

# CHAPTER I

## INTRODUCTION

This chapter discusses the background of the problem, problem formulation, research objectives, research benefits, and scope and limitations. The background explains the development of technology in the era of Industrial Revolution 4.0, which has driven the utilization of the Internet of Things (IoT) in home security systems. The high crime rate and the limitations of conventional security systems serve as the basis for developing a motion detection system using PIR sensors integrated with Telegram, employing the Fuzzy Logic method to enhance detection accuracy. Furthermore, this chapter also describes the direction and scope of the research through the formulation of problems, objectives, benefits, and established limitations.

### 1.1 Background

In recent years, the development of technology and communication worldwide has shown significant advancement. This progress is characterized by the emergence of the Industrial Revolution 4.0 era, which integrates digital technology, artificial intelligence, and the Internet of Things (IoT) into various aspects of human life. This revolution has not only changed the way humans interact and work but has also formed a new system that is more connected, automated, and responsive to environmental changes in real-time [1].

The development of technology and communication has impacted not only the industrial sector but also other fields, including increasingly sophisticated security systems. One of the milestones in modern technological development is the emergence of Industrial Revolution 4.0. Industrial Revolution 4.0 is a concept that refers to an industrial transformation integrating digital technology, artificial intelligence, Big Data, and the Internet of Things (IoT) into daily life processes and services. This revolution does not merely replace human labor with machines; it also demands interconnectivity among various processes and systems occurring in real-time. The advent of Industrial Revolution 4.0 marks the transition from traditional industry toward a more digitally integrated and environmentally

responsive industry. Consequently, the concept of the Internet of Things (IoT) has become a critical core supporting the success of this transformation [2][3].

Internet of Things, commonly abbreviated as IoT, is a concept in which physical devices, ranging from industrial machinery to household appliances, are interconnected through the internet network. IoT transforms objects that were previously passive into active entities capable of collecting data, communicating, transmitting information, and making simple decisions automatically. The application of IoT not only improves efficiency and productivity but also opens new opportunities in the development of personalized services, such as virtual assistants, recommendation systems, and smarter and more sustainable resource management. Household security represents one of the most fundamental aspects of human life, as the home serves not only as a shelter and place of rest but also as storage for valuable possessions and essential daily necessities [4][5].

In Indonesia, the rate of household burglary remains considerably high and has become a significant concern for the public. Socioeconomic factors, population density, and urbanization patterns contribute to the vulnerability of certain areas to various criminal acts. This condition is exacerbated by the low awareness and implementation of adequate security systems in residential homes, as well as weak coordination with local security authorities. According to reports from the Indonesian National Police, residential burglary cases account for approximately 20–30% of the total criminal offenses reported annually. This indicates that the protection of homes is critically important to reduce material losses and maintain public safety [6][7].

Common methods of residential burglary include entry through breaking windows, forcing doors open, or exploiting weaknesses in existing security systems. Furthermore, burglars take advantage of specific times, such as when residents are away from home, for instance during the daytime when most occupants are engaged in activities outside. Conventional home security systems generally still rely on relatively simple tools and methods, such as mechanical locks, padlocks, fences, and direct human surveillance. Although these systems still serve a purpose, the inherent limitations make them less capable of addressing increasingly complex and dynamic criminal threats [8][9].

Moreover, the absence of real-time notification systems in many traditional security systems makes it difficult for residents to immediately become aware of threats. In this context, the use of the Passive Infrared Receiver (PIR) sensor presents an attractive alternative solution. PIR sensors offer numerous advantages, such as being more affordable than CCTV systems, more energy-efficient than electronic alarms, and easier to integrate with software and applications. When connected to the Telegram Bot API, PIR sensors can directly send real-time notifications to homeowners [10].

However, in its implementation, the system still possesses a weakness, namely the possibility of false alarms caused by the movement of other objects such as animals. Therefore, a method capable of improving system accuracy and distinguishing threats is required. To address this issue, this research employs the Fuzzy Logic Simplified Mamdani method in a home security system that utilizes the ESP32-CAM and PIR sensor based on IoT. By employing this method, the home security system can consider all factors that can be measured clearly and precisely [11][12].

Based on the aforementioned description, this research is focused on the design of a motion detection system using a PIR sensor integrated with Telegram as a home security notification medium. With the implementation of the Fuzzy Logic Simplified Mamdani method, the developed home security system is expected to contribute to the development of more reliable, responsive, cost-effective, and easily implementable home security systems for the general public.

## **1.2 Problem Statement**

Based on the aforementioned background, the following problems can be formulated:

1. How to design and construct a motion detection system using PIR sensors for a Telegram-based home security system?
2. How to implement the Fuzzy Logic Simplified Mamdani method in a motion detection system using PIR sensors for a Telegram-based home security system?

### **1.3 Research Objectives**

Based on the problem formulation above, the objectives of this research are as follows:

1. To design and construct a motion detection system using PIR sensors for a Telegram-based home security system.
2. To implement the Fuzzy Logic Simplified Mamdani method in a motion detection system using PIR sensors for a Telegram-based home security system.

### **1.4 Research Benefits**

Based on the research objectives stated above, the results of this research are expected to provide the following benefits:

1. Theoretical Benefits

Through this research, it is expected that the designed security device can serve as a learning and development tool for building home security systems using microcontrollers and mobile phones, as well as practical knowledge acquired both from academic studies and external experiences. Additionally, this research can serve as a reference material for readers or subsequent researchers in developing this study, particularly in the application of the Fuzzy Logic Simplified Mamdani method.

2. Practical Benefits

Practically, this research can assist homeowners in enhancing their home security systems. With the design and construction of this home security system, it is expected that homeowners can promptly be informed of any incidents occurring at their residence. Furthermore, this device can also provide a sense of safety and comfort for homeowners when leaving their homes unoccupied.

### **1.5 Scope and Limitations**

The scope and limitations of this research are established to clarify the extent of the discussion and to avoid the expansion of issues that are irrelevant to the research objectives. The limitations of this research are as follows:

1. The developed system exclusively employs the Passive Infrared Receiver (PIR) HC-SR501 sensor as the sole motion detector.
2. The detection range of the PIR sensor in the system is limited to a range of approximately 1–5 meters.
3. The system only detects the presence of motion without identifying the type of object.
4. The method utilized is the Fuzzy Logic Simplified Mamdani approach based on the motionLevel value.
5. The system is limited to capturing static photographs under specific conditions, namely during the Waspada and Bahaya statuses.
6. Notification delivery is conducted through the Telegram application; therefore, the system's performance depends on the availability and stability of the internet connection.
7. System testing was conducted under limited environmental conditions, specifically indoors (indoor).
8. The system assembly utilizes a breadboard as a temporary prototype medium, which can be further developed into a permanent PCB-based circuit in subsequent research.