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Development of Sensor Network Data Analysis Management and Information System for Smart Factories

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Abstract **–** Nowadays, with the rapidly developing technology, many innovations have entered our lives. One of these technological advancements is Industry 4.0, known as the 4th Industrial Revolution, which is a set of values consisting of the internet of things, internet services and cyber-physical system. The Internet of Things (IoT) is used to send the received sensor data over the internet networks. IoT enables data sharing and centralized control mechanisms without the need for any human intervention. The paper aims to both reduce costs and ensure high efficiency. An intelligent system created with sensor networks written in C# language provides great comfort for the personal usage and company. In Smart Factories, which are equipped with automation systems that enable increased efficiency in production, real-time monitoring and remote control, it is aimed to ensure that the development in any section is achieved from a common point. Smart Factory Management Information System is a computer-based information system that produces management reports by creating and summarizing transaction records of data transferred through the sensors. This system in the Smart Factory provides energy efficiency in response to the growing energy requirements. It also provides person in charge with ease in accessing information, timely access, cost savings and system security. With the system to be built in this study, it is aimed to control the smart system more easily in visual manner and to create a smart factory management and information system that meets the requirements of Industry 4.0 with solid contribution.

Keywords – Industry 4.0, Smart Factory, Sensor, Management and Information System

I. Introduction

The main goal of advances in Industry 4.0 technology is advanced industrial automation and high efficiency. Industrial innovation has enabled the development of smart factories, which emerged with the Internet of Things and are widely used today. Additionally, IoT is evolving around smart industrial components such as cloud computing, cybersecurity, autonomous robotics, system integration, big data, data analytics and artificial intelligence [1]. Industry 4.0, also known as the fourth industrial revolution, is the vertically and horizontally integrated production of smart factories. It is characterized by the introduction into production of the concepts of IoT and the Internet of services, which enable it to have systems. In industries worldwide, highly flexible processes that can be changed quickly enable personalized mass production. Variants are self-determining through elements that transmit their own production data to intelligent machines that exchange environmental information and self-controlled processes in production and logistics [2]. Smart Factory is an intelligent production system that performs efficient and reliable production using advanced technologies such as artificial intelligence and cloud computing. A four-layer architecture developed based on recent research results in the field of smart manufacturing is proposed. The proposed architecture consists of smart device layer, network layer, cloud layer and application layer [3]. Moreover, Smart Factories are envisioned as the future state of a fully connected production system that operates essentially without human power by generating, transferring, receiving and processing the data necessary to produce all kinds of products [4]. Sensor networks will be used in the system to increase efficiency and minimize human-related problems.

In this study, a high value-added, smart factory management and information system was created in accordance with Industry 4.0 criteria by using a Xamarin-based personal tracking system and product tracking system.

II. MATERIALS AND METHOD

This study consists of two parts and includes details about the hardware and software components used in the smart factory system design. Software components are divided into Google Firebase and Visual Studio, and hardware components are divided into Sensors and microcontrollers. Sensors are divided into sub-branches as BME280 and sensor card, and microcontrollers are divided into sub-branches as Raspberry Pi.

A. *Hardware Elements*

Microcontroller technology belongs to the category of embedded computer systems that follow the rules of the traditional (sequential) programming method and do not run an operating system (OS). The second feature distinguishes microcontrollers from the similar technology of microprocessors. The DIY influence on microprocessor technology has shaped today's single-board computers (such as the Raspberry Pi board), where the operating system is often loaded onto an on board secure digital (SD) card[5]. Raspberry Pi Model 3 has a quad-core 64-bit ARM Cortex-A53 processor and operates at 1.2 GHz, providing fast and efficient performance. Raspberry Pi3 module is the unit that performs operations such as reading the data of the sensors used in the smart factory and sending it to the database.

Many sensors are used in the smart factory system to increase efficiency and provide remote control of the environment. The Pie IoT HAT Sensor Board is a sensor board that can be connected to the Raspberry Pi (Raspberry Pi 4 and earlier models) and is designed to measure a variety of environmental variables. As shown in Fig. 1, the board used in this study has a set of integrated sensors that can measure various parameters such as temperature, humidity, pressure, light, motion.

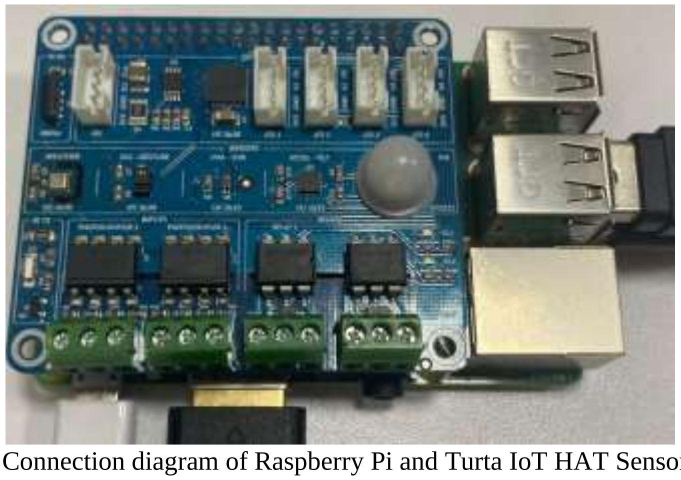


Fig. 1 Connection diagram of Raspberry Pi and Turta IoT HAT Sensor Card

While it can measure temperature in a wide temperature range via its temperature sensor, it can measure the humidity level in the environment as a percentage with its capacitive humidity sensor. It also includes a pressure sensor to measure atmospheric pressure and a photosensor to measure environmental light levels. Some models have a motion sensor to detect nearby movement. The board usually connects to the Raspberry Pi using communication protocols such as I2C or SPI and is designed to be used in various IoT projects with its wide range of sensors. Through these features, users can collect data by measuring various environmental variables quickly and effectively, thus enabling them to easily develop IoT projects.

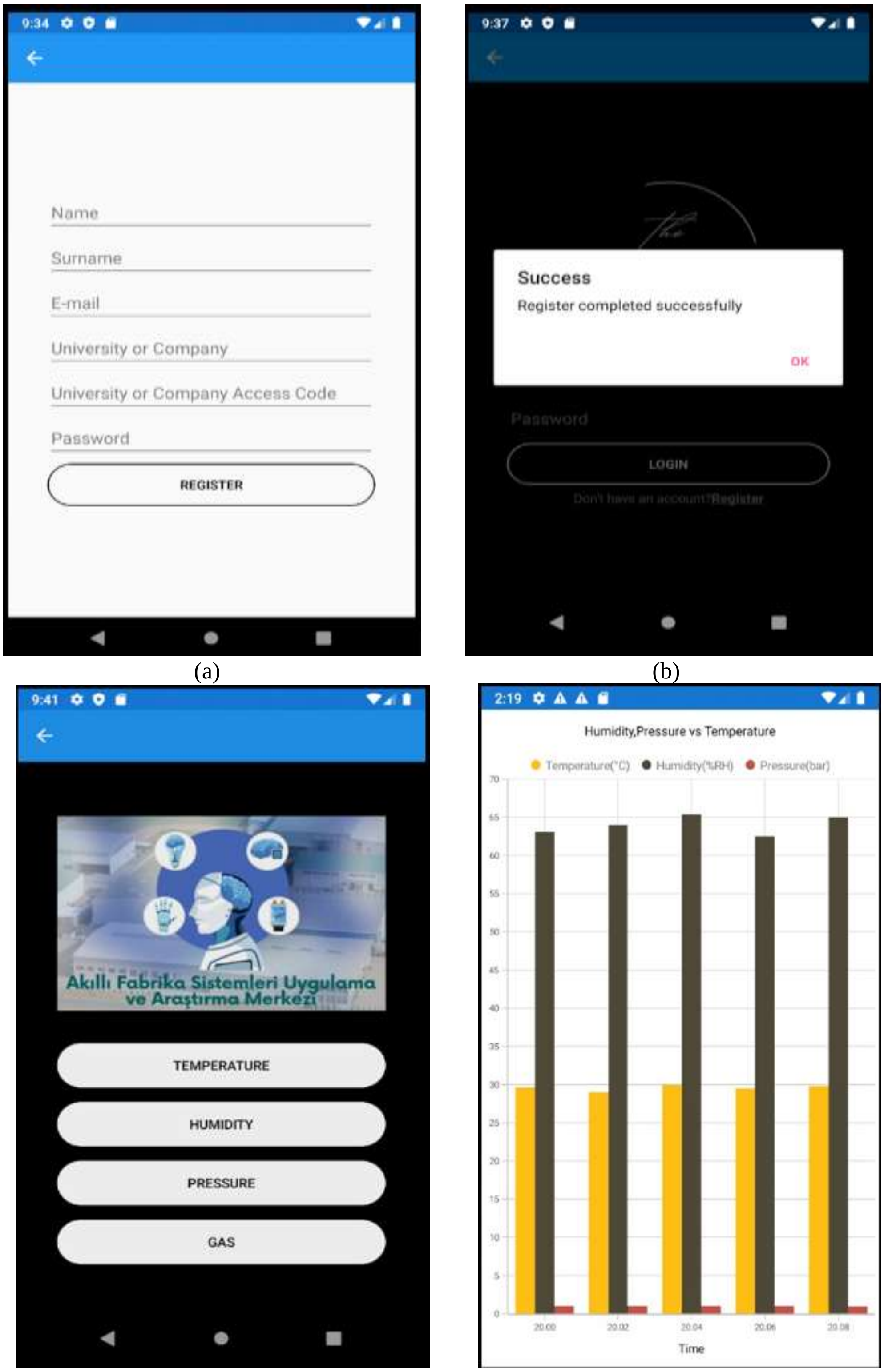
B. *Software Elements*

Xamarin.Forms is a framework that allows developers to quickly create cross-platform user interfaces. It provides its own abstraction for the user interface to be rendered using native controls on iOS, Android, or Universal Windows Platform (UWP). Xamarin.Forms applications are architected in the same way as traditional cross-platform applications [6]. Xamarin application is a cross-platform development framework with a focus on code sharing, increasing testability and reducing overall development and maintenance cost and efforts [7].Google Firebase is a platform-independent mobile and web application development platform that offers developers a variety of services for application development and distribution. In this study, tools such as real-time database, user authentication, cloud storage, analytics, notifications and application performance monitoring were used. In this way, it is possible to record all incoming data and to carry out retrospective studies and evaluations when necessary.

III. RESULTS

Software is required to control a communication system. The data collected wirelessly by the user must be processed and an interface tailored to the user's needs is designed. The information collected is used for various purposes such as tracking people, product inspection, and determining environmental conditions. The designed interface was written in C# programming language in Visual Studio-Xamarin application and is shown in Fig. The login screen of the software is shown in Fig. 2. On the screen in Fig. 2, Firebase Authentication database was used for the user to log in to the system. The email and password information required for the user to log in are stored in the Firebase Authentication database. The next time you log in, you can log in to the system using the information stored in the database.

Fig. 2 Login Screen



(a) (b) (c) (d)

Fig. 3. Application Interface (a) register screen, (b) successful register screen, (c) main screen, (d) temperature and humidity graph

IV. DISCUSSION

This study focuses on the development of smart factory management and information systems in accordance with Industry 4.0 criteria. Industry 4.0 involves the integration of technologies such as IoT, artificial intelligence and cloud computing and brings significant innovations in production processes. In the study, hardware components are specified with the use of microcontrollers and various sensors, and these components are used to measure environmental variables and transmit data to the database.

According to the study results, the management and information systems of smart factories are designed to meet the various needs of users. These systems process the data collected by users remotely and present it through user-friendly interfaces. It also increases the usability of data for different purposes such as product monitoring, determination of environmental conditions and people monitoring. Such intelligent systems have significant potential to increase efficiency and reduce costs in industry. A more detailed examination of these points will provide a comprehensive understanding of the system's capabilities and its potential impact in transforming factory management practices to Industry 4.0 standards.

V. CONCLUSION

In the Xamarin application, which is integrated in Visual Studio, an interface has been designed to make sensors used in smart factories easier and faster in situations. A login screen with a username and password has been created in the interface, and a registration mechanism has been created for non-registered users by giving them a special login code for each segment where reliability is at the forefront. A different page has been assigned for each sensor in the interface, but it should be on one screen to seem to be more organized and then an updated customized interface could even be adapted for the further system requirements with the main aim of more accurate results to display in the form of a table or graph.

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