Advances in Intelligent Systems and Computing 1350

Jessnor Arif Mat Jizat · Ismail Mohd Khairuddin · Mohd Azraai Mohd Razman · Ahmad Fakhri Ab. Nasir · Mohamad Shaiful Abdul Karim · Abdul Aziz Jaafar · Lim Wei Hong · Anwar P. P. Abdul Majeed · Pengcheng Liu · Hyun Myung · Han-Lim Choi · Gian-Antonio Susto *Editors*

Advances in Robotics, Automation and Data Analytics

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Preface

The International Conference on Innovative Technology, Engineering and Sciences 2020 (iCITES 2020), is the second edition of the conference series organized by Universiti Malaysia Pahang through its Alumni Society in an effort to promote key innovation in the following overarching themes and individual symposia, i.e. green and frontier materials, innovative robotics and automation, renewable and green energy, sustainable manufacturing as well as data analytics. The conference is aimed at building a platform that allows relevant stakeholders to share and discuss their latest researches, ideas and survey reports from theoretical to practical standpoint of the aforementioned fields.

ICITES2020 received more than 170 submissions. All submissions were reviewed in a single-blind manner, and the best 40 papers recommended by the reviewers are published in this volume. The editors would like to thank all the authors who submitted their papers as the papers are of good quality and represented good progress in industrial and robotic vision, motion control, autonomous mobile robots, intelligent sensors and actuators, multi-sensor fusion, deep learning and approaches and data processing.

The editors also would like to thank Assoc. Prof. Han-Lim Choi, Jamie Steel, Dr. Rabiu Muazu Musa, Dr. Miles Stopher, Assoc. Prof. Dr. Kazem Reza Kashyzadeh, Jee Kwan Ng for delivering their keynote speeches at the conference. They had to bring a new perspective on cutting-edge issues especially in the fields of robotics, automation and data analytics.

The editors hope that readers find this volume informative. We thank Springer for undertaking the publication of this volume. We also would like to thank the conference organization staff and the members of the international program committees for their hard work.

Contents

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Prototype Development of Graphical Pattern Security System on Raspberry Pi

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Abstract. Password is a primary security mechanism that consists of a secret phrase created using alphabetic, numeric, alphanumeric, and symbolic characters, or a combination. It is used to restrict access to a system, application, or service to only those users who have the authorization to use the system or device. Because of increased computing power, modern passwords must be very long and complicated, which will make them hard to remember. Some research studies show that it is easier for people to remember visual passwords instead of textual ones. Therefore, this research aims to enhance the authentication process's security using the graphical pattern unlock approach on Raspberry Pi. The grid size of 5×5 was selected in the implementation, as it provides the tradeoff between security strength and an easy pattern to remember. The proposed system could be connected to the smart home system, which can enhance their security. Prototype validation revealed that the prototype is working as intended, and the authentication process took around 1.2 seconds to complete.

Keywords: smart home, security enhancement, graphical pattern, Raspberry Pi.

1 Introduction

Nowadays, passwords hold a crucial role in our society as they are implemented in many different confidential situations. The passwords have been derived into various approaches like Personal Identification Number (PIN) codes, fingerprints, pattern locks, and passwords with the common goal to protect users' private information. Due to the numerous amounts of sensitive data stored on the devices, the need for security increases, which leads to the authentication process as an essential topic for research. Screen pattern locks are used as a protection mechanism to avoid sensitive information leakage from any device [1].

The graphic pattern is one of the examples of a graphical password mechanism used for an authentication process. A graphic pattern is a pattern that needs to be connected at least four contact points without lifting and avoiding any intermediate points [2]. The pattern itself is in various grid size patterns as 3×3 size with nine nodes inter-

face is commonly used in the different authentication process, i.e., the smartphone's graphical pattern. In [3], if the number of connected nodes must be at least four points, and each node can be touched only once, then the possible pattern is around 38911.

As stated by [4], the length and complexity of one text-based password determine how secure the code is, yet humans have difficulties recalling them. Users tend to select simpler passwords in terms of length, which are in the weak password category, without considering their security. It is also easier for users to remember a graphical approach than a text-based approach like PIN passwords, as described in [5].

One method to improve the security strength of a graphical pattern is by expanding the grid size or increasing the number of contact points [6], using embedded pattern strength [7], changing pattern layout arrangement [5], multi-layered drawing [8], rotation [9], or use a strength meter [10]. Many kinds of research have been conducted on improving the strength of a graphical pattern on a smartphone. However, not much of the research focused on improving a smart home system's security, like [11, 12]. Therefore, this paper aims to develop a fast and accurate graphics pattern recognition system implemented on Raspberry Pi. The target is to be able to validate and authenticate a user within 1 second processing time. Our proposed system's primary input device is an LCD touchscreen that functions as both the input and output at the same time. Moreover, the primary output device is the magnetic lock, which is controlled by Raspberry Pi.

2 Design of Graphical Pattern Security System

2.1 Hardware Design

Raspberry Pi is a single-board computer that can run various operating systems, either Linux or non-Linux based [13]. Examples of Linux-based operating systems are Raspbian, which is the most recommended operating system for Raspberry Pi, Android Things, an embedded version of the Android operating system, and Arch Linux ARM. Meanwhile, an example of non-Linux based operating systems is Windows 10 IoT Core, HelenOS, RISC OS Pi, and Haiku.

Fig. 1 shows the proposed block diagram of the graphical pattern security system using Raspberry Pi. The Raspberry Pi is connected to the LCD touchscreen, which is shown in Fig. 2. Raspberry Pi 3 has a quad-core processor, 1 GB RAM, dan built-in graphics [13]. The relay circuit is connected to Raspberry Pi and provides an interface to the high voltage magnetic lock. The status could be shown using LED indicators or further send messages using an internet connection or as part of a smart home system. Finally, the overall power required, including magnetic lock, is less than 3 A, so that a compact power supply, i.e., a smartphone charger, could be used as the power supply. The LCD touch screen has the function as output as well as input.

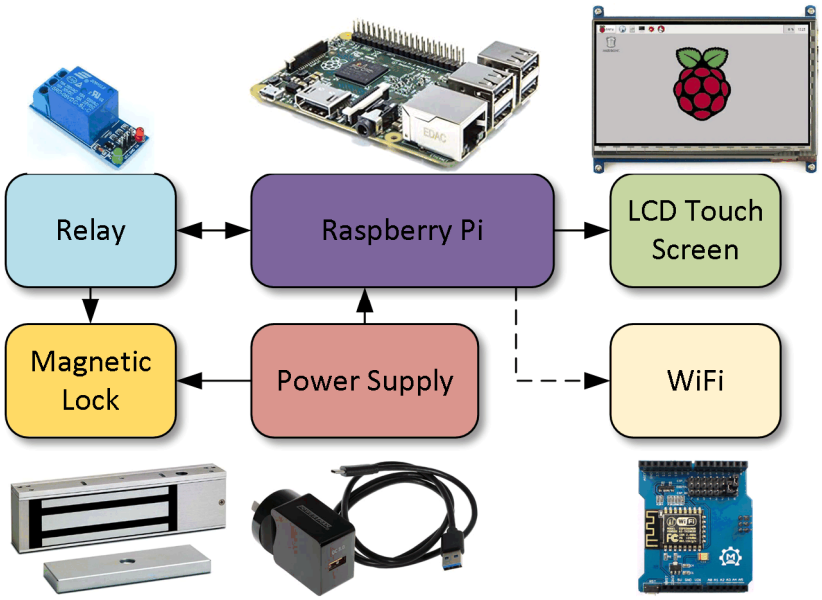


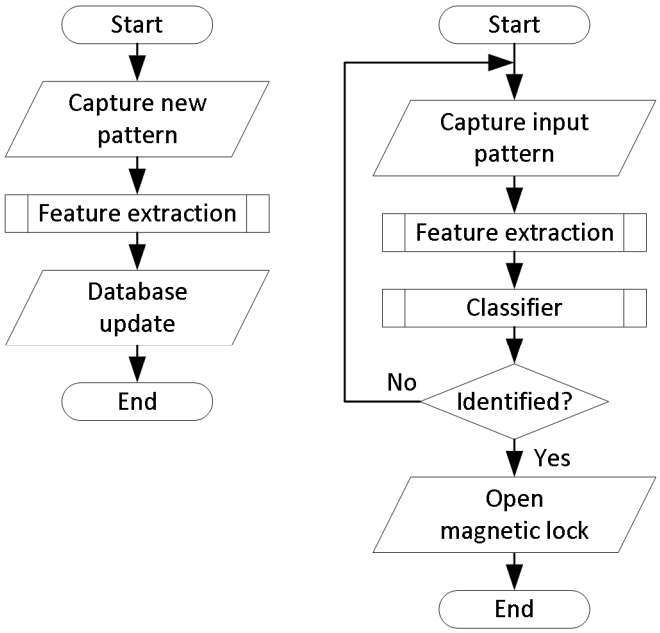
Fig. 1. Block Diagram of the Proposed Hardware

2.2 Software Design

Microsoft Visual Studio is an integrated development environment (IDE) used to develop programs and applications such as web applications and mobile applications. It uses Microsoft software development platforms, i.e., Windows API and Windows Forms. It supports different kinds of programming languages, and it allows users to edit and debug the code. Few examples of built-in language available include C, C#, Visual Basic, .Net, and JavaScript. After developing the program in Visual Studio, it needs to be copied into and run on Raspberry Pi 3. First, the mono repository package needs to be added to the system. As Raspbian Stretch is chosen to be installed for this research; thus, the package repository for Raspbian is added.

There are three central graphical security systems, including feature extraction, classifier, and training database. During the feature extraction phase, the system will extract the input pattern's behavior, i.e., the starting and ending node chosen by the user, the length of the pattern, and the distance between each selected node. Then, the classifier categorizes the complexity of the pattern based on the pattern behavior. The classifier is also used to compare the input pattern with the enrolled pattern in the database. Based on the flow process between the classifier and the database, if the input pattern matches the database's enrolled pattern, the system will send feedback to the decision rule.

Fig. 2 shows the flowchart of user registration, database creation, and login verification. In this research, the graphical approach used to develop the pattern layout is the expanded grid size approach proposed by [6]. The pattern layout is created in a 5×5 grid size.



(a) Registration (b) Authentication

Fig. 2. System Flowchart for Registration and Authentication

3 Implementation

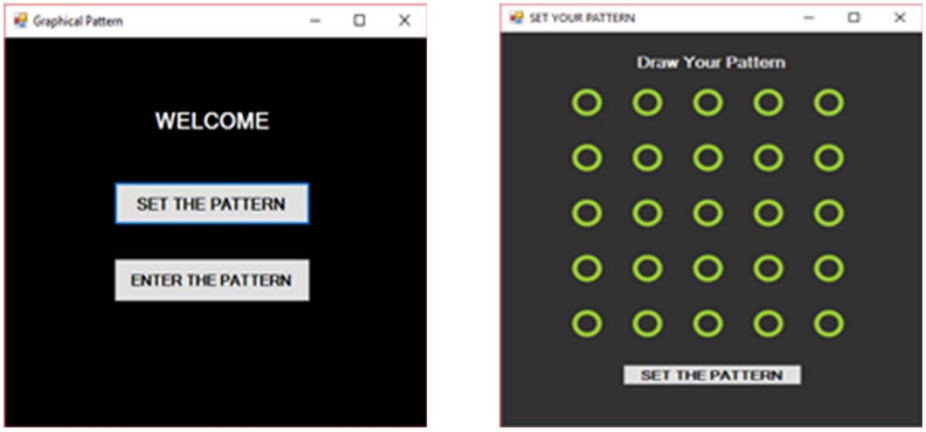
After the codes have been compiled in the Visual Studio, the executable file must be copied into the Raspberry Pi 3. Then, the Mono repository needs to be added to the system. The mono-devel package also needs to be installed in the code compilation system, as shown in Table 1.

Table 1. Installation of Mono Repository on Raspberry Pi 3

```
1 sudo apt install apt-transport-https dirmngr
2 sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --
  recv- keys 3FA7E0328081BFF6A14DA29AA6A19B38D3D831EF
  echo "deb https://download.mono-project.com/repo/debian sta-
  ble-raspbianstretch main" | sudo tee
  /etc/apt/sources.list.d/mono-official-stable.list
3 sudo apt update
4 sudo apt install mono-devel
```

A prototype is needed to test the coding and evaluate the design. The process involved is including software development, which is done by using Microsoft Visual Studio, and hardware development, which uses Raspberry Pi 3 and its components.

C# language is used to code all the instructions, programs, and graphical user interface (GUI).



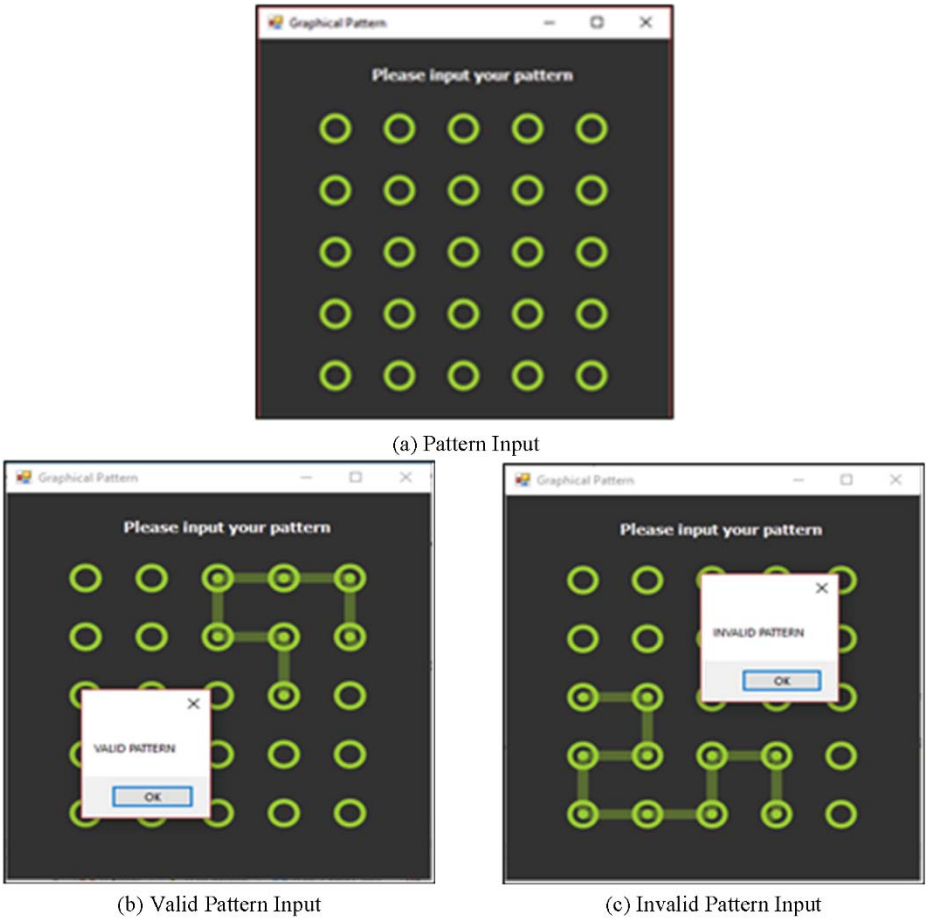
(a) Start Page (b) Pattern Set

Fig. 3. GUI Design for Start Page and Pattern Set Functions

Fig. 3 shows the user interface of the Start Page and Pattern Set functions. The layout pattern is created in the bigger size, i.e., 5×5 grid size. The pattern layout is created in a bigger size as it is one of the security enhancement approaches. As the pattern grid size increases, the number of possible patterns also increases. Hence, there would be a high possibility of the complexity of user-chosen patterns to increase. Some functions have been set on the lock screen pattern to help the user draw a better pattern. For instance, the user cannot create the closed-loop pattern, i.e., the node cannot be contacted more than once.

Moreover, the user is allowed to reverse the gesture while drawing the pattern. This function helps the user to create a better pattern with a better complexity. The coordinates of each node are saved as they will be used during the authentication process. The coordinates of the saved pattern are compared with the coordinates of the inputted pattern.

Fig. 4(a) shows the user interface of the Pattern Input function. During the authentication process, the user authenticates the input pattern with the pattern that has been created earlier. The coordinates of the inputted pattern are recorded and compared with the saved pattern. Next, the Valid Pattern message will be displayed if the coordinates of both patterns match, as shown in Fig. 4(b). Otherwise, the Invalid Pattern message will be displayed, as shown in Fig. 4(c).



(a) Pattern Input

(b) Valid Pattern Input

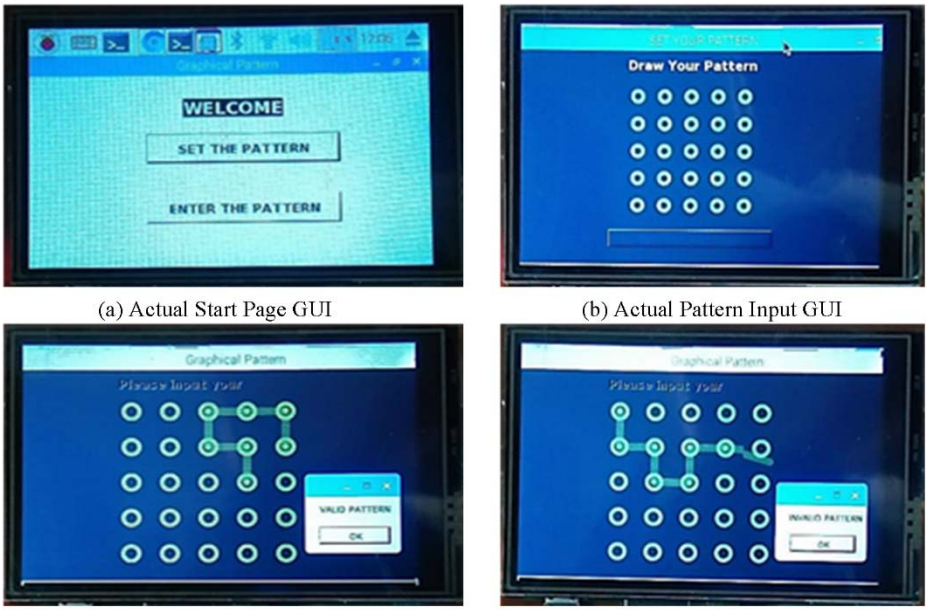
(c) Invalid Pattern Input

Fig. 4. GUI Design for Pattern Input, Valid, and Invalid Pattern Input

4 Prototype Validation

Fig. 5 (a) and (b) shows the actual Start Page and user interface of the Pattern Input function. It is the actual implementation of Fig. 3, previously. Pattern Input will capture and validate the user's graphical pattern password. Several evaluations have been conducted in this phase, in which we found that there is no lagging experienced by the user. The authentication time to authenticate registered users is 1.2 seconds on average when tested in 10 experiments.

Fig. 5 (c) and (d) shows the actual valid and invalid pattern message. It is the actual implementation of Fig. 4, previously. The system will validate the entered pattern to be checked with the database's registered user's pattern. If it is the correct pattern, it will open the magnetic lock. While if it is incorrect, it will provide the user with three more attempts before it triggers the alarm.



(a) Actual Start Page GUI (b) Actual Pattern Input GUI

(c) Actual Valid Pattern Message GUI (d) Actual Invalid Pattern Message GUI

Fig. 5. Actual Prototype GUI

5 Conclusions and Future Works

This paper has presented the development of a graphical pattern security system on Raspberry Pi. First, the hardware and software requirements have been designed so that it can fulfill the specifications. Next, a 5×5 pattern grid was implemented in Raspberry Pi using C#. Results showed that our proposed prototype works as intended with an authentication time around 1.2 seconds on average. Further research can be conducted, including implementation with various pattern grid size, implementation of pattern strength meter, and integration with the smart home system.

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