery and management.

Nowadays, users can realize surveillance functions through network cameras, and images can also be transmitted to mobile vehicles. Taking the campus as an example, under the no-wall policy, campus safety has become a hidden concern. The monitoring system can restore events, clarify relationships, and assist the police system in enhancing security. Campus security is divided into human and mechanical security. When manpower is insufficient, electronic fencing becomes an important means of protection. It is highly recognized by teachers, students, and parents, and has significant benefits in handling student affairs and police evidence collection.[4] In summary, the IoT technology is used to build a campus safety network, and electronic fences are used to effectively monitor outsiders entering the campus to maintain campus security. This is also an example of the application of IoT technology and sensors.

With the advancement of science and technology, smart monitoring systems are being widely used. Traditional traffic monitoring requires much money and manpower. When nighttime detection information is insufficient, vehicle light information (headlights and taillights) can be used for detection. The Center Surround Extrema's detector and color space analysis are used to match the distance between vehicle lights and improve the detection rate. Current technology law enforcement uses surveillance images to identify the license plates of cars running red lights, assisting the police in cracking down on violations, reducing accidents, and effectively saving construction costs. With the rapid development of urban areas, crime prevention and control have become significant public security challenges. Surveillance systems play a critical role in deterring and detecting crime; however, the absence of effective deployment strategies often limits their full potential. To maximize the benefits of surveillance, an intersection monitoring model should be developed based on an analysis of crime hotspots, geographic statistics, and spatial structures. By considering the correlation between crime hotspots and the locations of security agencies, a comprehensive "safe life map" can be established to enhance public safety and resource allocation.[5,6] Currently, the x digital subscriber line architecture is mostly used, which is limited by distance and bandwidth, thus affecting the quality of surveillance in suburban areas and harsh environments. Fiber optic containment has the advantages of stability and low power consumption, which can improve transmission and reduce maintenance costs. If it changes to a passive optical network architecture in the future, a wireless advanced photo system and sensors can be installed to provide value-added services such as Wi-Fi and information collection.

With the development of information systems, in order to enhance competitiveness and environmental awareness, enterprises are building green computer rooms and adding monitoring nodes to monitor power consumption and operation. The computer room has become the core of the enterprise and must be equipped with monitoring systems such as those for temperature and humidity, electricity, fire, access control, intrusion, and imaging to ensure the safe operation of the equipment, and it can be connected to smart phones to report and solve problems in a timely manner.[7] The Artificial Intelligence of Things (AIoT) system can monitor factory employee safety and environmental conditions, upload real-time data to the cloud, and present it on the application and host to realize factory safety and environmental monitoring.

2.2 Sensor application and feasibility assessment

With the development of science and technology from early voice communication to 3G high-speed downloading, emergency medical systems combined with medical functions to improve the treatment rate have been established. Technology further promotes smart life, from home remote controls to smart classrooms, allowing students to experience the wonders of technology. Smart sensors are widely used in health, safety, convenience, and other fields, for example, tire pressure detection, wearable devices, and environmental monitoring, to improve the quality of life. In the future, communications will integrate multimedia images and broadband networks to promote fiber optics.[8] Therefore, smart sensing technology and automation equipment can improve the efficiency of smart disaster prevention management, integrate old building spaces through network technology, and introduce smart sensors such as those for smoke detection, temperature detection, and face recognition to achieve smart safety protection.[9] Unlike in the past, IoT smart sensors only detect information at the moment of the incident. Nowadays, by combining deep learning and big data computing technology, the prediction model has been significantly improved, and the facial motion recognition system has improved recognition accuracy and stability.[10]

IoT technology and sensors have improved the convenience of people's lives, especially temperature and humidity sensors, which play an important role in smart homes. The temperature and humidity in northern Taiwan vary considerably. Through the IoT and temperature and humidity sensors, the work or home environment can be adjusted in real time. In addition, temperature and humidity sensors improve greenhouse production efficiency in agriculture, and many highly sensitive spaces (such as high-tech factories, laboratories, and warehouses) have extremely precise requirements for temperature and humidity. Chang[11] pointed out that the National Palace Museum in Taipei utilizes AIoT technology to balance the preservation of cultural relics with the management of the visitor environment. Additionally, the logistics industry employs IoT technologies to monitor temperature and humidity during transportation, thereby enhancing automation and supporting daily life services.

Fire smoke detection sensors play an important role in fire warning systems, especially in environments such as high-tech factories, where traditional sensors are not sufficiently effective. The government promotes the installation of fire prevention equipment, solves the shortcomings of fire warning through smoke detection sensors, and adjusts contingency measures in accordance with building structure. The special environment of high-tech factories requires automatic fire alarms and automatic fire extinguishing equipment to improve escape time and reduce casualties.[12] The use of aspirating smoke detectors and optical fiber sensing technology can effectively improve fire detection performance. In addition, combining a 3D model of the building with the IoT system can instantly reveal the current situation of the fire scene and reduce losses.

Facial recognition systems have made major breakthroughs with the development of AI. They use smart sensors to compare facial features and are used in financial payment, airport security, device unlocking, and other fields to improve the convenience of life. However, challenges related to accuracy and information security remain significant. Currently, there is no unified global legal framework governing the use of facial recognition technology. In Taiwan, facial recognition systems are regulated under the Personal Information Protection Act and the Consumer Protection Act. In contrast, some states in the United States have enacted legislation that prohibits the use of this technology altogether, underscoring the need for stronger and more consistent information security measures and regulatory safeguards worldwide.(13) In the past, face recognition systems were often affected by insufficient light, distance, and occlusion, resulting in poor recognition results. To address these challenges, Wang *et al.*(14) proposed the use of convolutional neural networks to enhance facial capture capabilities and improve recognition accuracy. Nowadays, deep learning technology has considerably improved recognition accuracy and enabled the effective identification of small facial changes. In addition, integrating facial recognition with file encryption solutions can address key security concerns.(15) During the COVID-19 pandemic, the demand for remote learning and contactless medical consultations accelerated the application of facial recognition technology. By combining AI and image transmission technologies, recognition results can be transmitted in real time and integrated with emergency notification systems for rapid response and protection. For example, facial recognition has been proposed as part of online testing systems to analyze students' facial expressions and monitor their learning status during remote courses. Programming techniques have been used to perform facial recognition and comparison to ensure student attendance, with accuracy improved to nearly 100% through the application of a deep residual learning model.

As the number of vehicles in the country increases, parking becomes a major management issue. Smart parking management uses license plate recognition systems to monitor vehicle entry and exit, and technologies such as object overlap detection, sound recognition, and traffic density are combined to promote the development of smart transportation.(16) Deep learning technology has gradually matured after the popularization of 5G networks. License plate recognition technology can utilize advanced image processing techniques to address challenges such as distorted text and suboptimal viewing angles, enabling applications such as automated parking fee collection and technology-assisted law enforcement. Additionally, to reduce the risk of vehicle theft in parking lots or on roadsides, AIoT systems integrate IoT technologies with image and voice recognition to provide functional early warning alerts and enable effective vehicle tracking. By streamlining access control and enhancing security monitoring, such systems can significantly improve management efficiency in environments such as hospitals and government institutions.(17)

3. Hypothesis Development

To ensure that the research findings were objective and reliable, we adopted a quantitative research approach. Data was collected through a structured questionnaire utilizing a five-point Likert scale. The respondents included construction workers, supervisors, and personnel from relevant user units who are currently involved in the implementation of smart police surveillance systems. Questionnaires were distributed to these groups to gather responses and explore the feasibility of sensor applications by analyzing the impact of IoT technology in practical user contexts.

After the questionnaires were collected, the data were comprehensively analyzed, and the appropriateness of the research model was verified through empirical statistical analysis. For this purpose, the statistical software package SPSS Modeler 18.0 for Windows (IBM) was employed to perform descriptive statistics, *t*-tests, one-way analysis of variance (ANOVA), correlation analysis, and stepwise regression as the primary analytical tools. Additionally, item analysis was conducted to assess the discriminator validity of the questionnaire. If the significance of the *F*-value was less than 0.05, the null hypothesis was rejected, indicating that significant differences existed between groups. The significance of the *t*-value was then tested; if the *t*-value was significant at the 0.05 level, this indicated that the item demonstrates adequate discrimination.

For the factor analysis procedure, it is recommended that each item achieves a factor loading of at least 0.40. We employed principal component analysis (PCA) combined with the varimax rotation method to extract underlying factors and further verify the construct validity of the measurement scale. The selection criteria for the construct validity of the scale were that the eigenvalues of each factor must be greater than 1 and the factor loadings after orthogonal rotation should be greater than 0.4.

Following the item analysis to evaluate validity, a reliability test was conducted for the IoT and sensor application and assessment aspects. Internal consistency and stability were examined using Cronbach's α coefficient. As a result, we found that to understand the covariation relationship between facets, structural equation modeling (SEM) needs to be used to test the comprehensive statistics of hypotheses between facets, estimate or test theoretical relationships between variables, and explore causal relationships between facets.

4. Research Methodology

4.1 Measurement scale development

This study was structured around three main dimensions: IoT technology, sensor applications, and feasibility assessment, which were further subdivided into five specific subdimensions. A questionnaire was developed using item analysis to ensure that the survey items effectively captured the relevant constructs and to examine the correlations and internal consistency among the variables. A five-point Likert scale was employed as the measurement tool. To ensure the validity and reliability of the measurements, established statistical analysis methods were applied. Moreover, the operational definitions of most dependent and independent variables were based on constructs and measurement scales drawn from existing relevant literature.

4.2 Data analysis technique

In this study, SPSS version 18.0 and SEM were employed for data analysis to verify the reliability and validity of each construct and its corresponding facets. Through measurement model analysis within the SEM framework, we aimed to ensure that the measurement model demonstrates sufficient reliability and validity, thereby providing a robust statistical foundation

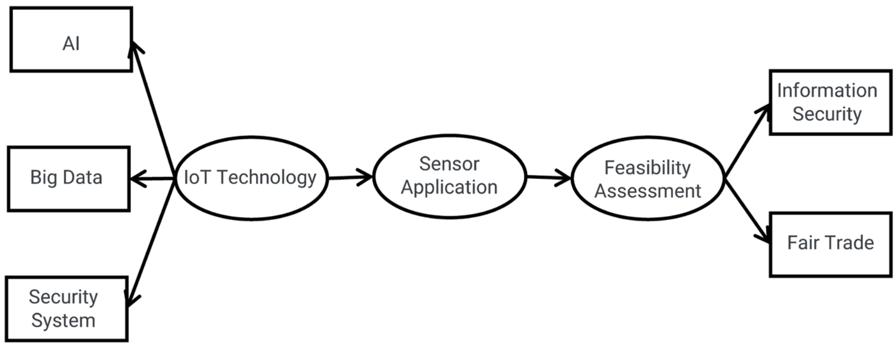

Fig. 1. Conceptual research model.

for testing the research hypotheses. The SEM measurement model was primarily used to examine convergent validity and discriminant validity to confirm the appropriateness of the constructs and their indicators.

Convergent validity: This was evaluated by examining the standardized factor loading, complex coefficient of determination (R^2), average variance extracted (*AVE*), and other indicators of each measurement index. When the factor loading value was higher than 0.5 and the AVE was greater than 0.5, the construct has good convergent validity.

Discriminant validity: On comparing the correlation coefficient between facets with the AVE value of each facet, if the square of the correlation coefficient of the facet is less than AVE, there is good discriminant validity between the facets. The suitability of the SEM measurement model was evaluated through multiple indicators, such as χ^2/df, comparative fit index (*CFI*), goodness of fit index (*GFI*), adjusted goodness of fit index (*AGFI*), and root mean square error of approximation (*RMSEA*). When these indicators meet relevant standards (such as χ^2/df less than 3, *CFI* greater than 0.9, *RMSEA* less than 0.1), the model has good adaptability and can reasonably explain the data. This model verification approach not only confirms the reliability and validity among the various facets but also enables an in-depth analysis of latent variables through SEM. This provides an important reference for validating future studies with larger sample sizes and in more diverse contexts, thereby enhancing the robustness, practical relevance, and academic contribution of the research findings.

5. Data Analysis and Results

5.1 Sample characteristics

The demographic characteristics of the participants in this study are as follows. All respondents were construction workers, supervisory (manufacturing) personnel involved in smart policing surveillance projects, and members of the user units. Among them, 71.5% had more than six years of work experience. Over half (55%) held a college degree or higher. The ages of the respondents ranged from under 20 to over 51 years old, with the largest proportion (33.5%) falling within the 31–40 age group (n = 67). Additionally, the gender distribution and marital status of the participants were approximately evenly divided.

5.2 Hypothesis testing

In summary, through the SEM model analysis results, the validated measures were found to be as follows: $\chi^2 = 205.451$; $\chi^2/df = 2.776$, $p < 0.001$; $GFI = 0.86$; $AGFI = 0.801$; $CFI = 0.958$; and $RMSEA = 0.94$. From the inspection standards of model indicators, this research model is judged to have good fitness. The results of the specific analysis are as follows. According to Kline,(18) χ^2/df within 3 is within the acceptable range. The χ^2/df ratio of this model is 2.776, which meets the recommended standards and indicates an acceptable model fit. Although the *GFI* and *AGFI* values do not reach the commonly accepted threshold of 0.90, the overall fit remains adequate. According to the recommendations of Baumgartner and Homburg(19) and Doll *et al.*,(20) a value greater than 0.80 is considered to fall within the acceptable range, indicating satisfactory reliability or construct validity. The *GFI* obtained in this study is 0.86 and *AGFI* is 0.801; both vmeet the requirements, showing that the model is still adaptable. According to Bentler,(21) a *CFI* above 0.9 represents a good fit. The *CFI* value this study was 0.958, indicating an excellent model fit. Fan *et al.*(22) demonstrated through Monte Carlo simulation that the *CFI* exhibits relatively low sensitivity to sample size and thus remains a reliable indicator of model fit even in studies with small-to-moderate samples. Following the recommendations of Browne and Cudeck,(23) the acceptable range of *RMSEA* can be relaxed to less than 0.1. The *RMSEA* value in this study was 0.94, which was within the acceptable range and supported the suitability of the model. In response to the problem of the underestimation of fitness indicators that may be caused by a small sample size, Ullman(24) suggested relaxing the standard for indicators such as NFI to 0.8 in this case. The results of this study showed that the model performs stably under each fitness index, supporting the research hypothesis and structural model.

6. Discussion and Conclusions

The aim of this study was to comprehensively examine the interactive relationship between IoT technology and sensor applications through empirical analysis, to further investigate the impact of sensor deployment, and to evaluate their feasibility and effectiveness. In terms of

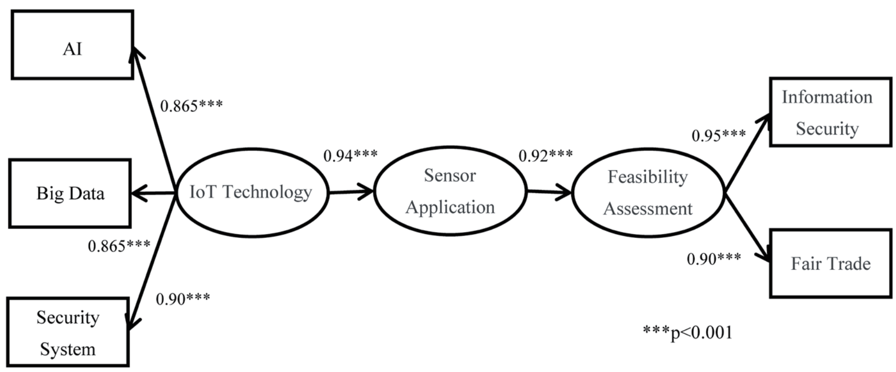

Fig. 2. Results of research model.

methodology, data were collected using structured questionnaires and analyzed with statistical software to interpret the underlying patterns in the data and test the proposed hypotheses. In the preliminary analysis stage, SPSS version 18.0, which includes *t*-test, ANOVA difference analysis, frequency distribution, correlation analysis, and stepwise regression analysis, was used for data testing. Subsequently, the relevant analysis results were input into AMOS version 22 software. The following main conclusions and findings were obtained.

(1) Positive impact of IoT technology and sensor applications: The analysis results showed that there is a significant positive relationship between IoT technology and sensor applications. At the same time, the correlation between sensor application and evaluation also shows a positive interaction, indicating that with the continuous development of IoT technology, people's increased acceptance of it directly promotes the positive evaluation of sensor applications.

(2) SEM model suitability assessment: Through a comprehensive evaluation of multiple fitness indicators, the SEM model constructed in this study showed good fitness in both data analysis and index testing. This includes that the performance of core indicators, such as χ^2/df, *GFI*, *AGFI*, *CFI*, and *RMSEA*, all reached or exceeded the acceptable range, verifying the rationality and robustness of the model. The results support the research hypothesis and further illustrate the significant impact of IoT technology and sensor applications on sensor evaluation.

(3) Theoretical and practical implications: The research results not only support the structural rationality of the hypothesis model but also provide a theoretical basis for the subsequent exploration of the impact mechanism of IoT technology and sensor applications. With the popularization of IoT technology, smart applications, such as smart cities, smart homes, and disaster prevention and fire detection systems, have gradually become the core of modern life, further improving the comfort and convenience of human life. The continued development of IoT technology in the future will change human life patterns and promote a more intelligent living environment.

(4) Importance of information security: Nevertheless, while enjoying the convenience and benefits brought about by IoT technology and sensor applications, special attention must be paid to the challenges of information security. With the popularization of IoT devices and sensors, potential information security issues have become increasingly prominent, which may affect user privacy and data protection. In future research, more attention should be directed toward how to balance the convenience and security of IoT technology to ensure that technological development can bring long-term positive impacts to human life.

(5) Future research directions: To further consolidate the robustness and generalizability of the research results, empirical analysis based on a larger sample size can be considered in the future to test the applicability of the model in different situations and ethnic groups. In addition, in-depth exploration of the application value of IoT technology in different industries, especially emerging fields such as smart medical care and smart agriculture, is also a direction worthy of attention. In summary, in this study, we conducted a comprehensive empirical discussion on the impact of IoT technology and sensor applications. The results not only support the research hypotheses but also offer valuable reference insights for the

development of related fields. It is anticipated that the findings of this study will contribute to the further application and continuous optimization of IoT technologies and sensor systems in practice.

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