STUDENT LAB SAFETY, HIRARC, DATASHEET VERIFICATION CHECKLIST, AND BRIEF REPORT SUBMISSION

EXPERIMENT DSP2: IMAGE PROCESSING

STUDENT NAME : _____
MATRIC NO. : _____
GROUP : _____
DATE : _____

A. Equipment and System Verification Checklist

Item	Verification Requirement	[X]
LabVIEW Environment	LabVIEW initialized correctly with Vision Development Module (IMAQ VIs) active.	[ ]
Memory Allocation	IMAQ Create properly initialized with unique session names ("Source Image", "Dest Image").	[ ]
File Path Dialog	File Dialog Express VI linked to IMAQ Read File without broken wire indicators.	[ ]
Window Display Sync	IMAQ WindDraw and external image displays configured to separate window numbers (0, 1).	[ ]
Tab / Case Control	Tab Controls properly wired to Case Selector terminals across all exercises.	[ ]
Memory Cleanup	IMAQ Dispose and IMAQ WindClose placed outside main While Loops to prevent leaks.	[ ]
File Architecture	VI source files saved with student ID and exercise designation in working directory.	[ ]

B. HIRARC Checklist

Hazard / Unsafe Condition	Potential Consequence	Control Measure	[X]
Unbound While Loop	High CPU utilization, system freeze, or lost simulation data.	Ensure execution timing delays (e.g., Wait ms) or Event-driven stopping conditions are wired.	[ ]
Buffer Memory Overflow	Memory leak causing software crash due to unreleased image buffers.	Always call IMAQ Dispose at the termination of image processing pipelines.	[ ]
Mismatched Image Types	Type-casting error or pipeline failure when processing non-U8 images.	Force incoming image channels to 8-Bit Grayscale (Grayscale U8) in IMAQ Create.	[ ]
Prolonged Workstation Use	Eye strain, physical discomfort, and fatigue.	Maintain ergonomic posture and practice the 20-20-20 visual rest rule.	[ ]

C. Engineering Practice Verification

Requirement	[X]
Image header properties (dimensions, spatial steps, format) are verified and logged.	[ ]
Quantization degradation is quantitatively mapped across varying bit depths ($b = 8 \rightarrow 1$).	[ ]
Spatial re-sampling techniques (Zero-Order, Bilinear, Bicubic) are evaluated for blocking artifacts.	[ ]
Geometric transformation VIs (Symmetry, Shift, Rotate) are verified for pixel indexing changes.	[ ]
Scalar arithmetic overflow/underflow phenomena (clipping at 0 and 255) are systematically measured.	[ ]

D. Student Declaration

I confirm that:

☐ All LabVIEW image-processing exercises were completed according to the laboratory instructions.

☐ The Front Panel and Block Diagram for each exercise were checked before execution.

☐ All required image files were loaded using supported file formats.

☐ Image-processing parameters were verified before running each VI.

☐ IMAQ image references and processing blocks were connected correctly

☐ The required screenshots of the Front Panel, Block Diagram, and processed images were obtained from actual LabVIEW outputs.

☐ Experimental observations and results were recorded accurately.

☐ Required VI files were saved and backed up.

☐ Hazards related to software operation, workstation use, and data integrity were identified.

☐ Engineering ethics and academic integrity were maintained throughout the experiment.

Student Signature : _____

Date : _____

E. Experiment Data Results and Discussion

In Lab Task (During Lab)
Table 1: Original Image Header Specifications

Parameter Name	Extracted Value	Units / Data Format	System Definition / Operational Function
Image Type		Grayscale / RGB	Data type encoding pixel intensity values.
Pixel Dimension X		Pixels	Total number of horizontal columns.
Pixel Dimension Y		Pixels	Total number of vertical rows.
X Step (Unit/Pixel)		Unit / Pixel	Spatial calibration distance per horizontal pixel.
Y Step (Unit/Pixel)		Unit / Pixel	Spatial calibration distance per vertical pixel.

Table 2: Bit-Depth & Quantization Reduction Matrix

Target Bit Depth (b)	Quantization Levels (L=2b)	Pixel Value Range	Visual Degradation / Observed Artifacts
8 Bits	256	0 to 255	Full continuous tonal range (Baseline reference).
6 Bits	64	0 to 63	
4 Bits	16	0 to 15	False contouring / noticeable banding.
2 Bits	4	0 to 3	
1 Bit	2	0 to 1	Binary thresholding effect; complete loss of subtle detail.

Exercise 3: Spatial Re-Sampling & Interpolation Evaluation

Table 3: Re-Sampling Performance & Interpolation Scheme Comparison

Test Scenario	New X / Y Resolution	Interpolation Type	Visual Quality & Artifact Observations
Baseline	Original ($N_x \times N_y$)	None	Original unscaled visual layout.
Downsampling	$0.5N_x \times 0.5N_y$	Zero Order / Nearest	
Upsampling A	$2.0N_x \times 2.0N_y$	Zero Order	Severe pixelation / blocking artifacts.
Upsampling B	$2.0N_x \times 2.0N_y$	Bilinear / Higher Order	Smooth edge transition; reduced blocking but slight blurring.

Exercise 4: Geometric Image Transformations

Table 4: Transformation Operations

Operation Mode	Input Parameters Configured	Pixel Index Mathematical Transformation	Observed Output Effect
Vertical Symmetry	Selected in VI Dropdown	$\text{Img}_2[x,y] = \text{Img}_1[\text{Width} - x, y]$	Left-right image mirror effect.
Horizontal Symmetry	Selected in VI Dropdown	$\text{Img}_2[x,y] = \text{Img}_1[x, \text{Height} - y]$	Upside-down image flip.
Spatial Shift	$\Delta x =$ _____, $\Delta y =$ _____	$\text{Img}_2[x,y] = \text{Img}_1[x - \Delta x, y - \Delta y]$	Translation of image frame.
Rotation	Angle $\theta =$ _____ Degrees	Coordinate rotation matrix transformation	Rotated frame; background padding.

Exercise 5: Scalar Arithmetic Image Processing (Open-Ended Design)

Table 5: Scalar Arithmetic & Saturation Logging Matrix

Selected Operation	Assigned Scalar (C)	Minimum Pixel Value	Maximum Pixel Value	Observed Brightness & Clipping Phenomenon
Addition	$+50$			Moderate brightening across all regions.
Addition	$+150$			Severe clipping at 255; loss of bright details.
Subtraction	-100			Image darkens; low values clip to 0.
Multiplication	$\times 1.5$			Contrast increase; high-intensity values saturate.
Division	$\div 2.0$			Dynamic range compression; overall darkening.

Theoretical Explanation of Arithmetic Processing & Saturation:

Quantitative Analysis:

Explain the dynamic range constraints of an 8-bit unsigned integer (U8) image. Detail why adding large scalar values (e.g., $+150$) leads to dominant white regions and detail loss, citing the arithmetic truncation/clipping boundary conditions imposed by LabVIEW Vision VIs.

DISCUSSION:

CONCLUSION:

LAB LECTURER

SIGNATURE : _____

DATE : _____

INSTRUCTOR

SIGNATURE : _____

DATE : _____