Faculty of Engineering

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CSE-483 Computer Vision

Milestone 2

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Contents

1. Barcode Decoding

a) Binary Conversion

- Converts the processed barcode region into a binary representation.
- Column-wise thresholding ensures consistent interpretation of black (1) and white (0).

b) Dynamic Narrow/Wide Bar Detection

- Automatically identify narrow and wide bar sizes based on detected patterns.
- Handles irregularities in barcode widths.

c) Mapping to Code 11 Encoding

- Matches binary patterns to predefined Code 11-character mappings.
- Returns the decoded string as the output.

ASCII CHARACTER	WIDTH ENCODING	BARCODE ENCODING
0	00001	101011
1	10001	1101011
2	01001	1001011
3	11000	1100101
4	00101	1011011
5	10100	1101101
6	01100	1001101
7	00011	1010011
8	10010	1101001
9	10000	110101
- (Dash)	00100	101101
Start/Stop	00110	1011001

2. Barcode Encoding

a) Encoding a Symbol

each character is converted into a series of narrow (0) and wide (1) bars and spaces, as specified by the encoding column.

- Number “1” represents a “dark” or “bar” section of the bar code.
- Number “0” represents a “Light” or “space” section of the bar code.
- Numbers “1””1” represent a wide bar as shown in the figure.
- The number “0” represents a single wide space

b) Components of Code 11 Barcode

- start/Stop Character: Every Code 11 barcode starts and ends with a special Start/Stop character, represented as 1011001 in Barcode Encoding.
- Data Characters: Encoded numeric characters (0-9) and the dash (-) symbol, using the Barcode Encoding from the table.
- Optional check digits:
    1) C check digit: recommended for all barcodes to ensure integrity
    2) K check digit: user for barcodes longer than 10 characters for further validation
- The bar code is concluded with the same start/stop character.

C) Notes about Encoding

- A narrow space (light) is automatically appended between each character to ensure proper separation
- Characters like 0,9 and – use 6 elements (3 bars and 2 spaces), while others use 7.

3. Decoder Code

-The function is designed to process and input image and decode a code 11 barcode from it.

```
def decode(out):
    # 0 means narrow, 1 means wide
    NARROW = "0"
    WIDE = "1"
    code11_widths = {
        "00110": "Stop/Start",
        "10001": "1",
        "01001": "2",
        "11000": "3",
        "00101": "4",
        "10100": "5",
        "01100": "6",
        "00011": "7",
        "10010": "8",
        "10000": "9",
        "00001": "0",
        "00100": "-",
    }

    # Get the average of each column in your image
    mean = out.mean(axis=0)

    # Set it to black or white based on its value
    mean[mean <= 127] = 1
    mean[mean > 128] = 0

    # Convert to string of pixels in order to loop over it
    pixels = ''.join(mean.astype(np.uint8).astype(str))
```

-We define a narrow and wide strings and as mentioned before “0” is a narrow bar while ”1” is a wide bar.

-We then make a dictionary mapping for specific binary patterns that correspond to code specific characters in the code 11 barcode standard.

-then we calculate the mean of each column in the input image and after that we convert the mean array into binary values.

Values<=127 become 1

Values>128 become 0

- we convert the binarized column array into a string of 1s and 0s to simplify the process of parsing the barcode

```
    # Get the average of each column in your image
    mean = out.mean(axis=0)

    # Set it to black or white based on its value
    mean[mean <= 127] = 1
    mean[mean > 128] = 0

    # Convert to string of pixels in order to loop over it
    pixels = ''.join(mean.astype(np.uint8).astype(str))

    # Need to figure out how many pixels represent a narrow bar
    narrow_bar_size = 0
    for pixel in pixels:
        if pixel == "1":
            narrow_bar_size += 1
        else:
            break

    wide_bar_size = narrow_bar_size * 2

    #print(f"narrow: {narrow_bar_size}, wide: {wide_bar_size}")

    #print(mean)
```

- then we count the consecutive 1s at the beginning of the barcode to determine the width of the narrow bar

- we calculate the width of the wide bar code and the rule used is according to the barcode standards.

```
digits = []
pixel_index = 0
current_digit_widths = ""
skip_next = False

pixels = pixels.lstrip('0')

while pixel_index < len(pixels):

    if skip_next:
        pixel_index += narrow_bar_size
        skip_next = False
        continue

    count = 1
    try:
        while pixels[pixel_index] == pixels[pixel_index + 1]:
            count += 1
            pixel_index += 1
    except:
        pass
    pixel_index += 1

    tolerance = narrow_bar_size // 2

    current_digit_widths += NARROW if narrow_bar_size - tolerance <= count <= narrow_bar_size + tolerance else WIDE

    if current_digit_widths in code11_widths:
        digits.append(code11_widths[current_digit_widths])
        current_digit_widths = ""
        skip_next = True  # Next iteration will be a separator, so skip it

print(digits)
```

- digits stores the dcoded symbols

- pixel_index is used to track the current position of the pixel's string

- current_digit_widths stores the patter of the bar widths that is being decoded

- skip_next is a flag to skip the separator bars

-the lstrip method is a built in method that removes the specified characters from the beginning of the string and in our case it removes the '0' character

- we then enter the **decoding loop** where :

1) we iterate over the pixels string to decode each character.

2) if the flag is true, we increment the pixel_index by the value of the narrow_bar_size to skip over those sigmnets

3) we set our flag to false then skip the rest of the loop

- if our flag was false we skip the if condition then we :

1. Count the number of consecutive pixels the have the same value
2. An except is used to handle out of bound issue

-we calculate tolerance, but why ?

- We calculate it to avoid incorrect classification due to the small variations in the bar width so It helps us get the proper classification of whether the bar is narrow or wide.

- tolerance is half of the narrow bar so that it creates for us a range in which the bar width is still conisdered narrow

- the condition then checks if the count is within the specified range. If it is we consider the bar narrow otherwise the bar is considered wide

- then we append the corresponding symbol to the current_digits_widths.

- then we do pattern matching:

1. We check if the bar width matches a key in the dictionary we defined earlier then the corresponding cahracter is added to the digits list.
2. Then we reset the width and skip the next bar spearation

- Finally, we output the decoded barcode as a list of symbols

Other functions

```python
def get_thresh_value(img): #not used
    hist = cv2.calcHist([img], [0], None, [256], [0, 256])
    peaks = np.argsort(hist.flatten())[-2:]
    thresh_value = (peaks[0]+peaks[1])/2

    _, thresholded = cv2.threshold(img, thresh_value+5, 255, cv2.THRESH_BINARY)
    plt.figure()
    plt.plot(hist)
    plt.scatter(peaks, hist[peaks], color='r', label='Peaks')
    plt.title("Histogram with Peaks")
    plt.legend()
    plt.show()
    return thresholded#, thresh_value
```

- this function is used for image thresholding and and binarizing an image

- it takes an image as an input

- then it calculates the histogram of the image where :

  - [0] : indicates grey scale channel
  - None: means that no mask is applied
  - [256]: max intensity of histogram (0 →255)
  - [0,256]: the range of intensity values that we conider

- the output hist is a 256x1 array where each element corresponds to a frequency of particular intenisty

- then we flaten the histogram into a 1D array using the .flatten() function.

- we use np.argsort to get the indices of the element of the histogram in ascending order

- [-2:] this is to select the higesht 2 peaks in the histogram

- then we apply binary thresholding to the image

- then we start with the plots

- at the end we return the thresholded binary image.

```python
def detect_contrast(image): #not used

    mean, stddev = cv2.meanStdDev(image)

    mean = mean[0][0]
    stddev = stddev[0][0]

    print(f"Mean intensity: {mean}")
    print(f"Standard Deviation: {stddev}")

    contrast_ratio = stddev / mean

    print(f"Contrast Ratio (stddev / mean): {contrast_ratio}")

    if contrast_ratio < 0.1:  # Example threshold for low contrast
        print("The image has low contrast.")
        return True  # Low contrast
    else:
        print("The image has sufficient contrast.")
        return False  # High contrast
```

- the function is used in contrast detection as it analayzes the it by computing the standard deviation and the mean intesnit of the pixels. Then we use the ratio of these values to determine whether the image has low contrast or sufficient contrast and return a boolean value in each case

- we use the function meanStdDev() to compute the mean and standard deviation of the image and return them as single element arrays

- then we extract the values and print them.

- the conrast ratio is calculated by deviding the standard deviation and the mean, it gives us a measure of how the pixels intensity are distributed across the image

- we assigned a thershold which if the contrast_ratio is smaller than , then we consider it low contrast

- then we print that our image is low contrast and return a boolean value true

- if the ratio was greater than the threshold then the image is of sufficient contrsat and we return false.

```python
def fix_contrast(gray): #not used

    min_intensity = np.min(gray)
    max_intensity = np.max(gray)

    stretched_image = (gray - min_intensity) * (255 / (max_intensity - min_intensity))

    return stretched_image.astype(np.uint8)
```

- we use this function to improve the contrast of our grayscale image to make sure that the pixels are scaled proporitonally.

- we are using the np.min() function to identify the darkest pixel in the image which we will lates use in normalization

- then we repeat the same step but with np.max() to identify the brightest pixel.

- after that we do contrast stretching :

- We subtract the minimum intesnity from each pixel so we shift the range so the minimum becomes 0
- (max_intensity- min_intesnity) calculates the original range of pixels
- We then divide 255 over (max_intensity- min_intesnity) to get a scaling factor to map the normalization range to 0-255
- Then we multiply the normalized values and the scaling factor to stretch the intensity range to span from 0 to 255
- The stretched_image is an array that contains the adjusted pixel intesntiteis.

- then we convert the pixel intesnity values to 8-bit unsigend integers (0→255) whis is the standar format of grey scale image.

-we return the image that now has enhanced contrast

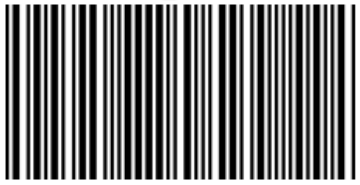
4. Test Cases

Test Case 1:

```
Test Case 1
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 447
Salt and Pepper approximate percentage: 0.093125 %
Distance between barcode bars: 8
```

Test Case

final_result



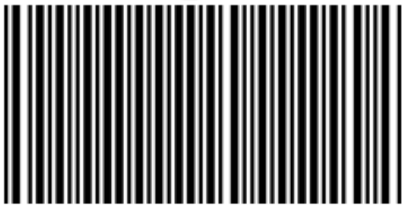
```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '1', '2', '3', '4', '5', '6', '7', '8', '9', '0', '-', 'Stop/Start']
Correct code:
['Stop/Start', '1', '2', '3', '4', '5', '6', '7', '8', '9', '0', '-', 'Stop/Start']
********************************************************************************
```

Test Case 2:

```
Test Case 2
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 349
Salt and Pepper approximate percentage: 0.07270833333333333 %
Distance between barcode bars: 8
```

Test Case

final_result



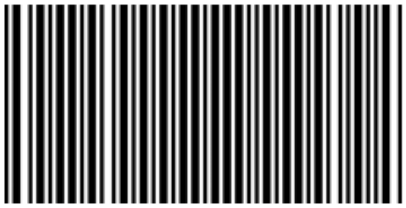
```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '1', '0', '4', '-', '1', '1', '6', '-', '1', '1', '6', 'Stop/Start']
Correct code:
['Stop/Start', '1', '0', '4', '-', '1', '1', '6', '-', '1', '1', '6', 'Stop/Start']
********************************************************************************
```

Test Case 3:

```
Test Case 3
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 377
Salt and Pepper approximate percentage: 0.07854166666666666 %
Distance between barcode bars: 8
```

Test Case

final_result



```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '1', '1', '2', '-', '1', '1', '5', '-', '5', '8', '-', 'Stop/Start']
Correct code:
['Stop/Start', '1', '1', '2', '-', '1', '1', '5', '-', '5', '8', '-', 'Stop/Start']
********************************************************************************
```

Test Case 4:

```
Test Case 4
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 461
Salt and Pepper approximate percentage: 0.09604166666666666 %
Distance between barcode bars: 8
```

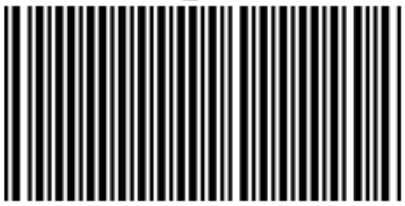

```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '-', '4', '7', '-', '4', '7', '-', '1', '2', '1', '-', 'Stop/Start']
Correct code:
['Stop/Start', '-', '4', '7', '-', '4', '7', '-', '1', '2', '1', '-', 'Stop/Start']
********************************************************************************
```

Test Case 5:

```
Test Case 5
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 302
Salt and Pepper approximate percentage: 0.06291666666666666 %
Distance between barcode bars: 8
```

Test Case

final_result



```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '1', '1', '1', '-', '1', '1', '7', '-', '1', '1', '6', 'Stop/Start']
Correct code:
['Stop/Start', '1', '1', '1', '-', '1', '1', '7', '-', '1', '1', '6', 'Stop/Start']
********************************************************************************
```

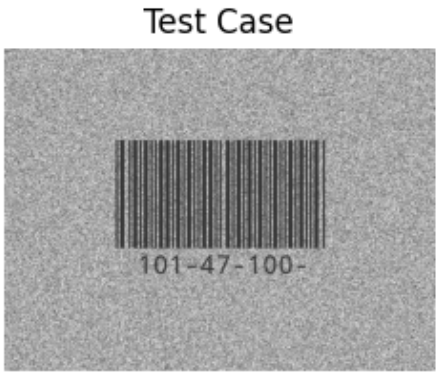
Test Case 6:

```
Test Case 6
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 432
Salt and Pepper approximate percentage: 0.09 %
Distance between barcode bars: 8
```


```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '-', '1', '1', '7', '-', '4', '6', '-', '9', '8', '-', 'Stop/Start']
Correct code:
['Stop/Start', '-', '1', '1', '7', '-', '4', '6', '-', '9', '8', '-', 'Stop/Start']
********************************************************************************
```

Test Case 7:

```
Test Case 7
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 121086
Salt and Pepper approximate percentage: 25.22625 %
Distance between barcode bars: 12
```



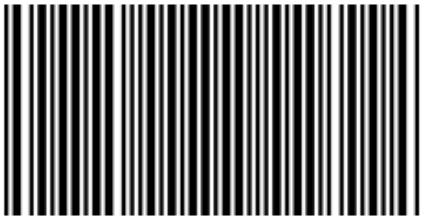

```
narrow: 4, wide: 8
[0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0.
 0. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1.
 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 0. 0.
 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1.
 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1.
 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.
 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1.
 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0.
 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0.
 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1.
 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0.
 0. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1.
 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0.
 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1.
 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0.
 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0.
 0. 1. 1. 1. 1. 0.]
['Stop/Start', '1', '0', '1', '-', '4', '7', '-', '1', '0', '0', '-', 'Stop/Start']
Correct code:
['Stop/Start', '1', '0', '1', '-', '4', '7', '-', '1', '0', '0', '-', 'Stop/Start']
********************************************************************************
```

Test Case 8:

```
Test Case 8
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 502
Salt and Pepper approximate percentage: 0.10458333333333333 %
Distance between barcode bars: 8
```

Test Case

final_result



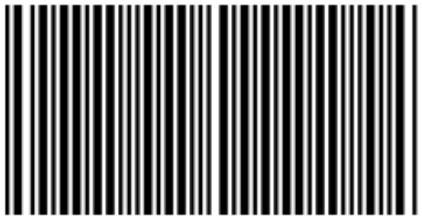
```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.]
['Stop/Start', '1', '1', '3', '-', '1', '1', '9', '-', '5', '2', '-', 'Stop/Start']
Correct code:
['Stop/Start', '1', '1', '3', '-', '1', '1', '9', '-', '5', '2', '-', 'Stop/Start']
********************************************************************************
```

Test Case 9:

```
Test Case 9
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 5811
Salt and Pepper approximate percentage: 1.210625 %
Distance between barcode bars: 8
```

Test Case

final_result



```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 0. 0. 0. 0. 1. 1. 1. 1. 0.]
['Stop/Start', '1', '1', '9', '-', '5', '7', '-', '1', '1', '9', '-', 'Stop/Start']
Correct code:
['Stop/Start', '1', '1', '9', '-', '5', '7', '-', '1', '1', '9', '-', 'Stop/Start']
********************************************************************************
```

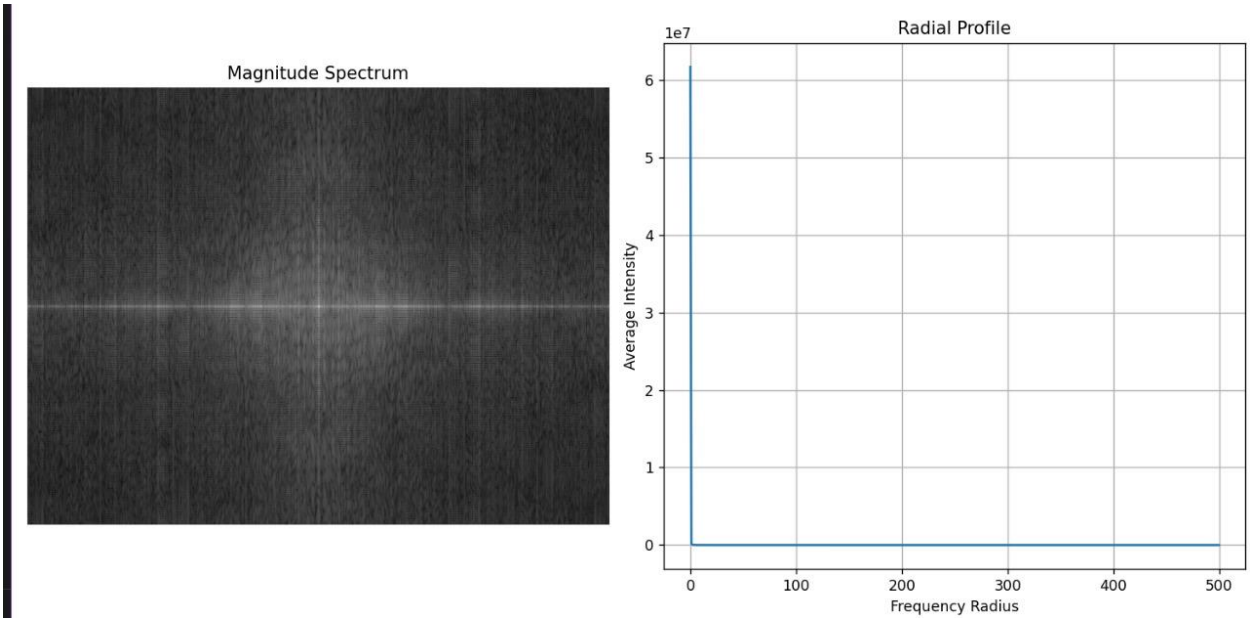
Test Case 10:

```
Test Case 10
Relevant information:
Total pixels in image:  480000
Total noisy pixels: 502
Salt and Pepper approximate percentage: 0.10458333333333333 %
Distance between barcode bars: 8
```

Test Case

final_result

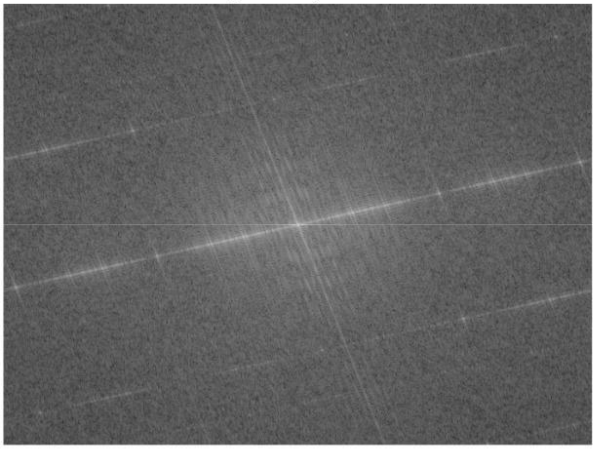
```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.
 0.]
['Stop/Start', '1', '0', '3', '-', '1', '2', '0', '-', '9', '9', '-', 'Stop/Start']
Correct code:
['Stop/Start', '1', '0', '3', '-', '1', '2', '0', '-', '9', '9', '-', 'Stop/Start']
********************************************************************************
```

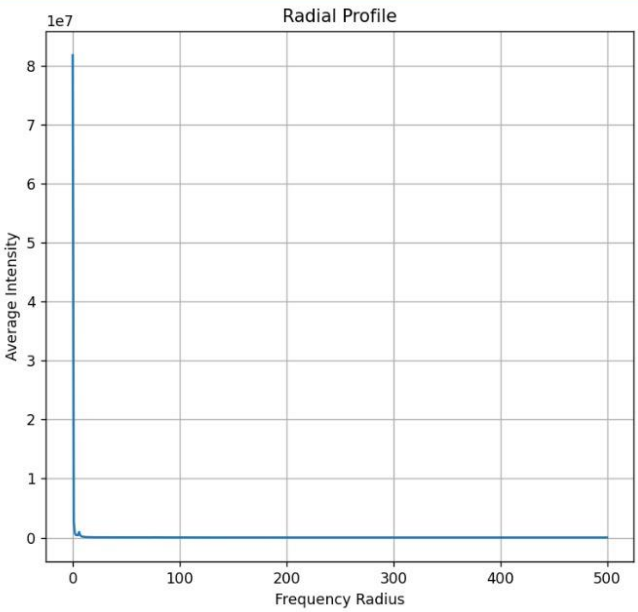

Magnitude Spectrum
Radial Profile
1e7
Average Intensity
Frequency Radius
0
1
2
3
4
5
6
0
100
200
300
400
500

Test Case 11:

```
Test Case 11
Relevant information:
Peak frequency in the radial profile is at: 374091.3199560753
Total pixels in image:  480000
Total noisy pixels: 6831
Salt and Pepper approximate percentage: 1.423125 %
Distance between barcode bars: 12
```


```
narrow: 4, wide: 8
[1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0.
 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1. 0. 0. 0. 0. 1. 1. 1. 1.
 0. 0. 0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 1. 1.
 0.]
['Stop/Start', '1', '1', '3', '-', '4', '7', '-', '3', '5', '-', '3', '5', 'Stop/Start']
Correct code:
['Stop/Start', '1', '1', '3', '-', '4', '7', '-', '3', '5', '-', '3', '5', 'Stop/Start']
********************************************************************************
```





The **Peak** due to **Sin Wave**

5. Video Link

https://drive.google.com/drive/folders/1-NvIzLb-FIgmQsGnFsRktBWd-bKJuenE