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School of Computer Science and Engineering (SCOPE)

PROJECT REPORT

<table>
<tr><td>COURSE CODE / TITLE</td><td colspan="3">BECE301L– DIGITAL SIGNAL PROCESSING</td></tr>
<tr><td>PROGRAM / YEAR/ SEM</td><td colspan="3">B.Tech (BEC)/II Year/ WINTER 2023-2024</td></tr>
<tr><td>DATE OF SUBMISSION</td><td colspan="3"></td></tr>
<tr><td rowspan="6">TEAM MEMBERS DETAILS</td><td>REGISTER NO.</td><td colspan="2">NAME</td></tr>
<tr><td>22BEC1063</td><td colspan="2">SYED NABIEL HASAAN M</td></tr>
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<tr><td>PROJECT TITLE</td><td colspan="3">IMAGE FUSION USING MATLAB</td></tr>
<tr><td>COURSE HANDLING FACULTY</td><td>Dr. ASHOK MONDAL
Associate Professor,
SENSE</td><td rowspan="2">REMARKS</td><td rowspan="2"></td></tr>
<tr><td>FACULTY SIGNATURE</td><td></td></tr>
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OBJECTIVE:

The primary objective of an image fusion project using MATLAB is to combine multiple input images, typically obtained from different sensors or modalities, into a single output image that provides a more comprehensive and informative representation of the scene or object being observed. The goal is to leverage the strengths and complementary features of the input images to create a fused output that enhances the overall visual representation and enables more effective interpretation and analysis of the data

THEORY:

Image fusion in digital signal processing refers to the process of combining information from multiple images of the same scene to create a single, more informative image. This technique is widely used in various fields such as remote sensing, medical imaging, surveillance, and computer vision. The goal of image fusion is to enhance the quality, contrast, and spatial resolution of the final image, as well as to extract relevant information that may not be visible in any individual input image alone.

1. **Image Acquisition**: The process starts with acquiring multiple images of the same scene using different sensors, imaging modalities, or from different viewpoints. These images may have different resolutions, contrasts, or spectral bands, depending on the sensors and techniques used.

2. **Preprocessing:** Before fusion, the input images typically undergo preprocessing to remove noise, correct geometric distortions, and enhance their quality. Preprocessing steps may include noise reduction, image registration (aligning images to a common coordinate system), and radiometric calibration (ensuring consistent intensity values across images).

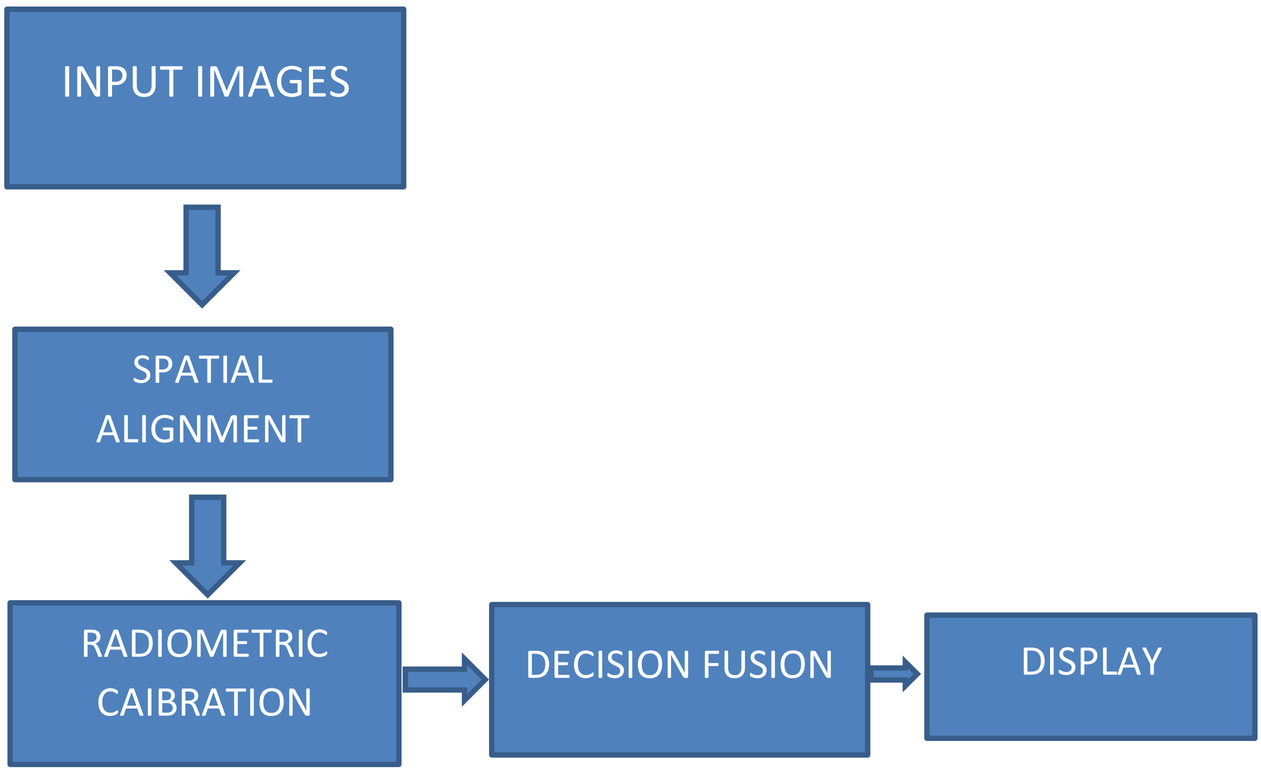
3. **Feature Extraction:** In this step, relevant features are extracted from each input image. These features can be spatial, spectral, or temporal characteristics that capture important information about the scene. Feature extraction techniques may include edge detection, texture analysis, color space transformations, and frequency domain analysis.

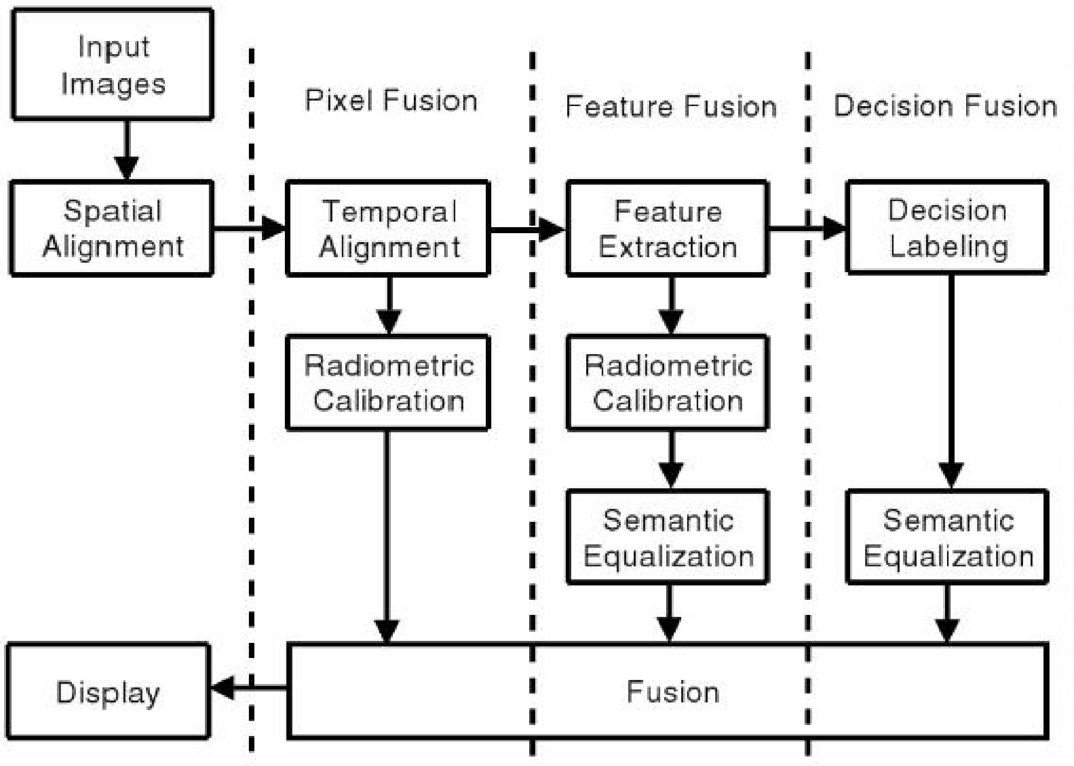
4. **Feature Fusion:** Once features are extracted, the next step is to fuse them to create a composite representation of the scene. Feature fusion can be performed at different levels, including pixel-level, feature-level, and decision-level fusion.
    - Pixel-level Fusion: In pixel-level fusion, individual pixel values from corresponding locations in the input images are combined to form the output image. Common techniques for pixel-level fusion include averaging, weighted averaging, and maximum or minimum selection.
    - Feature-level Fusion: In feature-level fusion, extracted features from different images are combined before generating the output image. This may involve mathematical operations such as addition, multiplication, or concatenation, depending on the nature of the features.
    - Decision-level Fusion: In decision-level fusion, decisions or classifications made based on the input images are combined to make a final decision. This approach is commonly used in applications such as target detection and recognition.

5. **Image Reconstruction**: After fusion, the composite image is reconstructed using the fused features. Depending on the fusion technique used, the reconstructed image may exhibit improved spatial resolution, enhanced contrast, and better overall quality compared to the individual input images.

6. **Postprocessing:** Finally, the fused image may undergo postprocessing to further enhance its quality or to adapt it to specific applications. Postprocessing techniques may include contrast enhancement, sharpening, color mapping, and artifact r

BLOCK DIAGRAM:





SOFTWARE REQUIRED:

Matlab

CODE:

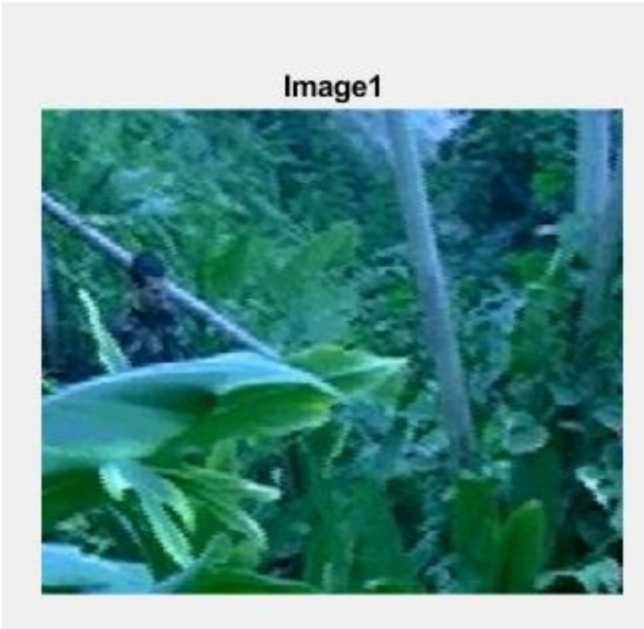
```
clear;
fusiontype='MaxMax';
wavetype='coif5';
[filename1,pathname1]=uigetfile('.','Select the 1st Image');
filewithpath1=strcat(pathname1,filename1);
img1=imread(filewithpath1);

%Load Image2
[filename2,pathname2]=uigetfile('.','Select the 2st Image');
filewithpath2=strcat(pathname2,filename2);
img2=imread(filewithpath2);

[row,col]=size(img1(:,:,1));

if ~isequal(size(img1),size(img2))
```

```
    img2=resize(img2,[row,col]);
end
fusedimageR=imgfusion(img1(:,:,1),img2(:,:,1),fusiontype,wavetype);
fusedimageG=imgfusion(img1(:,:,2),img2(:,:,2),fusiontype,wavetype);
fusedimageB=imgfusion(img1(:,:,3),img2(:,:,3),fusiontype,wavetype);
fusedimage=uint8(cat(3,fusedimageR,fusedimageG,fusedimageB));

imwrite(imresize(fusedimage,[row,col]),'fusedimage.jpg','Quality',100);

subplot(131)
imshow(img1)
title('Image1')
subplot(132)
imshow(img2)
title('Image2')
subplot(133)
imshow(fusedimage)
title('Fused Image')

%Function to create fused Image
function outimage=imgfusion(Im1,Im2,ftype,wtype)
[cA1,cH1,cV1,cD1]=dwt2(double(Im1),wtype,'per');
[cA2,cH2,cV2,cD2]=dwt2(double(Im2),wtype,'per');
[r,c]=size(cA1);
cA=zeros(r,c);
cH=zeros(r,c);
cV=zeros(r,c);
cD=zeros(r,c);

switch ftype
    case 'MeanMean'
        for i=1:r
            for k=1:c
                cA(i,k)=mean([cA1(i,k),cA2(i,k)]);
                cH(i,k)=mean([cH1(i,k),cH2(i,k)]);
                cV(i,k)=mean([cV1(i,k),cV2(i,k)]);
                cD(i,k)=mean([cD1(i,k),cD2(i,k)]);
            end
        end
    case 'MeanMax'
        for i=1:r
            for k=1:c
```

```
            cA(i,k)=mean([cA1(i,k),cA2(i,k)]);
            cH(i,k)=max([cH1(i,k),cH2(i,k)]);
            cV(i,k)=max([cV1(i,k),cV2(i,k)]);
            cD(i,k)=max([cD1(i,k),cD2(i,k)]);
        end
    end
case 'MeanMin'
    for i=1:r
        for k=1:c
            cA(i,k)=mean([cA1(i,k),cA2(i,k)]);
            cH(i,k)=min([cH1(i,k),cH2(i,k)]);
            cV(i,k)=min([cV1(i,k),cV2(i,k)]);
            cD(i,k)=min([cD1(i,k),cD2(i,k)]);
        end
    end
case 'MaxMean'
    for i=1:r
        for k=1:c
            cA(i,k)=max([cA1(i,k),cA2(i,k)]);
            cH(i,k)=mean([cH1(i,k),cH2(i,k)]);
            cV(i,k)=mean([cV1(i,k),cV2(i,k)]);
            cD(i,k)=mean([cD1(i,k),cD2(i,k)]);
        end
    end
case 'MaxMax'
    for i=1:r
        for k=1:c
            cA(i,k)=max([cA1(i,k),cA2(i,k)]);
            cH(i,k)=max([cH1(i,k),cH2(i,k)]);
            cV(i,k)=max([cV1(i,k),cV2(i,k)]);
            cD(i,k)=max([cD1(i,k),cD2(i,k)]);
        end
    end
case 'MaxMin'
    for i=1:r
        for k=1:c
            cA(i,k)=max([cA1(i,k),cA2(i,k)]);
            cH(i,k)=min([cH1(i,k),cH2(i,k)]);
            cV(i,k)=min([cV1(i,k),cV2(i,k)]);
            cD(i,k)=min([cD1(i,k),cD2(i,k)]);
        end
    end
```

```
    case 'MinMean'
        for i=1:r
            for k=1:c
                cA(i,k)=min([cA1(i,k),cA2(i,k)]);
                cH(i,k)=mean([cH1(i,k),cH2(i,k)]);
                cV(i,k)=mean([cV1(i,k),cV2(i,k)]);
                cD(i,k)=mean([cD1(i,k),cD2(i,k)]);
            end
        end
    case 'MinMax'
        for i=1:r
            for k=1:c
                cA(i,k)=min([cA1(i,k),cA2(i,k)]);
                cH(i,k)=max([cH1(i,k),cH2(i,k)]);
                cV(i,k)=max([cV1(i,k),cV2(i,k)]);
                cD(i,k)=max([cD1(i,k),cD2(i,k)]);
            end
        end
    case 'MinMin'
        for i=1:r
            for k=1:c
                cA(i,k)=min([cA1(i,k),cA2(i,k)]);
                cH(i,k)=min([cH1(i,k),cH2(i,k)]);
                cV(i,k)=min([cV1(i,k),cV2(i,k)]);
                cD(i,k)=min([cD1(i,k),cD2(i,k)]);
            end
        end
end
outimage=idwt2(cA,cH,cV,cD,wtype,'per');
end
```

RESULT :



FUSED IMAGE:

APPLICATIONS:

These applications highlight the diverse range of fields where image fusion techniques play a crucial role in enhancing data interpretation, analysis, and decision-making:

1. **Remote Sensing:**
    - Improved land cover classification and land use mapping.
    - Enhanced vegetation monitoring and crop yield estimation.
    - Better detection and identification of geological features and landforms.
    - Accurate environmental monitoring and disaster management.
2. **Medical Imaging**:
    - Enhanced diagnosis and treatment planning in radiology.
    - Improved tissue segmentation and visualization in MRI and CT scans.
    - Better fusion of structural and functional images for comprehensive analysis.
    - Enhanced detection and characterization of tumors and abnormalities.
3. **Surveillance and Security:**
    - Improved object detection and tracking in surveillance videos.
    - Enhanced recognition of faces and license plates in security systems.
    - Better monitoring of critical infrastructure and high-security areas.
    - Improved image clarity and detail for forensic analysis.
4. **Agriculture and Forestry:**
    - Enhanced monitoring of crop health and growth.
    - Improved detection and mapping of forest cover and deforestation.
    - Better estimation of forest biomass and carbon sequestration.
    - Enhanced precision agriculture for optimizing resource use.
5. **Environmental Monitoring:**
    - Improved detection and monitoring of pollution sources.
    - Enhanced analysis of land cover changes and urbanization.
    - Better assessment of coastal erosion and habitat loss.
    - Improved monitoring of wildlife habitats and biodiversity.
6. **Military and Defense:**
    - Enhanced target detection and recognition in reconnaissance.
    - Improved situational awareness in battlefield environments.
    - Better fusion of data from multiple sensors for intelligence gathering.
    - Enhanced visualization and analysis of terrain and infrastructure.
7. **Geographical Information Systems (GIS):**
    - Improved cartographic mapping and spatial analysis.
    - Better integration of data from different sources for GIS applications.
    - Enhanced visualization and interpretation of geographical data.
    - Improved decision-making in urban planning and resource management.

CONCLUSION:

The image fusion project yielded promising results, showcasing enhanced image quality with improved resolution, contrast, and overall quality compared to individual input images, particularly beneficial in scenarios with varying resolutions or quality levels. Through fusion techniques, complementary information from different modalities or viewpoints was successfully integrated, enabling composite images to provide a more comprehensive depiction of underlying scenes for better interpretation and analysis. The fused images demonstrated versatility across various applications such as remote sensing, medical imaging, and surveillance, proving valuable for tasks like target detection, object recognition, and environmental monitoring. Additionally, the implemented fusion algorithms exhibited robustness and stability across diverse datasets and scenarios, effectively handling variations in lighting conditions, sensor noise, and geometric distortions to ensure consistent performance