Übungsaufgaben I, SBV1

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1 Gauss Filter

1.0.1 Code

```
import ij.*;
import ij.plugin.filter.PlugInFilter;
import ij.process.*;

import ij.gui.GenericDialog;

public class Gauss_ implements PlugInFilter {

   public int setup(String arg, ImagePlus imp) {
               if (arg.equals("about"))
                       {showAbout(); return DONE;}
               return DOES_8G+DOES_STACKS+SUPPORTS_MASKING;
       } //setup



       public void run(ImageProcessor ip) {
               int width = ip.getWidth();
               int height = ip.getHeight();
               int tgtRadius = getUserInput(4, "radius");
               int sigma = getUserInput(4, "sigma");

               double[][] resultImage = runFilter(ip,
                  ↪ tgtRadius, sigma);

               ImageJUtility.showNewImage(resultImage, width,
                  ↪ height, "mean␣with␣kernel␣r=" + tgtRadius
                  ↪ );

       } //run

       void showAbout() {
               IJ.showMessage("About␣Template_...",
                       "this␣is␣a␣PluginFilter␣template\n");
```

```
} //showAbout

/**
 * Asks the user to input.
 *
 * @return value from user input. 0 if failed.
 */
public static int getUserInput(int defaultValue, String
    ↪ nameOfValue) {
        // user input
        System.out.print("Read␣user␣input:␣" +
            ↪ nameOfValue);
        GenericDialog gd = new GenericDialog("user␣
            ↪ input:");
        gd.addNumericField("defaultValue", defaultValue
            ↪ , 0);
        gd.showDialog();
        if (gd.wasCanceled()) {
            return 0;
        }
        int radius = (int) gd.getNextNumber();
        System.out.println(radius);
        return radius;
}

public static double[][] runFilter(ImageProcessor ip,
    ↪ int radius, int sigma) {
        // convert to pixel array
        byte[] pixels = (byte[])ip.getPixels();
        int width = ip.getWidth();
        int height = ip.getHeight();
        int tgtRadius = radius;

        int[][] inArr = ImageJUtility.
            ↪ convertFrom1DByteArr(pixels, width,
            ↪ height);
        double[][] inDataArrDouble = ImageJUtility.
            ↪ convertToDoubleArr2D(inArr, width, height
```

```
                ↪ );

            double[][] filterMask = ConvolutionFilter.
                ↪ GetGaussMask(tgtRadius,sigma);
            return ConvolutionFilter.ConvolveDoubleNorm(
                ↪ inDataArrDouble, width, height,
                ↪ filterMask, tgtRadius);

        }

} //class FilterTemplate_
```

1.0.2 Ablauf und Idee

1.0.3 Tests und Sonderfälle

2 MedianFilter

2.0.1 Code

```
import ij.*;
import ij.plugin.filter.PlugInFilter;
import ij.process.*;
import ij.gui.GenericDialog;
import java.awt.Rectangle;
import java.util.Arrays;

import com.sun.net.httpserver.Authenticator.Success;

public class Median_ implements PlugInFilter {

	public int setup(String arg, ImagePlus imp) {
		if (arg.equals("about")) {
			showAbout();
			return DONE;
		}
		return DOES_8G + DOES_STACKS + SUPPORTS_MASKING
		   ↪ ;
	} // setup

	public void run(ImageProcessor ip) {

		System.out.println("RUN:␣Plugin␣Median");
		int width = ip.getWidth();
		int height = ip.getHeight();


		int radius = getUserInputRadius(4);
		// int radius = 2; // default value for
		   ↪ debugging

		if (2 * radius > width || 2 * radius > height)
		   ↪ {
```

```
                System.out.println("Be␣aware␣that␣double
                    ↪ ␣the␣radius␣has␣to␣fit␣in␣the␣
                    ↪ image!");
            }

            double[][] resultImage = runFilter(ip, radius);

            System.out.println("Now␣show␣the␣result␣image!"
                ↪ );
            ImageJUtility.showNewImage(resultImage, width,
                ↪ height, "mean␣with␣kernel␣r=" + radius);
            System.out.println("SUCCESS:␣MEDIAN␣FILTER␣DONE
                ↪ .");

    } // run

    public static double[][] runFilter(ImageProcessor ip,
        ↪ int radius) {
            byte[] pixels = (byte[]) ip.getPixels();
            int width = ip.getWidth();
            int height = ip.getHeight();

            int[][] inArr = ImageJUtility.
                ↪ convertFrom1DByteArr(pixels, width,
                ↪ height);
            double[][] inDataArrDouble = ImageJUtility.
                ↪ convertToDoubleArr2D(inArr, width, height
                ↪ );

            double[][] resultImage = inDataArrDouble.clone
                ↪ ();
            int successIndex = 0;
            int failureIndex = 0;
            // step1: move mask to all possible image
                ↪ pixel positions
            for (int x = 0; x < width; x++) {
                    for (int y = 0; y < height; y++) {
```

```
                        double[][] mask = inDataArrDouble
                           ↪ .clone();
                        try {

                               // roi = new Rectangle(x
                                  ↪ - radius, y -
                                  ↪ radius, size -
                                  ↪ deltaX - 1, size);
                               Rectangle roi = getROI(
                                  ↪ width, height, x, y,
                                  ↪  radius);
                               mask = ImageJUtility.
                                  ↪ cropImage(mask, roi.
                                  ↪ width, roi.height,
                                  ↪ roi);
                               double median = getMedian(
                                  ↪ mask,roi.width,roi.
                                  ↪ height);
                               resultImage[x][y] = median
                                  ↪ ;

                               successIndex++;
                        } catch (java.lang.
                           ↪ ArrayIndexOutOfBoundsException
                           ↪  exc) {
                               // TODO: error handling
                                  ↪ for edge cases

                               resultImage[x][y] =
                                  ↪ resultImage[x][y];
                               failureIndex++;

                        }

                }
        }
        // System.out.println("SUCCESS: run over
           ↪ picture. succeed: " + successIndex + ",
```

```
            ↪ failed: " + failureIndex
        //  + ", sum: " + (int) (successIndex +
            ↪ failureIndex));
        return resultImage;
}

void showAbout() {
        IJ.showMessage("About␣Template_...", "this␣is␣a
            ↪ ␣PluginFilter␣template\n");
} // showAbout

/**
 * get region of interest. defined by a Rectangle with
    ↪  x and y coorinates of the
 * upper left corner and width and hight as parameters
    ↪ .
 *
 * @param width of the image
 * @param height of the image
 * @param x the x coordinate of the center of the mask
 * @param y the y coodrinate of the center of the mask
 * @param radius of the mask
 * @return
 */
public static Rectangle getROI(int width, int height,
   ↪ int x, int y, int radius) {
        int xsize = 2 * radius + 1;
        int ysize = 2 * radius + 1;


        // special behaviour
        if (x - radius < 0) {
                xsize = xsize - (radius - x);
                x = radius;
        }// set minimum x
        if (y - radius < 0) {
                ysize = ysize - (radius - y);
                y = radius;
```

```
        } // set minimum y


        if (x + radius >= width) {
               int d = (radius - (width - x));
               xsize = xsize - d - 1 ;
        }// set maximum x
        if (y + radius >= height) {
               int d = (radius - (height - y));
               ysize = ysize - d - 1 ;
        } // set maximum y

        return new Rectangle(x - radius, y - radius,
           ↪ xsize, ysize);
    }

    public static double getMedian(double[][] inputImg, int
       ↪  width, int height) {
        int size = width * height;

        // fill array
        double[] arr = new double[size];
        int index = 0;
        for (int i = 0; i < width; i++) {
               for (int j = 0; j < height; j++) {
                      arr[index] = inputImg[i][j];
                      index++;
               }
        }

        // sort array
        Arrays.sort(arr);
        // System.out.println("SUCCESS: getMedian.
           ↪ size: " + size);
        return arr[(int) (size / 2 + 1)];
    }

    /**
```

```
         * Asks the user to input a radius.
         *
         * @return radius from user input. 0 if failed.
         */
        public static int getUserInputRadius(int defaultValue)
           ↪ {
                // user input
                System.out.println("Read␣user␣input:␣radius");
                GenericDialog gd = new GenericDialog("user␣
                   ↪ input:");
                gd.addNumericField("radius", defaultValue, 0);
                gd.showDialog();
                if (gd.wasCanceled()) {
                        return 0;
                }
                return (int) gd.getNextNumber();
        }

} // class FilterTemplate_
```

2.0.2 Ablaufund Idee

2.0.3 Tests

3 Steuerung des Filtereffekts

3.0.1 Code

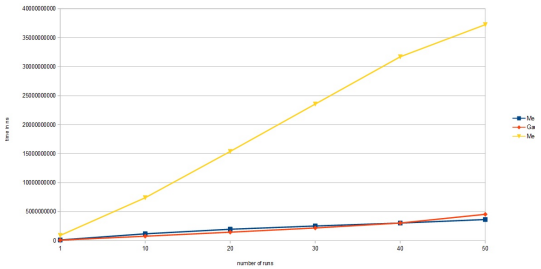
```
import ij.*;
import ij.plugin.filter.PlugInFilter;
import ij.process.*;
import ij.gui.GenericDialog;


public class FiltereffektEvaluierung_ implements PlugInFilter
   ↪ {

       public int setup(String arg, ImagePlus imp) {
              if (arg.equals("about")) {
                     showAbout();
                     return DONE;
              }
              return DOES_8G + DOES_STACKS + SUPPORTS_MASKING
                 ↪ ;
       } // setup


       public void run(ImageProcessor ip) {

              System.out.println("RUN:␣Time␣Evaluation");
              // convert to pixel array
              int width = ip.getWidth();
              int height = ip.getHeight();
              int tgtRadius = 4; // default value
              int sigma = 4;

              double[][] resultImage = new double[width][
                 ↪ height];
              int [] iterations = {1,10,20,30,40,50};

              System.out.println("Please␣Input␣the␣radius␣of␣
                 ↪ the␣mask␣for␣all␣the␣filters.");
```

```
tgtRadius = getUserInput(tgtRadius, "radius");
System.out.println("Please␣type␣a␣proper␣sigma␣
   ↪ value.");
sigma = getUserInput(sigma, "sigma");

// ---------- MEAN ----------
long startTime = System.nanoTime();
for (int j = 0; j < iterations.length; j++) {
       System.out.println("Run␣Mean␣Filter␣" +
          ↪ iterations[j] + "␣times.");
       startTime = System.nanoTime();
       for (int i = 0; i < iterations[j]; i++)
          ↪ {
              resultImage = Mean_.runFilter(ip,
                 ↪  tgtRadius); // for time
                 ↪ measurement the input
                 ↪ image is not important
       }
       System.out.println("Took:␣" + (System.
          ↪ nanoTime() - startTime) + "␣
          ↪ nanoseconds.");
}

// ---------- GAUSS ----------

for (int j = 0; j < iterations.length; j++) {
       System.out.println("Run␣Gauss␣Filter␣" +
          ↪  iterations[j] + "␣times.");
       startTime = System.nanoTime();
       for (int i = 0; i < iterations[j]; i++)
          ↪ {
              resultImage = Gauss_.runFilter(ip
                 ↪ , tgtRadius, sigma); // for
                 ↪  time measurement the
                 ↪ input image is not
                 ↪ important
       }
```

```
                System.out.println("Took:␣" + (System.
                    ↪ nanoTime() - startTime) + "␣
                    ↪ nanoseconds.");
        }

        // ---------- MEDIAN ----------
        for (int j = 0; j < iterations.length; j++) {
                System.out.println("Run␣Median␣Filter␣"
                    ↪ + iterations[j] + "␣times.");
                startTime = System.nanoTime();
                for (int i = 0; i < iterations[j]; i++)
                    ↪ {
                        resultImage = Median_.runFilter(
                            ↪ ip, tgtRadius); // for time
                            ↪  measurement the input
                            ↪ image is not important
                }
                System.out.println("Took:␣" + (System.
                    ↪ nanoTime() - startTime) + "␣
                    ↪ nanoseconds.");
        }

        //ImageJUtility.showNewImage(resultImage,
            ↪ width, height, "mean with kernel");
        System.out.println("SUCCESS:␣␣Time␣Evaluation:␣
            ↪ DONE.");

    } // run

    void showAbout() {
            IJ.showMessage("About␣Template_...", "this␣is␣a
                ↪ ␣PluginFilter␣template\n");
    } // showAbout



    /**
     * Asks the user to input.
```

```
         *
         * @return value from user input. 0 if failed.
         */
        public static int getUserInput(int defaultValue, String
            ↪ nameOfValue) {
                // user input
                System.out.print("Read␣user␣input:␣" +
                    ↪ nameOfValue);
                GenericDialog gd = new GenericDialog("user␣
                    ↪ input:");
                gd.addNumericField("defaultValue", defaultValue
                    ↪ , 0);
                gd.showDialog();
                if (gd.wasCanceled()) {
                        return 0;
                }
                int radius = (int) gd.getNextNumber();
                System.out.println(radius);
                return radius;
        }

} // class FilterTemplate_
```

3.0.2 Ablaufund Idee



3.0.3 Tests

4 Histogrammeinebnung

4.1 Code

```
import ij.*;
import ij.plugin.filter.PlugInFilter;
import ij.process.*;
import ij.gui.GenericDialog;
import java.awt.Rectangle;
import java.util.Arrays;

import com.sun.net.httpserver.Authenticator.Success;

public class Median_ implements PlugInFilter {

	public int setup(String arg, ImagePlus imp) {
		if (arg.equals("about")) {
			showAbout();
			return DONE;
		}
		return DOES_8G + DOES_STACKS + SUPPORTS_MASKING
		    ↪ ;
	} // setup

	public void run(ImageProcessor ip) {

		System.out.println("RUN:␣Plugin␣Median");
		int width = ip.getWidth();
		int height = ip.getHeight();


		int radius = getUserInputRadius(4);
		// int radius = 2; // default value for
		    ↪ debugging

		if (2 * radius > width || 2 * radius > height)
		    ↪ {
```

```
                System.out.println("Be␣aware␣that␣double
                    ↪ ␣the␣radius␣has␣to␣fit␣in␣the␣
                    ↪ image!");
            }

            double[][] resultImage = runFilter(ip, radius);

            System.out.println("Now␣show␣the␣result␣image!"
                ↪ );
            ImageJUtility.showNewImage(resultImage, width,
                ↪ height, "mean␣with␣kernel␣r=" + radius);
            System.out.println("SUCCESS:␣MEDIAN␣FILTER␣DONE
                ↪ .");

    } // run

    public static double[][] runFilter(ImageProcessor ip,
        ↪ int radius) {
            byte[] pixels = (byte[]) ip.getPixels();
            int width = ip.getWidth();
            int height = ip.getHeight();

            int[][] inArr = ImageJUtility.
                ↪ convertFrom1DByteArr(pixels, width,
                ↪ height);
            double[][] inDataArrDouble = ImageJUtility.
                ↪ convertToDoubleArr2D(inArr, width, height
                ↪ );

            double[][] resultImage = inDataArrDouble.clone
                ↪ ();
            int successIndex = 0;
            int failureIndex = 0;
            // step1: move mask to all possible image
                ↪ pixel positions
            for (int x = 0; x < width; x++) {
                    for (int y = 0; y < height; y++) {
```

```
                    double[][] mask = inDataArrDouble
                       ↪ .clone();
                    try {

                           // roi = new Rectangle(x
                              ↪ - radius, y -
                              ↪ radius, size -
                              ↪ deltaX - 1, size);
                           Rectangle roi = getROI(
                              ↪ width, height, x, y,
                              ↪  radius);
                           mask = ImageJUtility.
                              ↪ cropImage(mask, roi.
                              ↪ width, roi.height,
                              ↪ roi);
                           double median = getMedian(
                              ↪ mask,roi.width,roi.
                              ↪ height);
                           resultImage[x][y] = median
                              ↪ ;

                           successIndex++;
                    } catch (java.lang.
                       ↪ ArrayIndexOutOfBoundsException
                       ↪  exc) {
                           // TODO: error handling
                              ↪ for edge cases

                           resultImage[x][y] =
                              ↪ resultImage[x][y];
                           failureIndex++;

                    }

             }
      }
      // System.out.println("SUCCESS: run over
         ↪ picture. succeed: " + successIndex + ",
```

```
            ↪ failed: " + failureIndex
        //  + ", sum: " + (int) (successIndex +
            ↪ failureIndex));
        return resultImage;
}

void showAbout() {
        IJ.showMessage("About␣Template_...", "this␣is␣a
            ↪ ␣PluginFilter␣template\n");
} // showAbout

/**
 * get region of interest. defined by a Rectangle with
    ↪  x and y coorinates of the
 * upper left corner and width and hight as parameters
    ↪ .
 *
 * @param width of the image
 * @param height of the image
 * @param x the x coordinate of the center of the mask
 * @param y the y coodrinate of the center of the mask
 * @param radius of the mask
 * @return
 */
public static Rectangle getROI(int width, int height,
   ↪ int x, int y, int radius) {
        int xsize = 2 * radius + 1;
        int ysize = 2 * radius + 1;


        // special behaviour
        if (x - radius < 0) {
                xsize = xsize - (radius - x);
                x = radius;
        }// set minimum x
        if (y - radius < 0) {
                ysize = ysize - (radius - y);
                y = radius;
```

```
        } // set minimum y


        if (x + radius >= width) {
               int d = (radius - (width - x));
               xsize = xsize - d - 1 ;
        }// set maximum x
        if (y + radius >= height) {
               int d = (radius - (height - y));
               ysize = ysize - d - 1 ;
        } // set maximum y

        return new Rectangle(x - radius, y - radius,
           ↪ xsize, ysize);
    }

    public static double getMedian(double[][] inputImg, int
       ↪  width, int height) {
        int size = width * height;

        // fill array
        double[] arr = new double[size];
        int index = 0;
        for (int i = 0; i < width; i++) {
               for (int j = 0; j < height; j++) {
                      arr[index] = inputImg[i][j];
                      index++;
               }
        }

        // sort array
        Arrays.sort(arr);
        // System.out.println("SUCCESS: getMedian.
           ↪ size: " + size);
        return arr[(int) (size / 2 + 1)];
    }

    /**
```

```
         * Asks the user to input a radius.
         *
         * @return radius from user input. 0 if failed.
         */
        public static int getUserInputRadius(int defaultValue)
           ↪ {
                // user input
                System.out.println("Read␣user␣input:␣radius");
                GenericDialog gd = new GenericDialog("user␣
                   ↪ input:");
                gd.addNumericField("radius", defaultValue, 0);
                gd.showDialog();
                if (gd.wasCanceled()) {
                        return 0;
                }
                return (int) gd.getNextNumber();
        }

} // class FilterTemplate_
```

4.2 Tests

5 Raster-Entfernung im Frequenzraum

5.1 Workflow

- Starten von *imageJ.exe*
- Öffnen eines Bildes
- *Process* $\rightarrow$ *FFT* $\rightarrow$ *FFT*
- Zuschneiden des interessanten Bereichs im FFT Bild
- *Process* $\rightarrow$ *FFT* $\rightarrow$ *inverse FFT*

5.2 Beispiele

5.2.1 Auge

Es wurde ein Bild gewählt, welches (wie bei einem Plakatdruck) Punkte in regelmässigen Abständen aufweist. Die eigentliche Bildinformation steckt in der Dicke er Punkte. Eine FFT Transformation zeigt deutlich ein periodisches Muster. Will man nur die eigentliche Bildinformation gewinnen, müssen hochfrequente Anteile des Bildes entfernt werden. Tabelle 1 zeigt deutlich dass durch ein Entfernen der Randbereiche (höhere Frequenzen) im FFT Bild und die anschließende Rücktransformation die eigentliche Bildinformation gewonnen werden konnte.

5.2.2 Elefant

In diesem Bild sind viele periodisch auftretende Elemente enthalten. Es wurde versucht die Schrift, die Gitterstäbe im Hintergrund und natürlich die beiden Tiere gut sichtbar zu erhalten. Da aber die Gitterstäbe selbst periodisch im Bild vorkommen und auch die Schrift sich wiederholende senkrechte Kanten hat, war dies nicht einfach. Ein Auslöschen der horizontalen und vertikalen Anteile aus dem Bild brachte in unseren Versuchen das beste Ergebnis. Hierbei ist aber zu beachten, dass das Zentrum des FFT Bildes die meiste Information enthält. Daher wurde diese bestehen gelassen. Auch die Randbereiche der FFT wurden belassen, da diese für scharfe Kanten im Bild verantwortlich sind. Ein Wegschneiden dieser Bereiche würde auch die Konturen des Elefanten und die Schrift unscharf machen.

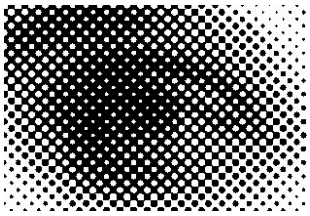
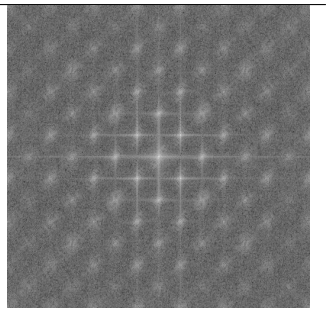
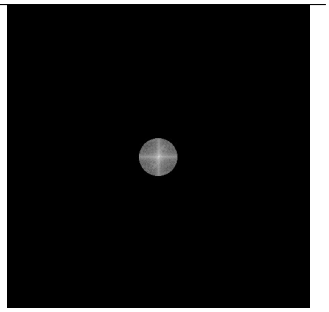
Bild	FFT
	
	

Table 1: Auswertung Auge

5.2.3 Lochgitter

Hier handelt es sich um ein perspektivisch beläuchtetes Lochgitter. Die Löcher sind sechseckig. In der FFT erkennt man gut die Periodizität. Ein Wegschneiden der äusseren Bereiche der FFT und eine Rücktransformation zeigt deutlich die perspektivische Beläuchtung. Das Lochgitter konnte aber vollkommen entfernt werden. Interessant ist auch zu bemerken, dass im Rücktransformierten Bild eine Schrift *"colourbox"* deutlich zu erkennen ist. Bei genauerer Betrachtung des Ursprungsbildes ist diese hinter dem Gitter zu erkennen.

5.3 Analyse eines Frequenzmusters

Ein sich wiederholendes Muster in einem Bild ist mittels *FFT* gut vom eigentlichen Bildinhalt zu unterscheiden. So kann das Muster entfernt werden und das eigentliche Bild mittels *inverseFFT* ermittelt werden. Leider sind reale Bilder meist nicht genau horizontal ausgerichtet. Auch kann man nicht davon ausgehen, dass sich wiederholende Elemente in der Realität unverzerrt

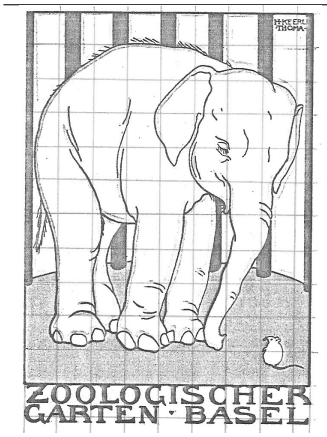
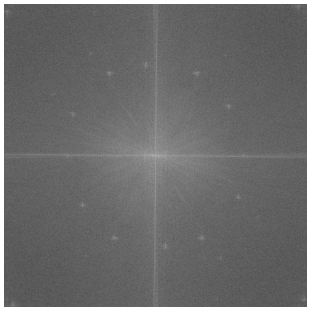
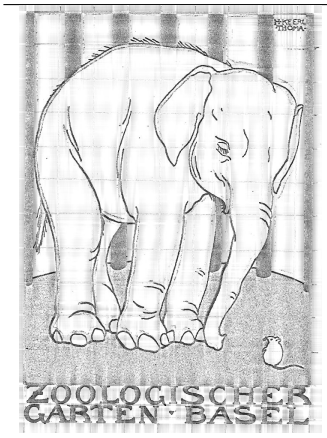
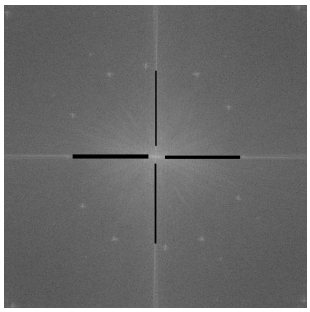
Bild	FFT
	
	

Table 2: Auswertung Elefant

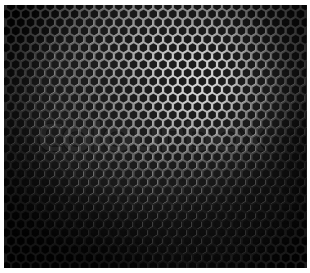
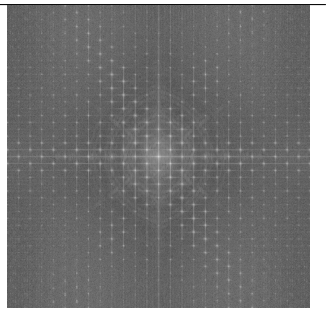
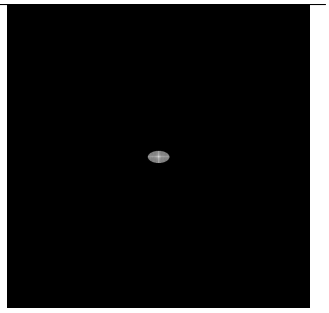
Bild	FFT
	
	

Table 3: Auswertung Lochgitter

in einem Bild dargestellt sind. Kanten werden nur in den seltensten Fällen genau durch einen Pixel des Bildes dargestellt. All diese Umstände machen es schwer aus einem Alltagsfoto wiederkehrende Elemente herauszufiltern.