

Application of Directed Graph as Pattern Lock for Android

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Abstract—Application of directed graph is not only to find the shortest path. Directed graph can be implemented in protection of device. Screen lock which used the concept of directed graph is called pattern lock. Android has developed this method and implement it in several device, especially for touch screen device.

Index Terms—directed graph, pattern lock, Android

I. INTRODUCTION

Protecting an electronic device such as mobile phone and tab, is important. The purpose is to give limit who are allowed to use the device, and keep the device away from stranger. Besides, it also as privacy protection.

There are many ways can be choose to protect our electronic device. This purpose of this protection is to lock the device. So that the device can only used by the owner or someone that allowed to use the device by the owner. It also purposes to keep our privacy from the stranger.

Most devices used password or pin to unlock them. Everytime the user want to unlock the device, he or she should insert some code, it can be numbers (pin) or some letter. If the code is match with the password or pin which is saved by the device as the key. Then, it will be unlock, and the user can use the device.

There are some innovation in device protection. Like face detector, finger print detector and also pattern lock. The last innovation is developed by android for touch screen device. Different with many device protection, pattern lock use graph or pattern instead of codes as the key to unlock the system.

If we observe the concept of pattern lock in Android, we will realize that pattern lock in Android is one of application of graph, especially directed grap.

II. BASE THEORY

A. GRAPHS [1]

We begin with the definition of a graph. A graph $G = (V, E)$ consists of V , a nonempty set of vertices (or nodes) and E , a set of edges. Each edge has either one

or two vertices associated with it, called its endpoints. An edge is said to connect its endpoints.

Graph is divided into five kinds of graphs, they are *simple graph*, *multiple graph*, *pseudo graph*, *directed graph* and *directed multi graph*.

A graph in which each edge connects two different vertices and where no two edges connect the same pair of vertices is called a simple graph. A simple Graph $G = (V, E)$ consist of V , a nonempty set of vertices, and E , a set of unordered pairs of distinct elements of V called edges.

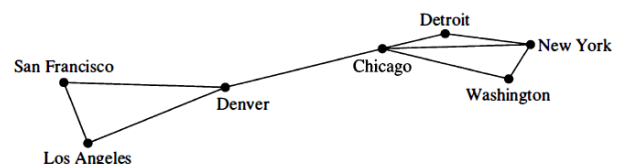


FIGURE 1 A Computer Network.

Graphs that may have multiple edges connecting the same vertices are called multigraphs. A multi graph $G = (V, E)$ consist of a set of V of vertices, a set E of edges, and a function f from E to $\{\{u, v\} \mid u, v \in V, u \neq v\}$. The edges e_1 and e_2 are called multiple or parallel edges if $f(e_1) = f(e_2)$.

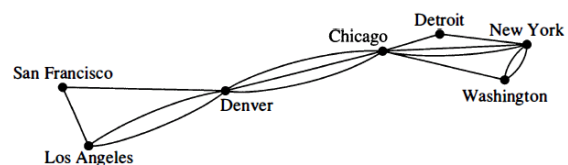


FIGURE 2 A Computer Network with Multiple Links between Data Centers.

Graphs that may include loops, and possibly multiple edges connecting the same pair of vertices, are sometimes called pseudographs.

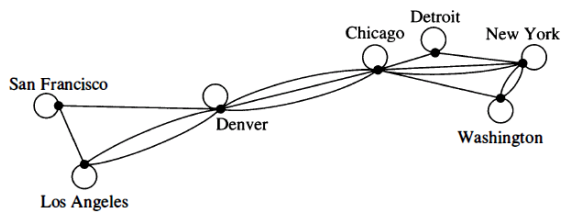


FIGURE 3 A Computer Network with Diagnostic Links.

Directed graph (V, E) consist of a set of vertices V and a set of edges E that are ordered pairs of element V .

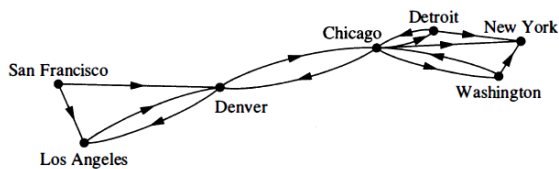


FIGURE 4 A Communications Network with One-Way Communications Links.

Directed graphs that may have multiple directed edges from a vertex to a second (possibly the same) vertex are used to model such networks. We called such graphs directed multigraphs. When there are m directed edges, each associated to an ordered pair of vertices (u, v) , we say that (u, v) is an edge of multiplicity m .

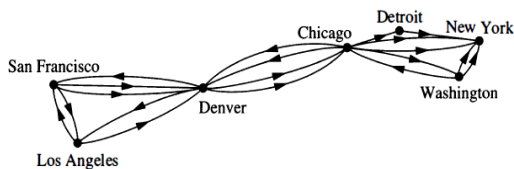


FIGURE 5 A Computer Network with Multiple One-Way Links.

A graph usually have path. a path is a sequence of edges that begins at a vertex of a graph and travels from vertex to vertex along edges of the graph. A path is build by the connection between each edge on the graph.

An undirected graph is called connected if there is a path between every pair of distinct vertices of the graph. While in directed graphs, there are two notions of connectedness in directed graphs depend on whether the directions of the edges are considered. A directed graph is strongly connected if there is a path from a to b and from b to a whenever a and b are vertices in the graph. It is unilateral connected if

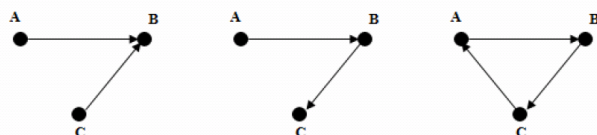


Figure 6 direction graph weakly connected, unilateral connected and strongly connected. [2]

B. TYPES OF LOCK

1. Pin
This types ask the user to give some digits of numbers and save it as the key to unlock the device.
2. Password
Identical to the concept of pin. Password also ask the user to type some letters, numbers and punctuation mark as the key to unlock the device. Password give more protection than pin. Because pin is combination of 10 element (1, 2, 3, 4, 5, 6, 7, 8, 9, 0). While password has more than ten element, and could be Case Sensitive.
3. Face Detector
This lock is used in some laptops. It detect the face of user. If it is match with the picture which had been saved before, it will unlock the device.
4. Fingerprint Detector
This lock is used in some laptops. It needs additional hardware and software which can detect and save fingerprint. Then match it everytime somebody want to unlock the device.
5. Pattern Lock
While the key to unlock pin and password are insert some code (numbers/letters), pattern lock use graph as the key to unlock its protection. It saves the pattern/graph, then match it with the graph drawn by the user to unlock it.

III. DIRECTED GRAPH IN ANDROID PATTERN LOCK

Pattern lock developed in Android used the concept of directed graph instead of simple graph and directed multi graph. It used only one directed. Theres nine edges which can be connected to make a pattern in directed graph (see figure 7).

Pattern lock does not allow null graph or graph without any side. It allows alone edge, which makes us don't have to use all the edge to make a pattern key. It means, the most weak pattern key is by connecting two edges in the screen.

The connection between each edge in pattern is a unilateral conneted, so yhe last edge never connected to another edge. It means, the pattern never be a circuit and there's one edge that didn't have a direction if we use all the edge as pattern key. (see figure 8).



Figure 7. The appearance of pattern lock. [3]

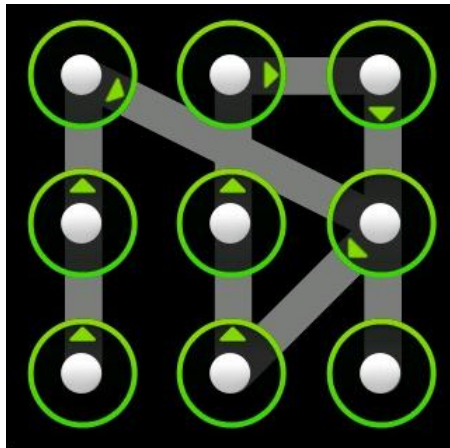


Figure 8. Sample of directed graph we can make to lock our device [3]

Pattern lock Using directed graph means that the same pattern if the ordered is not the same, will not recognize as the same graph. If the pattern and its sequence didn't match with the directed graph which saved as a key.

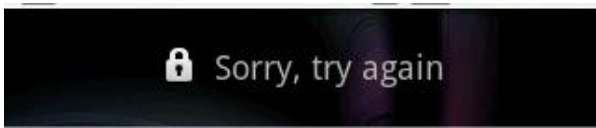


Figure 9. Warning, if the pattern didn't match the key pattern [4]

Theres an emergency call button if we are in emergency, doesn't have much time to draw pattern. If we tap this button, we can make an emergency call. This is button only allow us to call emergency number like 911 in united states, or 112 in Indonesia.

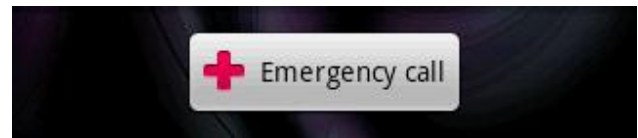


Figure 10. Emergency call button [4]

User can only try to draw the pattern five times. If after the fifth, she or he still can't draw the right pattern. The device will delay 30 second. During this, we can't draw any pattern. The screen appearance will be different than before, because there is "forgot pattern?" button beside emergency call button. If we tap this button, the device will ask us to insert some identity, it can be our email and the password.

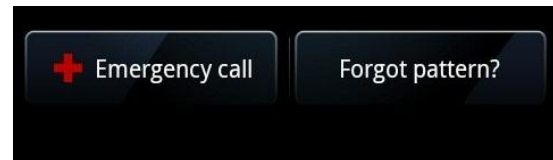


Figure 11. Forgot pattern button after five times pattern mismatch [5]

Figure 12. Account unlock if we forgot pattern [5]

IV. THE EXCESS AND THE LACK OF PATTERN LOCK

There are many good aspect which make pattern lock is better than another lock system. The using of directed graph means that the same pattern if the ordered is not the same, will not recognize as the same graph. It makes the possibility of stranger to know the pattern is smaller.

Pattern lock is very suitable used in touch screen device if we compare with another lock system. Password and pin will take a lot of time. Because it is more difficult

to type some numbers or some letters using touchscreen device. Another lock like finger print is not effective. Because, we need to add hardware or software that can recognize and save finger print.

The difficulties in drawing pattern to unlock this protection system is depend on the screen sensitivity. This is the lack of pattern lock. If the screen sensitivity is low, it will take much time just to unlock simple pattern. And a lot of time to unlock a complex pattern.

But this lack, doesn't decrease the goodness of pattern lock system. Because pattern lock offer the strenght protection than another lock system like pin or password.

V. CONCLUSION

A directed graph is a better innovation to protect touchscreen device. Because, it's not only save pattern as the key to unlock this system, but also see the directed of the pattern.

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PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

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