

AUTOMATION AND CONTROL OF INDUSTRIAL OPERATIONS USING ANDROID MOBILE DEVICES BASED ON THE INTERNET OF THINGS

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Abstract

In this study, we will look at a simplified model of a larger industrial system that uses relays to carry out sequential actions. Automatically shuts off when it senses water or temperature levels that are too high for safe industrial use. To put this idea into action, an Arduino microcontroller is used because it is the best option available. Because it's a free, open-source platform, it's great for prototyping the system with little hassle. Because of its interoperability with sensors, the system may get the necessary feedback and be fine-tuned by the Arduino. The status of the system is represented via various indicators such as the liquid crystal display (LCD), the buzzer, and so on. Data from the sensors is collected and stored in a Data Acquisition System (DAS), from which it may be accessed and used for management and oversight.

ARTICLE INFO

Article history:

Received 6 Jul 2022

Revised form 5 Aug 2022

Accepted 5 Sep 2022

Ключевые слова: IoT, Industrial Automation, Control, Android Mobile, Supervisory Control and Data Acquisition (SCADA), Distributed Control System (DCS), Programmable Logic Controller (PLC).

As an added bonus, it allows for quick prototyping and simple error correction, allowing for more adaptability. However, the implementation of the design in an industrial context may be hindered by the need for more specialised hardware, certifications, and technical support than is typical for industrial systems.

Introduction:

The AVR family of microcontrollers is at the heart of our system, handling everything from internet connectivity and command reception to processing human input [1-3]. The data is deciphered by the Wi-Fi modem and sent to the microcontroller [4]. The microcontroller responds to user input by performing the required tasks. The LCD Showcase shows the current status of the system. As a result, an online GUI is used to automate the entire industry [5-13]. Today's smartphone culture has led to a preference for more technologically advanced methods of labour. And the same holds true for economic sectors. The rise of automation in the workplace has had far-reaching effects [14]. The level of automation varies between industries, with some being totally mechanised and others only somewhat so [15-22]. In sum, "automation" is no longer a buzzword, but rather a standard part of everyday conversation and business. The automation of manufacturing processes is the main objective of our work. Manual operation from afar is also possible for certain machines [23-31].

- The goal of developing a Smart Industrial environment is to provide the means for real-time monitoring and control of industrial parameters via a mobile device [32-41].
- With the goal of eliminating or greatly minimising any potential sources of plant-related incidents [42].
- Eliminating potential accident triggers will reduce worker fatalities, long-term disabilities, and wage losses [43].

Need for Industrial Automation

Automation is essential in business because it expedites the distribution of high-quality goods and services, cuts down on wasteful downtime, and eliminates the possibility of human error. It is currently supporting supply chains around the globe [44-67]. The more widespread the use of automation becomes throughout industries, the better our lives will be. Fear not, human beings; the robots will not take over the earth [68-88]. They will continue to fail as long as we keep making them. Automation performs dangerous tasks, such as smelting metal, making those tasks safer for humans to accomplish elsewhere [89-92]. Just as it helps people make fewer mistakes, it also boosts productivity so that more stuff may be made by each person [93-99].

Motivation

Thanks to advancements in technology, most people now have access to mobile phones, transforming the globe into a global community [100-111]. The portable allows for instantaneous communication with a specified individual. However, mobile apps aren't limited to initiating SMS or starting chats. It has the potential to spark new ideas and innovations, expanding its usefulness. In recent years, we've seen the development of several technologies like infrared, Bluetooth, etc [112-119].

Literature Review

IoT-Based Industry Automation Using ARM7

As proposed by [1], this system is. In order to find previous work done on the subject by a variety of scholars, we have combed through the relevant literature published over the past twenty years. Many systems for remote observation and control began life as commercial goods or experimental research platforms. Most of the research that has been shared has been classified as falling into one of the following groups: internet-based monitoring employing servers, GPRS modems, etc., and a wide range of methods [120-135]. The GSM-SMS protocol uses GSM modules either alone or in conjunction with internet technologies for communication. Sensor networks that don't use wires. Use of radio frequency (RF),

Bluetooth, Wi-Fi, and Zigbee for wireless monitoring (radio frequency). Many other fields have found use for these technologies, including home automation, security systems, biomedical applications, agriculture, reservoir and bridge health observation, and so on [136-149].

Industrial Appliances Control Using Android Mobile and Bluetooth Technology

Hardware and software for regulating induction motor speed were created by Khairnar et al. [3]. In this case, Bluetooth and android applications are favoured for wirelessly regulating the induction motor's speed. Embedded system and Android mobile technology are combined in this integrated system [150-159]. Users of Android mobile devices will need to download an app to their device in order to operate the gadgets. Microcontroller (ATmega16) as an embedded target and Bluetooth device were used in the design of the Bluetooth-based remote monitoring and control system by June and Unnikrishnan. Several sensors (including thermometers, pressure gauges, and humidity detectors) are linked to the controller through Bluetooth, allowing the latter to monitor and regulate the process's environment in real time. Control, monitoring, and coordinating home appliances are all made possible by Belgi et al. illustrated 's Control System, which is accessed through cell phone. The system can adjust the power of the lights and the velocity of the fans [160-175].

A Review on Industrial Automation Using IoT

The project is described as "industrial automation using CAN protocol [2]," and its goal is to control DC motor-driven loads in industrial settings according to process temperature changes. Several kinds of temperature-based control systems are used in industrial processes [176-181]. The CAN protocol, which is used in this project, is a low-cost, highly efficient means of communication. The DC motor in this project is controlled by one of two microcontrollers that also collect temperature data. Both microcontrollers are wired to the CAN Controller MCP2515 and CAN transceiver MCP2551, allowing for bidirectional CAN communication and data exchange; however, the number of nodes that can effectively communicate is restricted to 110 due to the hardware transceivers. Cable runs of up to 250 metres in length are supported [182-199]. The ZigBee module is set up to accept data from the microcontroller and transfer it to the far-off receiver in industrial automation systems utilising the ZigBee transmitter. An analog-to-digital converter is used to keep track of the system's temperature, voltage, and current, and the microcontroller is instructed to record this information. Any information transmitted by a Zigbee transmitter is picked up by a Zigbee module at the receiving end. The embedded circuitry then transfers this information to the microcontroller, where a programme checks it against known criteria. For loads like motors, relays, circuit breakers, and more, a microcontroller can send instruction signals to a relay driver IC when a certain threshold is exceeded [200-212]. As a Human machine interface, an LCD displays all of this data. Therefore, the short-range, cheap, and low-powered Zigbee communication technology can be used to quickly monitor and regulate industrial parameters [213-234]. From a distance of 10 to 100 metres, it enables bidirectional communication between transmitting devices and controllers [235-255].

Existing System

Existing System Using GSM and Bluetooth

Only the GSM Module and Bluetooth Module form the basis of the current system. Bluetooth and Wi-Fi, two technologies made possible by recent advances in technology, have given rise to a plethora of gadgets with networking capacities [256-261]. To save money and make the Arduino board usable without a computer, you may use a WIFI shield to make it a Microweb server. In order for an Arduino to talk to the internet, a Wi-Fi shield must first establish a connection with the internet through a wireless router or hotspot [262-272]. Thus, a home automation system built on the internet is created to allow for remote management of electrical devices [273-281].

Limitations of Existing System

- Under some conditions, it may lose contact.

- Compared to Wi-Fi, it has a poor data transfer rate and can only be used for close-range communications [282].
- Being hackable makes security a top priority.

Proposed System

Proposed System Using IoT

Our suggested system is a Wi-Fi-connected Arduino-based industrial automation system that can be managed from a smartphone app or social media platform. This system is concerned with industrial safety and employs smart technology that will reduce costs [283-299]. The Internet of Things, built on the foundation of industrial automation, is the answer to localised communication needs [300-314]. From one central location, we can regulate and keep tabs on everything. In order to eliminate the need for localised conversations, our project prioritises IoT-based automation [315]. With the advent of the internet, businesses now have the ability to manage their applications from anywhere in the globe [316].

Advantages of Proposed System

- Remote monitoring and control is feasible.
- Increased output with less labour expenses.
- Can do what humans can't
- It's a lot more dependable.
- Providing field monitoring is unnecessary.

System Overview

The term "internet of things" (IoT) refers to a set of protocols for interacting with and managing physical objects from a remote location [317-321]. In this paper, we offer an effective industrial automation system for remotely controlling machines and other devices in the business sector. We show the system in action using three loads, which we interpret to be machines or industrial equipment. All user input is handled by a microcontroller in the Arduino family. A wireless modem communicates with the internet and takes input from the user [322]. When we issue a command over the internet, our Wi-Fi modem is the first device to receive it [323-329]. Data is decoded by the modem before being sent to the microcontroller [330]. The microcontroller subsequently makes the necessary switches, loads the appropriate data, and performs the requested operation based on the information received from the remote location. The current status of the system is also shown on the mobile app. Therefore, we use a web-based GUI to automate the whole business [331-336]. When connecting to the page, we use the domain as an IP address. The available power of one set of characteristics is converted by the power supply unit to fulfil the needs. To run electronic devices, power sources typically alter the voltage and/or current from their raw input form (figs. 1 and 2).

Proposed Architecture

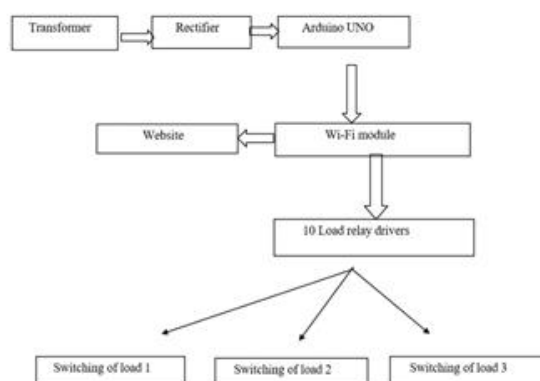


Figure 1: Block diagram of proposed industrial automation

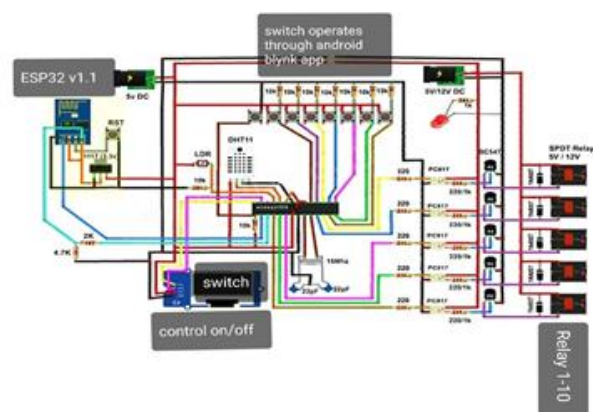


Figure 2: Circuit Diagram

Working Principle

The Internet of Things (IoT) is crucial to our project's functionality. Our suggested system is a Wi-Fi-connected Arduino-based industrial automation system that can be managed from a smartphone app or social media platform. This system is concerned with industrial safety and employs smart technology that will reduce costs [337-341]. The Internet of Things, built on the foundation of industrial automation, is the answer to localised communication needs. From one central location, we can regulate and keep tabs on everything. In order to eliminate the need for localised conversations, our project prioritises IoT-based automation. With the advent of the internet, businesses now have the ability to manage their applications from anywhere in the globe [342-349]. The suggested system includes sensors and controls for a variety of household appliances, including a heating coil's temperature, a light's lux level, a DC motor's speed, and its direction. The embedded system is interfaced with a Wi-Fi module to allow for remote control of the appliances. The operator utilises a Smartphone connected to the system's Wi-Fi in order to manage these devices. In order to control it, the operator must first install a programme to their computer. The microcontroller in the system will be responsible for operating the various appliances in response to the operator's commands, which will be received by the device in the system via the channels it has been given access to.

Components Required

Hardware and Software Requirements

Hardware Requirements

- Arduino UNO
- Transformer
- Rectifier
- WiFi module ESP32 v 1.1
- 10 channel load driver
- Required loads

Software Requirements

- Arduino software
- IDE
- Blynk

Arduino UNO

Arduino is a free, open-source electronics platform with user-friendly hardware and software. Arduino boards may convert data received as inputs (such as from a light sensor, a button press, or a tweet) into a desired output (such as the operation of a motor, the illumination of an LED, or the uploading of content to the internet). Instructions can be transmitted to the board's microcontroller to tell it what to do. For this purpose, many people turn to the Arduino programming language and the Arduino Software (IDE). (fig.3).

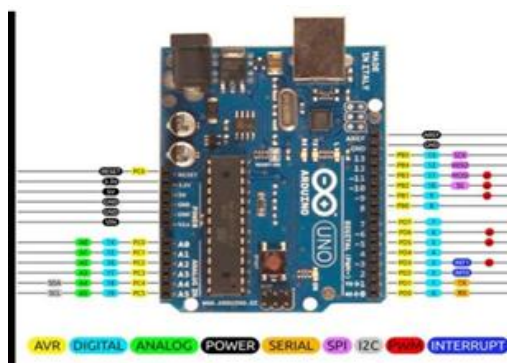


Figure 3. Arduino UNO

There have been thousands of projects over the years that have used Arduino as their central processing unit. At the Ivrea Interaction Design Institute, Arduino was conceived as a simple tool for rapid prototyping that would be accessible even to students with little to no experience in electronics or programming. Because of its popularity, the Arduino board has evolved from a basic 8-bit board to specialised offerings for Internet of Things (IoT) applications, wearables, 3D printing, and embedded systems. Each Arduino board is free and open-source, allowing anybody to create one and modify it to suit their own purposes. The programme is freely available to anyone who wants to use it, and it continues to develop thanks to donations from users all over the world.

ATMEGA 328P – Microcontroller

The controller does nothing at all if it isn't programmed to. It is necessary to first programme the controller by loading the necessary code into the FLASH memory of an ATMEGA328P microcontroller. The controller then runs the code it has received, giving the expected result (figs 4 and 5).

- The ATMEGA328P has a wide variety of uses due to its large 32 Kbyte programme memory.
- Multiple POWER SAVING modes allow it to function on

Mobile Embedded Systems

- Systems with low user involvement can benefit from the error-resetting Watchdog timer.
- With its cutting-edge RISC architecture, the controller can quickly run programmes.
- The temperature sensor on the chip allows the controller to function in extremely high temperatures.

PIN Configuration

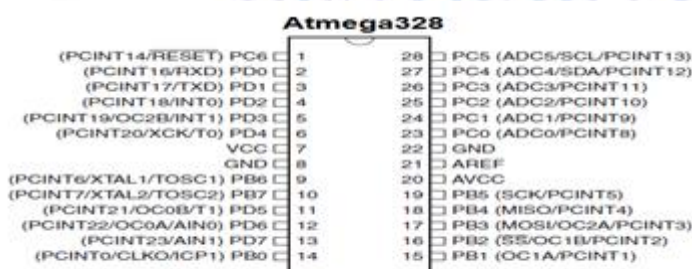


Figure 4: Pin Configuration

Layout Connection of ARDUINO UNO

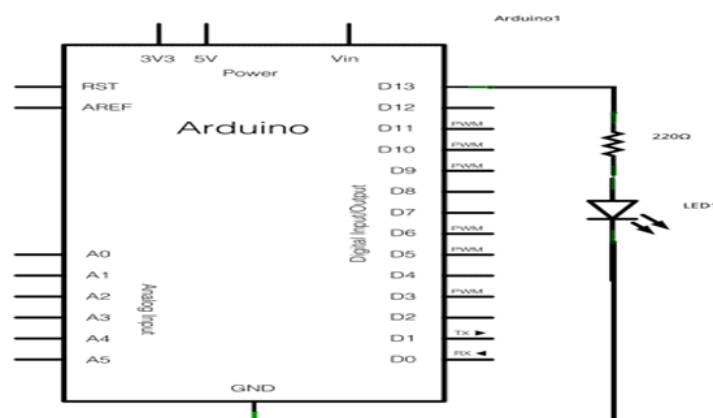


Figure 5: Layout connection of Arduino UNO

Arduino IDE Software

The IDE combines an editor, linker, and compiler to facilitate the creation of firmware for cutting-edge research and development initiatives. The Arduino IDE is an easily accessible library that plays a crucial

role in open-source, rapid prototyping platforms. It's a helpful programme for novices because it works with a variety of languages. There have been thousands of projects over the years that have used Arduino as their central processing unit. It's compatible with the full range of Arduino boards, including the Uno, Nano, Mega, and more. The Arduino board has evolved from its original 8-bit design to include products for Internet of Things (IoT) applications, wearables, 3D printing, and embedded environments as it gained traction in the maker community (fig. 6)



Figure 6: Arduino IDE Software

Power Supply

This method use a single circuit to generate a dual-voltage DC power supply (12V and 5V). Two integrated circuits (ICs)—a 7812 and a 7805—are used in the circuit to generate the necessary voltages. The transformer will reduce the mains AC voltage, the bridge will rectify it, and the capacitor will filter it such that the resulting voltage is a stable DC. The 7812 controls this voltage so that 12V DC is produced consistently. With the 7805 in place, the 5V DC output from IC1 will be stable. This allows for the production of both 12V DC and 5V DC. In the beginning, a small step-down transformer decreases the 230V AC voltage to 12V AC. The sinusoidal AC voltage produced by the transformer must be rectified to provide the periodic DC voltage required for use. A filter circuit receives this output and smoothes down the ac noise while letting the dc through. The 7812 regulator changes the voltage from 12V DC to 5V DC while the 7805 regulator does the opposite.

Wi-Fi Module

This method use a single circuit to generate a dual-voltage DC power supply (12V and 5V). Two integrated circuits (ICs)—a 7812 and a 7805—are used in the circuit to generate the necessary voltages. The transformer will reduce the mains AC voltage, the bridge will rectify it, and the capacitor will filter it such that the resulting voltage is a stable DC. The 7812 controls this voltage so that 12V DC is produced consistently. With the 7805 in place, the 5V DC output from IC1 will be stable. This allows for the production of both 12V DC and 5V DC. In the beginning, a small step-down transformer decreases the 230V AC voltage to 12V AC. The sinusoidal AC voltage produced by the transformer must be rectified to provide the periodic DC voltage required for use. A filter circuit receives this output and smoothes down the ac noise while letting the dc through. The 7812 regulator changes the voltage from 12V DC to 5V DC while the 7805 regulator does the opposite.

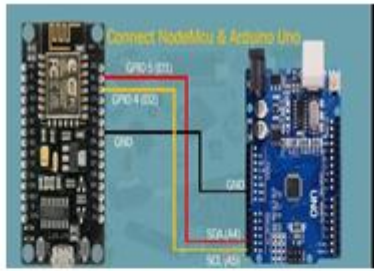


Figure 7: Wi-Fi module connected to Arduino

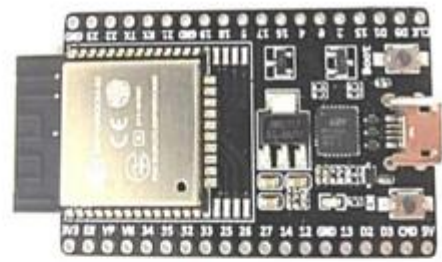


Figure 8: Wi-Fi Module

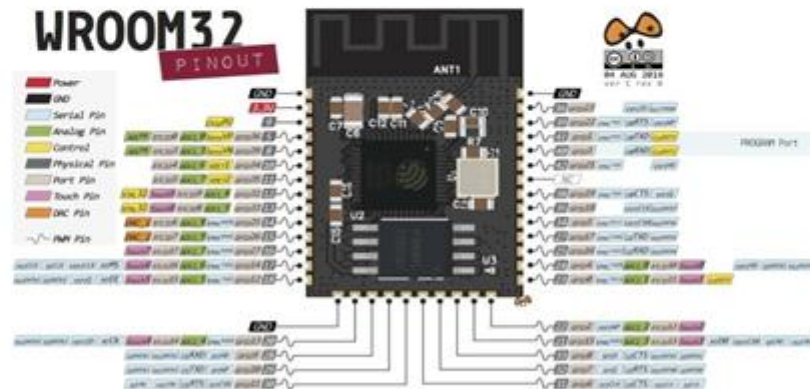


Figure 9: Wi-Fi module pin diagram

Relay Module

An electromagnet controls the switch in a power relay module. A microprocessor sends a separate low-power signal to trigger the magnets. Upon being engaged, the electromagnet acts as a switch, opening or closing a circuit (fig.10).



Figure 10: Relay Module

In most cases, an electrical current will trigger a relay, which is an electromechanical device. One circuit's current can open or close another. As a form of remote-controlled switch, relays have many uses due to their low cost, great durability, and consistent performance. There are many different types of industrial uses for relays, from telecommunications to digital computing to automation. Power outages and other disruptions can be avoided, and the power grid can be regulated and controlled, all with the help of highly complex relays.

Features

- The voltage across the coil, or the trigger voltage, is 5V DC.
- Average Nominal Current (Trigger Current): 70ma
- There should be no more than 10 amps of alternating current (AC) load at 250/125 volts.
- 10A DC at 30/28V DC is the maximum allowable load current.
- Miniature plastic-molded 5 pin connector layout

- Duration of operation: 10msec It takes 5msec to release.
- Optimal rate of 300 operations per minute (mechanically)

Applications

- Switching circuits typically employ
- Changing the AC current in a house automatically
- A method for regulating massive loads under strictly controlled conditions and at specified times
- Used to cut power to the load in the case of a circuit breakdown, they are a staple of safety circuitry.
- Commonly found on the dashboard of a car, this electronic component controls the indicators, glass motors, and other features.

Android

Smartphones are mobile phones that run on a mobile operating system and have more powerful computational capabilities and network connections than feature phones. Android is an OS, middleware, and core applications for mobile devices. By definition, Android is a mobile phone operating system. Android is a flexible system that can be tailored to the needs of individual devices. With Android, we have the resources to make apps that not only look good but also take advantage of the device's unique hardware. Android's role in this project is to provide remote smartphone control over Wi-Fi (fig. 11).



Figure 11: Android software

Users of Android mobile devices will need to download an app to their device in order to operate the gadgets. Start AC Motor, Stop AC Motor, Start Fan, Stop Fan, etc. Control the lighting by turning it on and off. That industrial work can be managed by mobile command.

Results

STEP 1: Activate the circuit's power source. Second, activate the wireless router.

STEP 3: Launch the blynk android app, choose the metric you wish to keep tabs on, and start controlling. (fig.12).



Figure 12: Screenshot of relay operation using blynk software

The developed hardware, as seen, allows a micro-controller-based system to function as a miniature version of a sequential logical operation. With the right precautions, this design can be used in a manufacturing

setting. Due to their high initial setup cost in comparison to a basic microcontroller system, conventional controllers are prohibitively expensive for small enterprises. The low price of an Arduino makes it a realistic choice. Arduino is a free and open-source platform that can mimic any industrial process or control function with only C/C++ code. Assembly, production, and upkeep costs, in addition to the original setup price, are reduced (fig.13).

Figure 13: Automation and control through an android mobile

Conclusion

In this paper, we present the results of a real-time, miniature implementation of a straightforward industrial system. The flexibility of this design makes it useful for a wide variety of modest projects. This paper discusses the current state of the art in remote control technology for physical devices. In this paper, we present an effective industrial automation system for remotely managing machines and other devices in manufacturing environments. The control system for industrial appliances that was developed makes use of android mobile and Wi-Fi technology is both practical and easy to use. By allowing for wireless connection between the system and a user's Android smartphone, this setup makes it simple to keep tabs on various system characteristics in real time. The user can use this system to make sure that parameters like temperature, intensity, and DC motor speed stay within the predetermined parameters. Because of this, it is expected to give fine regulation of all appliances.

Future Enhancement

We can avoid direct communication with IoT-based automation. With the internet, businesses can regulate their software globally. Internet of Things increases corporate output and profits. Novel hybrid business models provide innovative expansion methods. Third, they're retooling their staff and using smart fuel innovation technology. Time and effort saved by the initiative bode well for its long-term advantages. Iterations of the project aim to create an industrial automation system that lets users interface with their industry. Soon, self-contained gear will be immune to power outages. Data analysis with computers is possible. Manufacturing has been a leader in IoT deployment and uptake. The Industrial Internet of Things has a higher ROI than other industries. Flexible industries that produce new value and use the world's resources will survive. As a new paradigm, IoT has ushered in rapid technological innovation that has replaced previous methods. The Internet of Things has revolutionised the built environment, home life, transportation, and several companies. IoT has been the subject of several studies and investigations. Before IoT's full potential can be realised, many difficulties must be tackled. To address these concerns, the Internet of Things must be seen from numerous viewpoints, including its applications, challenges, enabling technologies, social and environmental ramifications, etc. This review article aims to provide a complete technological and societal analysis. This article covers IoT application domains, architecture, and challenges. The article highlights available literature and how it has contributed to IoT. Big data and IoT research have also been discussed. This essay helps readers and scholars understand IoT's practical consequences.

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