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| University of Missouri – St. Louis |
| **Beyond Fobs: A Secure QR Code-Based Access System** |
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## Abstract

In this project, I propose a secure QR code authentication system that enhances traditional authentication methods.

While QR codes are widely used for authentication, conventional systems simply attempt to match a displayed QR code to a database. In the best case, these standard QR code detection methods are simply unreliable in challenging environments such as in low-light conditions with user-induced motion blur. In the worst case, standard QR code detection methods are subject to cybersecurity threats.

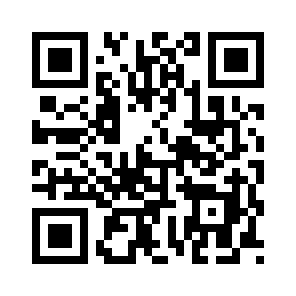
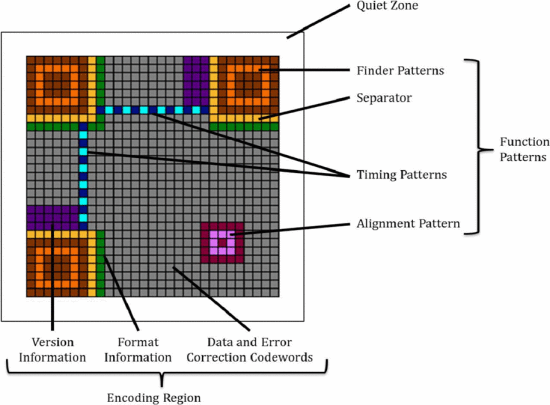
To address these issues, this project integrates two key components: (1) Enhanced QR code detection using adaptive thresholding, homography transformations, and deblurring techniques to improve robustness in real-world conditions; and (2) A time-based system that ensures QR codes dynamically refresh to prevent reuse or replay.

This approach provides a secure and user-friendly authentication solution that can be deployed in various environments, offering improved protection while maintaining ease of use.

## Introduction

### Background on QR Codes

“Quick Response” codes, otherwise known as “QR” codes, give users a two-dimensional matrix of white and black pixels (*Figure*). These codes – unlike more standardized one-dimensional barcodes – are capable of storing large amounts of data, offer a much faster recognition, and can be read omni-directionally.

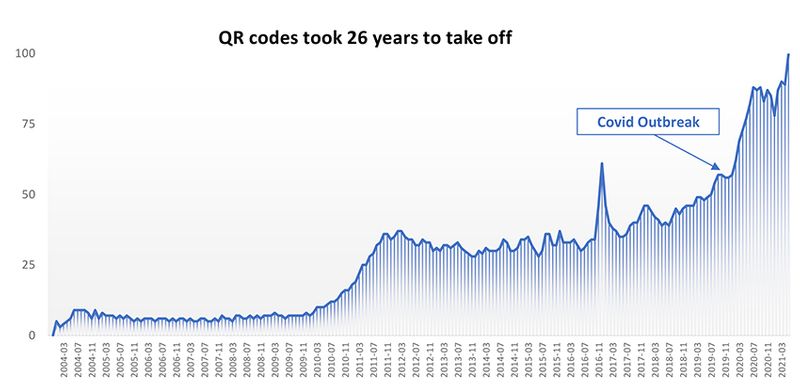
QR code functionality is simple, but highly effective. These codes contain four types of patterns, giving it structural integrity and enabling accurate data retrieval [1]. The *finder pattern* encompasses three of the four corners of the QR code and correctly orients the decoder with its perfect ratio of a 7 x 7 outer dark square, 5 x 5 inner light square, and 3 x 3 inner dark square. *Separators* encompass the white space around each finder pattern. The *timing patterns* are alternating black and white pixels that form horizontal and vertical lines in 6th row and 6th column, respectively, to ensure proper alignment. Finally, *alignment patterns* consist of a 5 x 5 dark module surrounding a 3 x 3 light module, and 1 pixel dark module. See *Figure* for a visual description [1]. These patterns distinguish QR codes from other encoding methods.

### The Rising Popularity of QR Codes

The four patterns and the two-dimensional structure previously introduced allow QR codes ability to store much more data than a traditional bar code.

**Reed-Solomon Error Correction**

While QR codes were created in 1994 as a means of tracking inventory, they become much more popular with the increasing use of smartphones.



### Problem Statement

What issues exist with current QR code authentication methods?

* Low-light
* Motion blur
* Sharing a QR code

### Objective

A QR code detection system that resolves issues in detection and security.

## Literature Review

### Techniques in QR-Based Authentication

What approaches have been attempted? What were the results?

### Security Vulnerabilities in QR-Based Authentication

What approaches have been attempted? What were the results?

### Time-Based Authentication with QR Codes

What approaches have been attempted? What were the results?

## Methodology and Implementation

### System Overview

High level description of the approach with a flowchart.

### Technologies Used

What were all the technologies used?

### Enhanced QR Code Detection

#### Adaptive Thresholding

Text here.

#### Homography Transformations

Text here.

#### Deblurring Techniques

Text here.

### Time-Based QR Code Refresh System

Talk about the implementation of dynamic QR codes that prevent reuse or replay.

### Challenges and Solutions

What sorts of issues arose and how were they solved?

## Experimental Results and Evaluation

### Test Setup

How did I test my system, including what dataset and parameters?

### Performance Analysis

How well did the system hold up?

### Security Analysis

How well did the system hold up?

### User Experience

How well did the system hold up?

## Discussion

How should the results be interpreted?

## Conclusion

Summary of key findings and final remarks.

## Works Cited

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| [1] | S. Tiwari, An Introduction to QR Code Technology, Bhubaneswar: 2016 International Conference on Information Technology (ICIT), 2016, pp. 39-44. |