

code to parse qrcode using zxing-cpp with best preprocessing and without opencv

Certainly! To parse QR codes using the ZXing-C++ library without relying on OpenCV, you typically need to:

1. Load the image.
2. Preprocess the image (adjust brightness/contrast, apply thresholds, etc.).
3. Decode the QR code.

Below is a general structure in C++ using ZXing-C++ library for QR code parsing.

First, ensure you have ZXing-C++ installed. You can find the instructions on their [GitHub page](#).

Here's a simple example code:

```
#include <iostream>
#include <fstream>
#include <vector>
#include <zxing/common/Counted.h>
#include <zxing/Bitmap.h>
#include <zxing/DecodeHints.h>
#include <zxing/MultiFormatReader.h>
#include <zxing/common/GlobalHistogramBinarizer.h>
#include <zxing/Exception.h>
#include <zxing/ReaderException.h>

using namespace std;
using namespace zxing;
using namespace zxing::multi;

vector<char> readFile(const string& filePath) {
    ifstream file(filePath, ios::binary);
    return vector<char>((istreambuf_iterator<char>(file)),
        istreambuf_iterator<char>());
}

int main(int argc, char *argv[]) {
    if (argc < 2) {
        cerr << "Usage: " << argv[0] << " <path-to-qr-code-image>" << endl;
    }
}
```

```

        return 1;
    }

    string filePath = argv[1];
    vector<char> imgData = readFile(filePath);
    if (imgData.empty()) {
        cerr << "Error reading file: " << filePath << endl;
        return 1;
    }

    try {
        Ref<LuminanceSource> source(new GreyscaleLuminanceSource(
            reinterpret_cast<const unsigned char*>(&imgData[0]), imgData.size(),
            imgData.size(), 1));

        Ref<Binarizer> binarizer(new GlobalHistogramBinarizer(source));
        Ref<BinaryBitmap> binary(new BinaryBitmap(binarizer));

        DecodeHints hints(DecodeHints::DEFAULT_HINT);
        MultiFormatReader reader;

        Ref<Result> result(reader.decode(binary, hints));
        cout << "QR Code Text: " << result->getText()->getText() << endl;
    } catch (const ReaderException& e) {
        cerr << "Failed to decode QR code: " << e.what() << endl;
    } catch (const zxing::Exception& e) {
        cerr << "ZXing error: " << e.what() << endl;
    } catch (const exception& e) {
        cerr << "Error: " << e.what() << endl;
    }

    return 0;
}

```

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Key Points:

1. **Reading Image:** The `readFile` function reads the entire image into memory. You might want to implement your own image loading mechanism suited for your needs.
2. **GreyscaleLuminanceSource:** Being used here to convert the image to greyscale. Ensure the image is in the correct format.
3. **GlobalHistogramBinarizer:** Used to binarize the greyscale image.
4. **MultiFormatReader:** Reader to decode the QR code from the binary image.
5. **Error Handling:** Basic error handling is done in the catch blocks.

This example lacks sophisticated image preprocessing. Depending on the image quality, you might need custom image operations (e.g., resizing, noise reduction), and you could add your own preprocessing steps before creating `LuminanceSource`.

Would you like to dive deeper into specific preprocessing techniques or further details on ZXing-C++? Let me know!

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Yes. please let me dive further details

Certainly! Let's go a bit deeper into specific preprocessing techniques and optimizations for better QR code parsing. I'll break it down into manageable sections.

1. Image Loading:

First, you'll need to load the image. Without using OpenCV, libraries like `STB Image` or `libpng` could be useful for handling image files. Here's an example using `STB Image`:

```
#define STB_IMAGE_IMPLEMENTATION
#include "stb_image.h"

#include <iostream>
#include <vector>
#include <zxing/common/Counted.h>
#include <zxing/LuminanceSource.h>
#include <zxing/BinaryBitmap.h>
#include <zxing/DecodeHints.h>
#include <zxing/MultiFormatReader.h>
#include <zxing/common/GlobalHistogramBinarizer.h>
#include <zxing/Exception.h>
```

```

#include <zxing/ReaderException.h>
#include <zxing/Result.h>

using namespace std;
using namespace zxing;
using namespace zxing::multi;

vector<unsigned char> preprocessImage(const unsigned char* imageData, int width,
int height, int channels) {
    vector<unsigned char> greyData(width * height);
    for (int i = 0; i < width * height; ++i) {
        int offset = i * channels;
        // Simple grayscale conversion
        greyData[i] = static_cast<unsigned char>(0.299f * imageData[offset] +
                                                    0.587f * imageData[offset + 1] +
                                                    0.114f * imageData[offset + 2]);
    }
    return greyData;
}

class CustomLuminanceSource : public LuminanceSource {
private:
    vector<unsigned char> luminances_;
    int width_;
    int height_;

public:
    CustomLuminanceSource(const unsigned char* data, int width, int height)
        : LuminanceSource(width, height), luminances_(data, data + width*height),
width_(width), height_(height) {}

    ArrayRef<char> getRow(int y, ArrayRef<char> row) const override {
        if (row->size() != width_) {
            row.reset(ArrayRef<char>(width_));
        }
        memcpy(&row[0], &luminances_[y * width_], width_);
        return row;
    }

```

```

    }

    ArrayRef<char> getMatrix() const override {
        ArrayRef<char> matrix(width_ * height_);
        memcpy(&matrix[0], &luminances_[0], width_ * height_);
        return matrix;
    }
};

int main(int argc, char *argv[]) {
    if (argc < 2) {
        cerr << "Usage: " << argv[0] << " <path-to-qr-code-image>" << endl;
        return 1;
    }

    int width, height, channels;
    unsigned char* imageData = stbi_load(argv[1], &width, &height, &channels, 0);
    if (imageData == nullptr) {
        cerr << "Error loading image: " << argv[1] << endl;
        return 1;
    }

    vector<unsigned char> greyData = preprocessImage(imageData, width, height,
channels);
    stbi_image_free(imageData); // Don't forget to free the image memory

    try {
        Ref<LuminanceSource> source(new CustomLuminanceSource(&greyData[0], width,
height));
        Ref<Binarizer> binarizer(new GlobalHistogramBinarizer(source));
        Ref<BinaryBitmap> binary(new BinaryBitmap(binarizer));

        DecodeHints hints(DecodeHints::DEFAULT_HINT);
        MultiFormatReader reader;

        Ref<Result> result(reader.decode(binary, hints));
        cout << "QR Code Text: " << result->getText()->getText() << endl;
    }
}

```

```

    } catch (const ReaderException& e) {
        cerr << "Failed to decode QR code: " << e.what() << endl;
    } catch (const zxing::Exception& e) {
        cerr << "ZXing error: " << e.what() << endl;
    } catch (const exception& e) {
        cerr << "Error: " << e.what() << endl;
    }

    return 0;
}

```

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2. Preprocessing:

Preprocessing can dramatically improve QR code recognition, especially on noisy images. Here are some steps:

- **Grayscale Conversion:** Convert your image to grayscale as shown in `preprocessImage`. It simplifies further processing.
- **Thresholding/Binarization:** Convert the grayscale image to a binary image using techniques like Otsu's method or adaptive thresholding.

3. Custom LuminanceSource:

For better control, I've created a custom implementation of `LuminanceSource`. This allows us to use our preprocessed image data

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Certainly! Let's continue from where we left off and delve into more preprocessing details and how to implement them in your C++ code.

Further Preprocessing Techniques:

1. **Thresholding:** This can help in converting a grayscale image to a binary image, which is often required for better QR code detection. While the `GlobalHistogramBinarizer` does some of this for you, you might want to consider custom solutions if it's not performing well enough.

2. **Noise Reduction:** Apply noise reduction algorithms like median filtering to remove small artifacts in the image which might interfere with QR code detection.

Here's an example of how you might implement thresholding and noise reduction:

```
#include <numeric>
#include <algorithm>

// Median Filter for noise reduction
void medianFilter(vector<unsigned char>& data, int width, int height) {
    vector<unsigned char> filteredData = data;
    const int windowSize = 3;
    const int kernelSize = windowSize * windowSize;
    const int edge = windowSize / 2;

    for (int y = edge; y < height - edge; ++y) {
        for (int x = edge; x < width - edge; ++x) {
            vector<unsigned char> window;
            for (int ky = 0; ky < windowSize; ++ky) {
                for (int kx = 0; kx < windowSize; ++kx) {
                    window.push_back(data[(y + ky - edge) * width + (x + kx - edge)]);
                }
            }
            std::nth_element(window.begin(), window.begin() + kernelSize / 2, window.end());
            filteredData[y * width + x] = window[kernelSize / 2];
        }
    }
    data = filteredData;
}

// Otsu's Thresholding
unsigned char otsuThreshold(const vector<unsigned char>& data, int width, int height) {
    int hist[256] = {0};
    for (unsigned char pixel : data) {
        hist[pixel]++;
    }
}
```

```

    }

    int total = width * height;
    int sumB = 0, wB = 0;
    float maxVar = 0;
    unsigned char threshold = 0;

    int sum1 = 0;
    for (int i = 0; i < 256; i++) sum1 += i * hist[i];

    for (int i = 0; i < 256; i++) {
        wB += hist[i];
        if (wB == 0) continue;

        int wF = total - wB;
        if (wF == 0) break;

        sumB += i * hist[i];
        float mB = static_cast<float>(sumB) / wB;
        float mF = static_cast<float>(sum1 - sumB) / wF;

        float varBetween = static_cast<float>(wB * wF) * (mB - mF) * (mB - mF);
        if (varBetween > maxVar) {
            maxVar = varBetween;
            threshold = i;
        }
    }
    return threshold;
}

void applyThreshold(vector<unsigned char>& data, int width, int height) {
    unsigned char threshold = otsuThreshold(data, width, height);
    for (size_t i = 0; i < data.size(); ++i) {
        data[i] = (data[i] > threshold) ? 255 : 0;
    }
}

```


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Integrating Preprocessing with QR Code Parsing:

Here's how you would integrate these preprocessing steps into the main image loading and QR code parsing flow:

```
int main(int argc, char *argv[]) {
    if (argc < 2) {
        cerr << "Usage: " << argv[0] << " <path-to-qrcode-image>" << endl;
        return 1;
    }

    int width, height, channels;
    unsigned char* imageData = stbi_load(argv[1], &width, &height, &channels, 0);
    if (imageData == nullptr) {
        cerr << "Error loading image: " << argv[1] << endl;
        return 1;
    }

    vector<unsigned char> greyData = preprocessImage(imageData, width, height,
channels);
    stbi_image_free(imageData);

    medianFilter(greyData, width, height); // Apply noise reduction
    applyThreshold(greyData, width, height); // Apply thresholding

    try {
        Ref<LuminanceSource> source(new CustomLuminanceSource(&greyData[0], width,
height));
        Ref<Binarizer> binarizer(new GlobalHistogramBinarizer(source));
        Ref<BinaryBitmap> binary(new BinaryBitmap(binarizer));

        DecodeHints hints
```

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Certainly! Here's the continuation of the code:

```
DecodeHints hints(DecodeHints::DEFAULT_HINT);
MultiFormatReader reader;

Ref<Result> result(reader.decode(binary, hints));
cout << "QR Code Text: " << result->getText()->getText() << endl;
} catch (const ReaderException& e) {
    cerr << "Failed to decode QR code: " << e.what() << endl;
} catch (const zxing::Exception& e) {
    cerr << "ZXing error: " << e.what() << endl;
} catch (const exception& e) {
    cerr << "Error: " << e.what() << endl;
}

return 0;
}
```

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Explanation of the Code:

1. Image Loading:

2. `unsigned char* imageData = stbi_load(argv[1], &width, &height, &channels, 0);`
3. `if (imageData == nullptr) {`
4. `cerr << "Error loading image: " << argv[1] << endl;`
5. `return 1;`
6. `}`

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7. Preprocessing:

- o Convert image data to grayscale:
- o `vector<unsigned char> greyData = preprocessImage(imageData, width, height, channels);`

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- Free the original image data since it's now in `greyData` and we no longer need the raw image data:
- `stbi_image_free(imageData);`

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- Apply noise reduction using a median filter:
- `medianFilter(greyData, width, height);`

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- Apply Otsu's thresholding to binarize the image:
- `applyThreshold(greyData, width, height);`

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8. Custom LuminanceSource:

- Use `CustomLuminanceSource` to wrap the preprocessed image data:
- `Ref<LuminanceSource> source(new CustomLuminanceSource(&greyData[0], width, height));`

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9. Binarization and QR Code Decoding:

- Create a `GlobalHistogramBinarizer` from the `LuminanceSource`:
- `Ref<Binarizer> binarizer(new GlobalHistogramBinarizer(source));`

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- Wrap the binarizer result into a `BinaryBitmap`:
- `Ref<BinaryBitmap> binary(new BinaryBitmap(binarizer));`

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- Set decode hints, if any. Here, default hints are set:
- `DecodeHints hints(DecodeHints::DEFAULT_HINT);`

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- Initialize a `MultiFormatReader` and decode the QR code:
- `MultiFormatReader reader;`
- `Ref<Result> result(reader.decode(binary, hints));`

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10. Error Handling:

- Handle different potential exceptions to ensure the program exits gracefully if something goes wrong:
- `catch (const ReaderException& e) { cerr << "Failed to decode QR code: " << e.what() << endl; }`
- `catch (const zxing::Exception& e) { cerr << "ZXing error: " << e.what() << endl; }`
- `catch (const exception& e) { cerr << "Error: " << e.what() << endl; }`

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Testing and Optimization:

- **Test with Different Images:** Ensure to test with a variety of QR code images to validate robustness.
- **Fine-Tuning:** Depending on the quality and nature of your QR code images, you might need to tweak the preprocessing parameters such as filter window size and thresholding technique.
- **Logging and Debugging:** Add logging or debugging statements to better understand where the process might be failing, especially with images that do not get decoded correctly.

This complete example should give you a solid foundation for reading and preprocessing QR code images without relying on OpenCV, but leveraging the power of ZXing-C++.

If you have any other questions about specific parts of the process or need further assistance, feel free to ask!