# Anomaly Detection Dataset - Industry Expert Survey Labelling Guide

## Introduction

### Thanks

Firstly, thank you for agreeing to partake in this Industry Expert Survey, in support of developing this 3D Anomaly Detection in Additive Manufacturing Dataset. Your effort in support of this development is much appreciated, and will be a big help in delivering this dataset both as a paper for publication, and as a key deliverable for my PhD.

Many thanks, Paul McHard

### Task Outline

Alongside this guide, you have been provided with a set of images which comprise a randomised sample of the dataset in development. These are the raw images obtained from one of the cameras used in the data acquisition stage of the project. While the images provided are randomised to maximise coverage of the dataset across the survey, all images are selected from the same camera to ensure a uniformity and consistency in the task.

The breakdown of the task is as follows. Your randomised set contains images from six unique parts scanned for the dataset. You should find a separate folder for each part you have been assigned within the main folder for that this guide sits in. Each of these folders should contain six images respectively, for a total of 36 for the whole task. This represents approximately 1% of the total dataset.

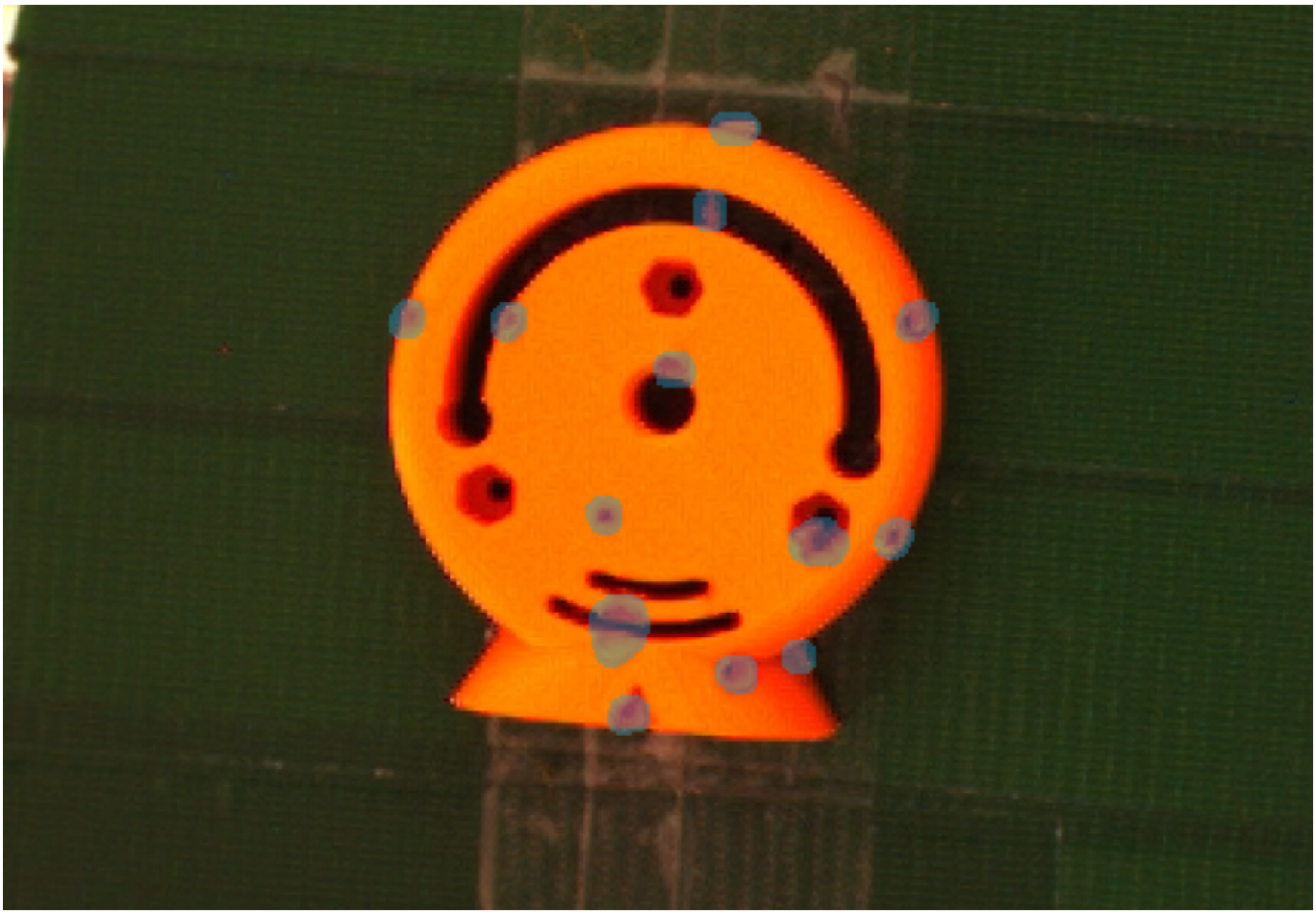
Your task is to act as the industry expert, identifying defects in the images you see. For each image, you will load it into image editting software, use a paint tool to draw binary masks for each identified defect, and save these masks to the output folder. Any imaging software capable of handling different image layers (unfortunately this disqualifies Microsoft Paint) can be used, however this guide will focus on either GIMP or Paint.NET, both of which are free open-source platforms.

As we'll go on to describe in the **"Saving and Completion"** section at the end, you can either choose to draw binary masks as separate layers for each defect, saving these as separate images, or you can draw all defects onto the same layer as one mask. Either is fine, a single mask is less work so I would recommend this approach in the interest of saving time. However, the most important part is that masks are saved with a named correctly, as described in the aforementioned saving section.

### Example Labelled Image

Here is an example of a fully labelled defective part. For the full dataset, we used the Labelbox platform to complete the labelling work, so your labelled image may appear slightly different to this. What's important to note from this image is the level of detail which is taken with the drawn masks - **We are NOT looking for pixel perfect masks of defects.** As long as all noticed defects in an image are completely captured by a mask with limited overlap, this is perfectly sufficient. Remember that the goal of this dataset is ultimately for training autonomous defect correction behaviours in industrial robots, whose precision is by-and-large at a

millimeter scale at best, and therefore the macroscopic goal of capturing the entirety of a defective region by a mask, rather than the microscopic goal of minimising "good" areas in the same mask, is far more important to us. (I hope this part makes sense, feel free to email me if not.)



## Housekeeping

The goal of this guide is to make the task as frictionless as possible. Part of this is aiming to use free, open-source and easy to use software platforms. For this reason, you are asked to complete the task using a commonplace image editor such as GIMP or Paint.NET to save time as opposed to providing training in using a more cumbersome platform such as labelbox. Both GIMP and Paint.NET are freely available, so please choose one based on your own preference and hardware requirements, as Paint.NET is only available for Windows machines, as far as I am aware.

### GIMP

**Download:** GIMP Website

**Note:** GIMP is also available for free from the microsoft store for Windows users.

**System Requirements:**

- Windows 7 or newer, macOS 10.12 or newer, or Linux
- 1 GHz processor
- 2 GB RAM
- 200 MB hard disk space
- OpenGL 2.0 capable graphics card

### Paint.NET

**Download:** Paint.NET Website

**Note:** Paint.NET is also available via the microsoft store, however this is a paid option with no discernable benefit over the free direct download.

**System Requirements:**

- Windows 10 or newer
- 1 GHz processor
- 1 GB RAM
- 200 MB hard disk space
- DirectX 11 capable video card

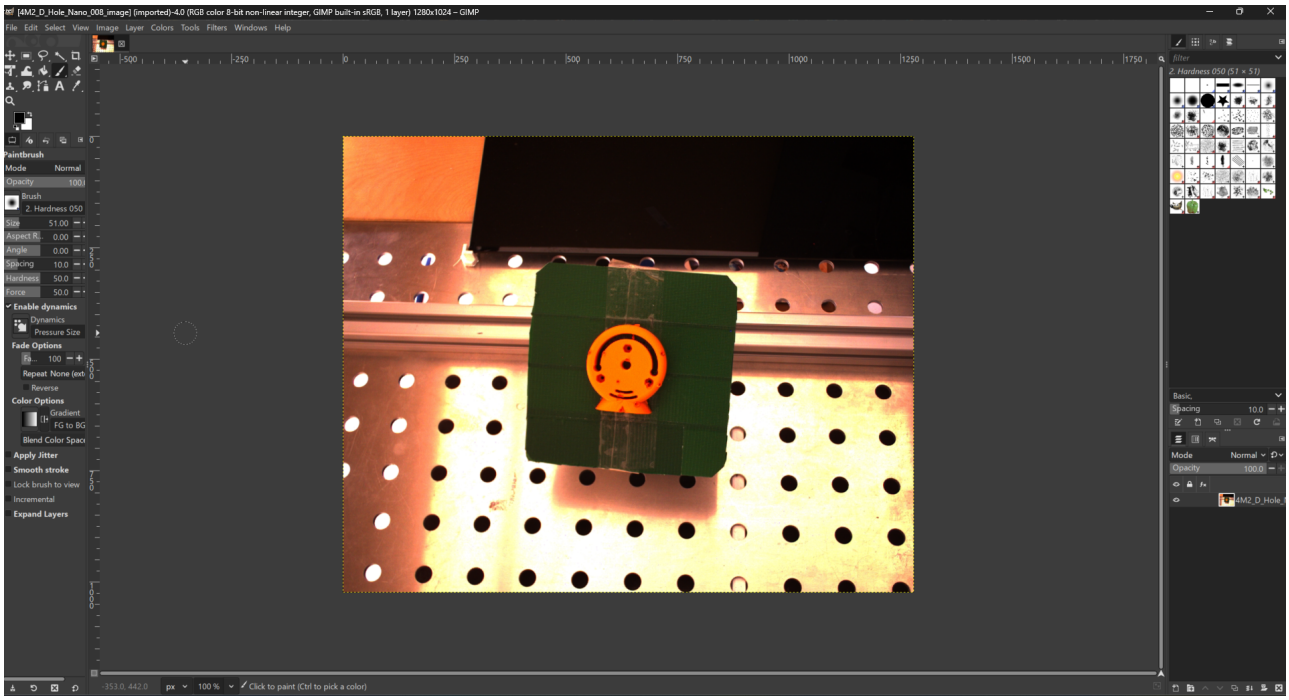
## How To Create Binary Masks

In this section we'll go into detail on creating binary masks for the defects you can see in an image. Some defects, such as the holes drilled in the previous example image, will be immediately obvious on inspection, however more subtle defects such as minor burrs, scratches or gaps etc. which can occur during the additive manufacturing process might not be as obvious. The goal of this survey is to quantitatively and qualitatively assess the quality of the labelling in the main dataset using your industry expertise, so please use your best judgement on what you personally consider to be a defect or not. I appreciate this isn't the easiest without having access to the as-designed parts, but this is meant to be a reasonably quick exercise so please don't fret over edge cases. Or feel free to email me if there are consistent issues that you need me to clarify at all.

**Note on naming conventions:** When saving the mask for an image, please keep the original name for the part, replacing the suffix "_image" with "_labelled" at the end. For example, The part shown in the original example image would go from "4M2_D_Hole_Nano_008_image.png" to "4M2_D_Hole_Nano_000_labelled.png". This will be a big help when it comes to analysing the survey results.

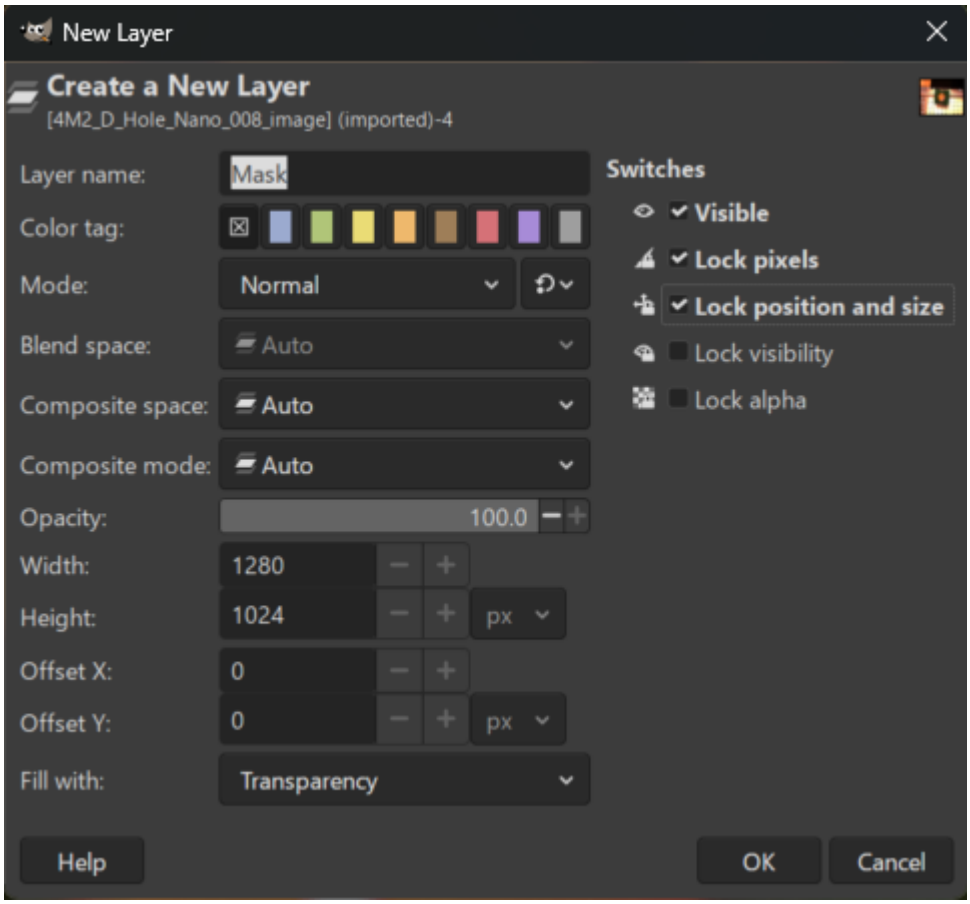
### Creating Binary Masks in GIMP

1. **Open your image**
    - File > Open > Navigate to your assigned folder > Select an image



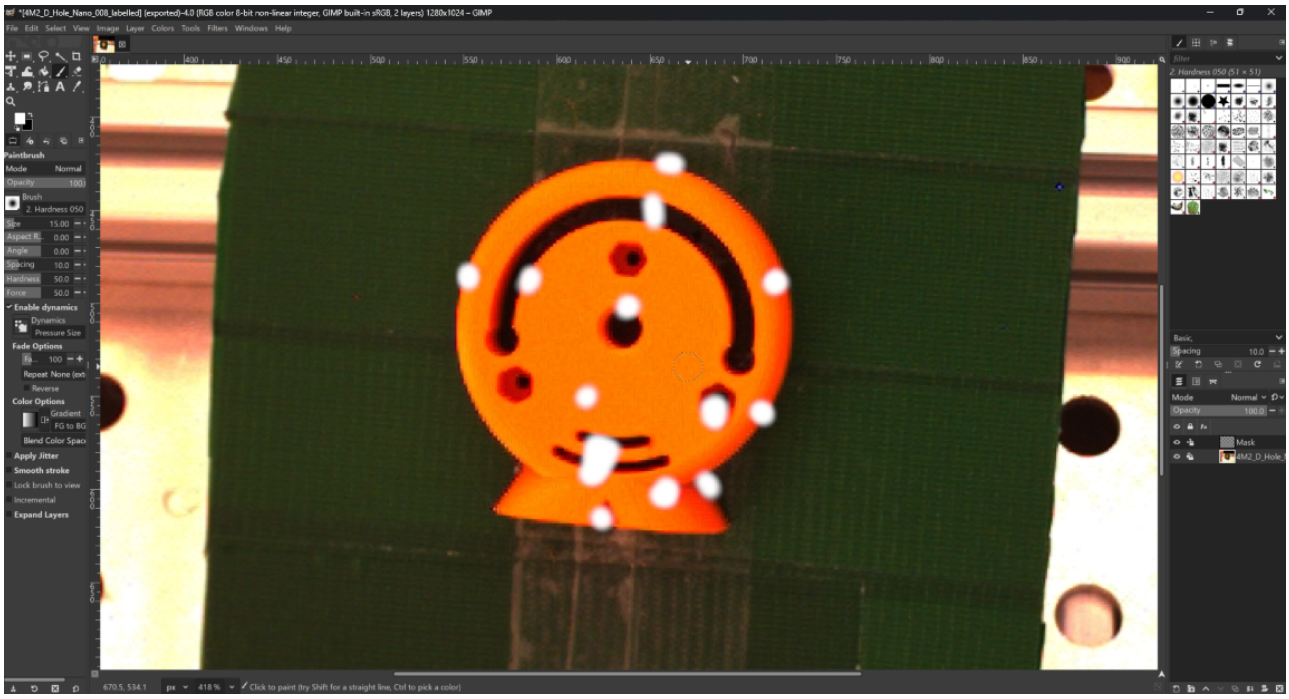
2. **Create a layer mask**

    - In the Layers panel (usually on the right side), start by locking the pixels and position/size of the base image. Do this by clicking on the image layer then click the box in the "lock" column next to the layer name, selecting the "Lock pixels" and "Lock Position and Size" options. These are the two leftmost choices, but this can be checked by hovering over the icons for each.
    - Create a new Layer, by right-clicking in the Layers panel then selecting new layer, or with Ctrl-Shift-N.
    - Name this layer something appropriate such as "Mask", "Mask Layer", "Binary Mask" etc. and ensure in the Switches options that lock pixels and lock position and size are also selected.
    - Click "OK"
    - Ensure your new layer is the active layer before proceeding by selecting the layer in the Layers panel, which will highlight the layer.




**Note:** Separate layers can be made for each defect if you so choose, but this is not required and drawing all defects on a single layer mask is wholly sufficient and significantly faster.

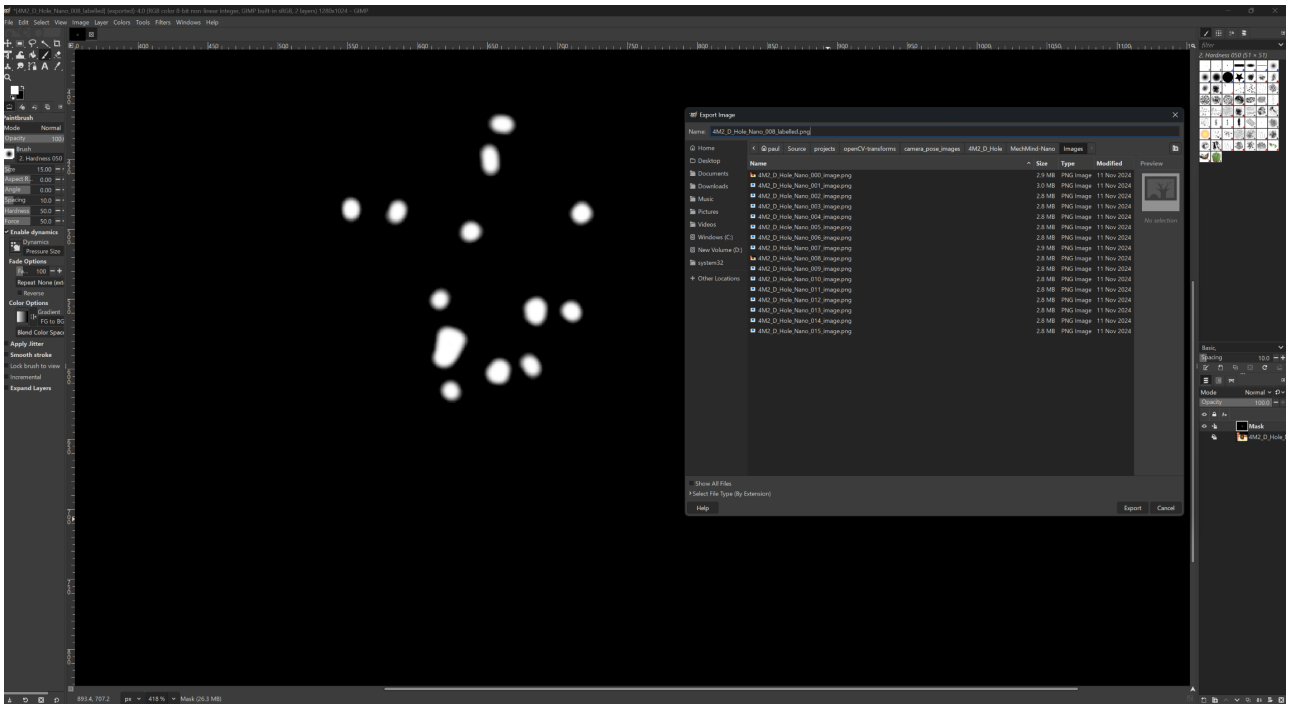
3. **Paint on the mask**
    - Select the Brush tool (P) from the toolbox
    - Set foreground color to white, and the background colour to black. This should involve simply reversing the default options.
    - Adjust brush size using the tool options dialog (see more on this below.)
    - Use the brush tool to paint over all defects seen in an image.



As seen in the tool settings on the right hand side of the above image, we have selected a brush size of 15, although some defects in this image were also labelled at size 10. We recommend anywhere between size 10 and 20 approximately, based on the defects themselves as well as personal preference.

4. **Export your binary mask**

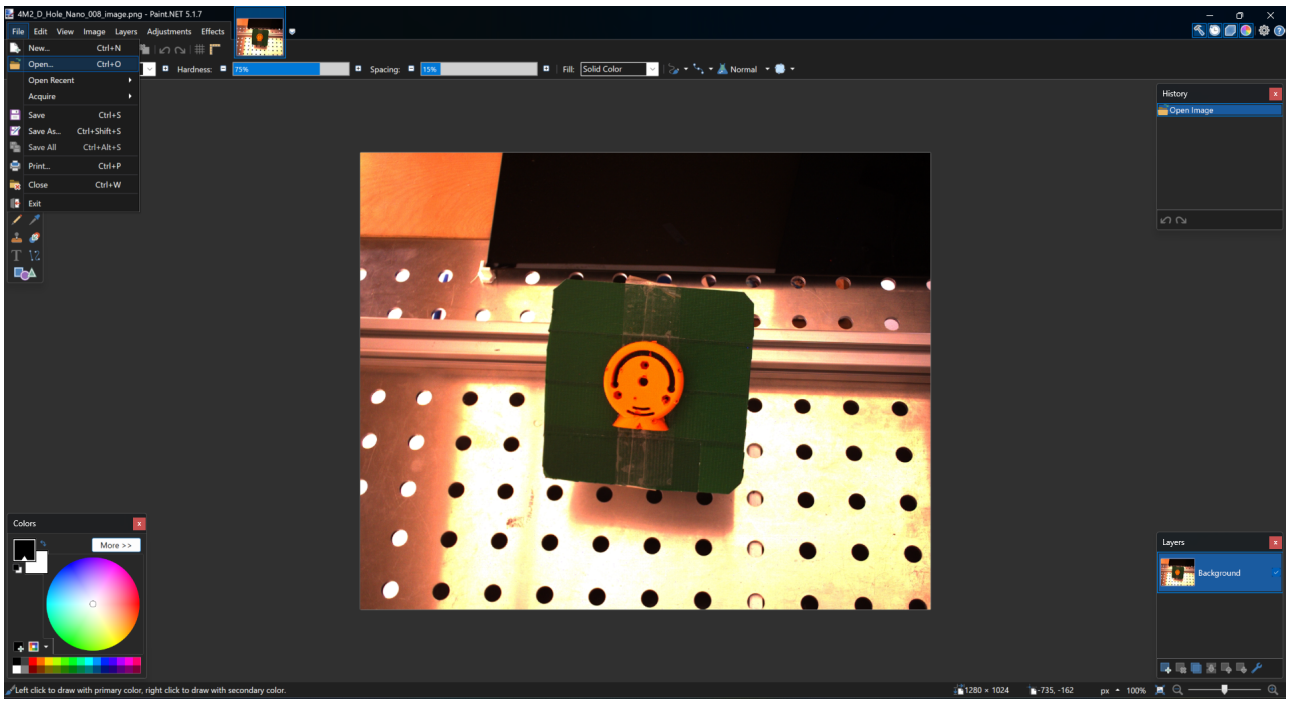
    - In the Layers panel, toggle the visibilty of the base image layer to off/invisible. This should leave you with only the defect mask over a transparent background.
    - Right-click on the Mask layer in the layer, and select the option "Remove Alpha Channel". This should colour the background of the mask in black.
    - With only the mask visible, export the mask as a new image: File > Export As
    - Navigate to the "output" folder within your test set.
    - Name your file according to the convention (<original_name>_labelled.png)
    - Select PNG as the file format
    - Click "Export"



5. **Additional Resources**
    - This YouTube guide can also serve as a helpful walkthrough of the process of creating layer masks in GIMP, if required.
    - gimp_youtube_link

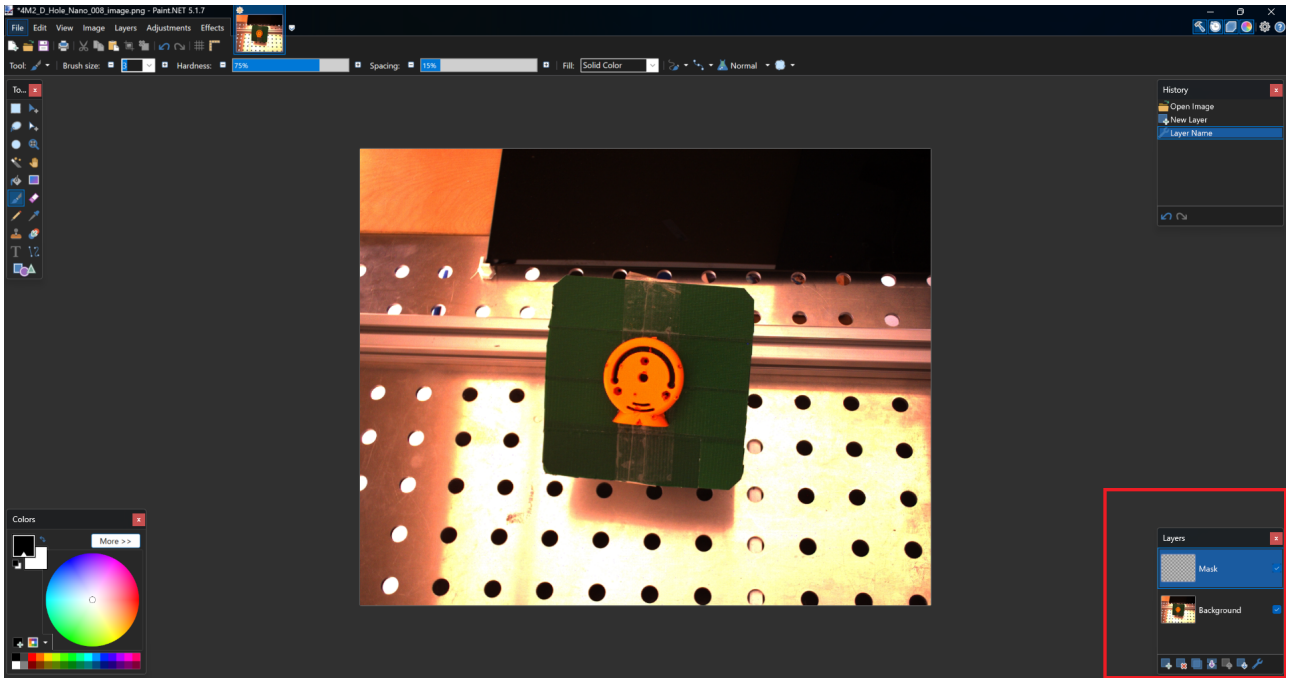
## ** Creating Binary Masks in Paint.NET

1. **Open your image**
    - File > Open > Navigate to your assigned folder > Select an image



2. **Create a new layer for your mask**
    - Go to the Layers panel (usually on the right side)

- Click the "Add New Layer" button (or press Ctrl+Shift+N)
- Ensure this new layer is positioned above your image layer
- (Optional) Rename this layer to an appropriate name such as "Mask".

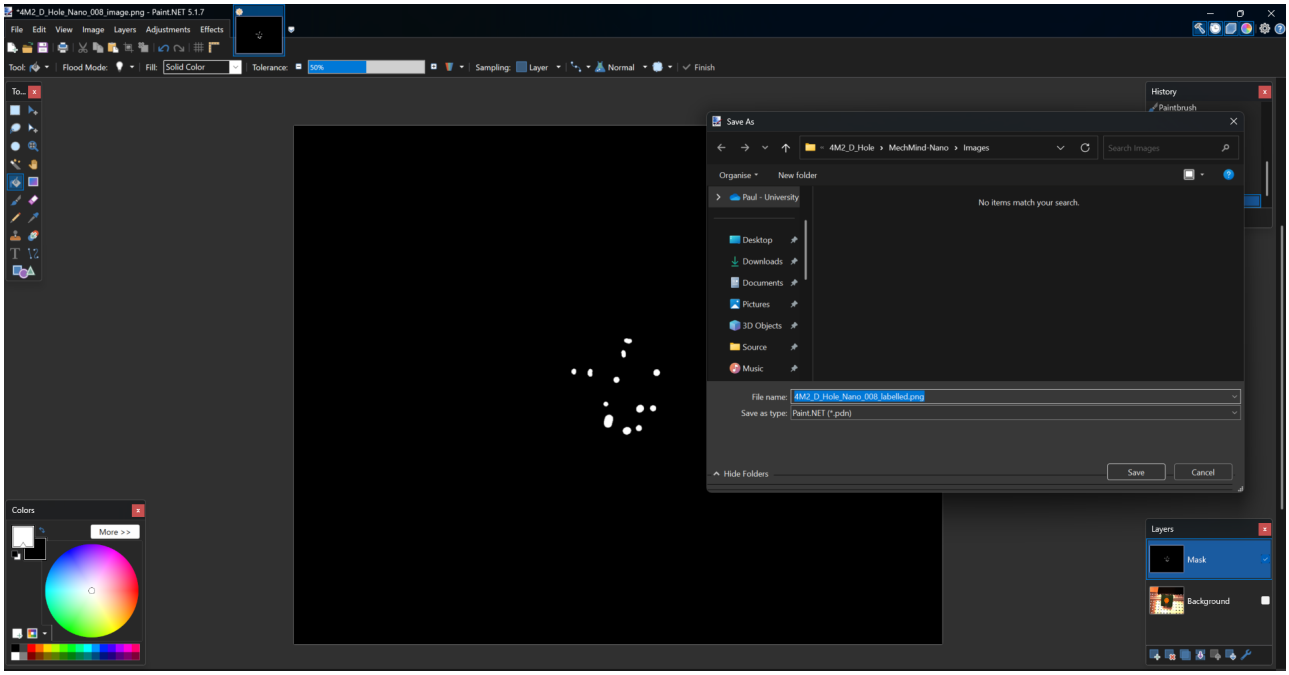



3. **Drawing the mask**

- Choose the Brush tool (B) or Pencil tool from the toolbar
- Set the foreground color to white for regions of the image where we believe there are defects, and set the background colour to black. In most cases this should simply be reversing the defaults.
- Adjust brush size using the tool options at the top (more on this below the image.)
- Paint directly on the mask layer to create your binary mask
- Use the Eraser tool (E) to make corrections as needed

As seen in the Tool toolbar at the top of the above image, we have selected a brush size of 15, although some defects in this image were also labelled at size 10. As with the GIMP guide, we recommend anywhere between size 10 and 20 approximately, based on the defects themselves as well as personal preference.

4. **Export your binary mask**
    - Hide the original image layer by clicking the tick box next to it in the Layers panel, so that it is disabled.
    - Ensure only your mask layer is visible
    - Using the Paint Bucket Tool (F), fill the background in black by right-clicking anywhere in the transparent area. **Make sure to do this AWAY from your drawn masks.** This should fill black if you followed the steps above to ensure black was your background colour.
    - Go to File > Save As
    - Navigate to the "output" folder
    - Name your file according to the convention (<original_name>_labelled.png)
    - Select PNG as the file format
    - Click Save




# Common Issues and Solutions

## Paint.NET

- **Issue**: Mask appears transparent instead of solid white
    - **Solution**: Ensure you're using 100% opacity white
- **Issue**: Difficulty seeing the mask against the image
    - **Solution**: Temporarily lower the opacity of your image layer

## GIMP

- **Issue**: Changes affecting the image instead of the mask
    - **Solution**: Check that you have the mask selected, not the layer

- **Issue**: Selections not working as expected
    - **Solution**: Ensure you're in the mask, not the layer

## Submission Process

After completing all 36 image masks:

1. Verify that all files are named correctly and saved in the output folder
2. Ensure all masks are binary (black and white only)
3. Compress the output folder to a .zip file
4. Submit by responding to the original email, or by emailing [p.mchard@hal-robotics.com] with your completed image set attached in zip format.

Thank you very much for participating in this labelling survey! Your contributions will help massively in validating our anomaly detection in additive manufacturing dataset.