**Chapter 1**

**Introduction**

**1.1 The broad statement of design problem**

Image Denoising is one of the fundamental challenges in the field of image processing and computer vision, where the underlying goal is to estimate the original image by suppressing noise from a noise-contaminated version of the image. In Image Denoising we try to remove the noise from an image by using certain techniques so as to recovers the original image by retaining its quality, which gets corrupted during its acquisition or transmission. Therefore, image denoising plays an important role in a wide range of applications such as image restoration, visual tracking, image registration, image segmentation, and image classification, where obtaining the original image content is crucial for strong performance.  Noisy images are generally produced during medical procedures which require instruments to produce detailed pictures of the inside of your body such as MRI, CT scan, ultrasound, x-ray etc. In medical operation it is important to denoise an image so as to recover the suppressed anatomical details due to the noise. Bio-medical images are normally - corrupted with noise; which degrades the useful detail of medical images which may affect the diagnosis. In Bio-medical images the denoising should be done by balanced edge preservation as edges are an important aspect of the image. Thus, all medical imaging devices need denoising technique to enhance the image quality which will help the doctors and medical experts for proper diagnosis. In traditional denoising techniques, to improve the quality of the image the filter such as Median filter, Gaussian filter and Fspecial filter are directly applied over noisy image. But in our proposed method we first decompose the noisy image using BEMD (Bi dimensional Empirical Mode Decomposition) then we filter out the three images obtained from the decomposed image and add it to make a new and better image which recovers more details of the original image than the traditional method. In traditional method we directly apply the filter to the noisy image but in our proposed method we decompose the image into four parts using BEMD then we apply the filter to the IMF1, IMF2, IMF3 individually and adding these three images with residue image we get a better quality image than the traditional method. In our proposed method we have used BEMD instead of DWT (Discrete Wavelet Transform) because [1]. IDWT (Inverse Discrete Wavelet Transform) is required to reconstruct the image from the decomposed images and [2]. DWT is an image independent technique. This image denoising implementation will help us to get a better clarity picture and help us to study the problems and the details of an image. Most of the times the details of MRI, Ultra-sound images are hidden due to the noise caused by the equipments which causes the doctors, medicals specialists to pinpoint the actual problem. It will reduce the noise of an image which will give a clearer picture of the image and the actual problem or the area where the action has to be taken can be located.

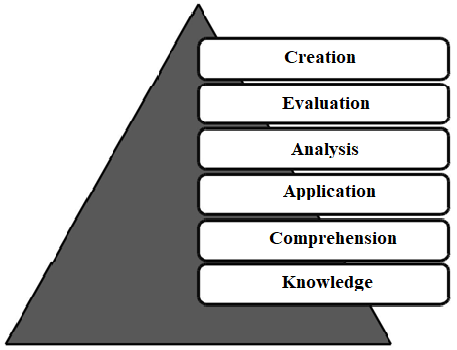
**1.2 Student’s outcomes and Bloom taxonomy of learning levels**

To facilitate the process of evaluation of the progress of the project, there are eleven student outcomes (student outcome A - student outcome K) for the Electrical and Electronics Engineering program. Each outcome is unique in its approach to inspect the ability of the student or the team in understanding and overcoming various issues faced during the course of the project. The table containing the description of each of these eleven student outcomes used to examine the quality of progress of the group is shown below.

Table 1.1.Student Outcomes:-

|  |  |
| --- | --- |
| **Outcome** | **Description** |
| A | An ability to apply knowledge of mathematics, science, and engineering |
| B | An ability to design and conduct experiments, as well as to analyses and interpret data |
| C | An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability |
| D | An ability to function on multidisciplinary teams |
| E | An ability to identify, formulate, and solve engineering problems |
| F | An understanding of professional and ethical responsibility |
| G | An ability to communicate effectively |
| H | The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context |
| I | A recognition of the need for, and an ability to engage in life-long learning |
| J | A knowledge of contemporary issues |
| K | An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice |

Bloom’s taxonomy is a three-tier hierarchical model used to promote higher forms of thinking in the educational system. It promotes understanding, processing, analyzing, etc instead of just memorizing things the old way. The three domains under the Bloom’s taxonomy are: cognitive, affective and psychomotor domains. For structuring and evaluating the project in the educational realm, only the cognitive domain is considered. There are six levels of learning as defined in the cognitive domain of the Bloom’s taxonomy: knowledge, comprehension, application, analysis, evaluation and creation. The levels are classified on the basis of complexity and specificity. The figure 1.1 graphically shows the cognitive learning levels of the Bloom’s taxonomy while the table 1.2 lists the descriptions of each learning level.



**Table 1.2. Learning levels**

|  |  |  |
| --- | --- | --- |
| **Level** | **Name** | **Description** |
| L-1 | Knowledge | Retrieving, recognizing, and recalling relevant knowledge from long-term memory |
| L-2 | Comprehension | Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining |
| L-3 | Application | Carrying out or using a procedure through executing, or Implementing |
| L-4 | Analysis | Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through diﬀerentiating, organizing, and attributing |
| L-5 | Evaluation | Making judgments based on criteria and standards through checking and critiquing |
| L-6 | Creation | Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing |

**1.3 Course Outcomes**

Course outcomes are statements that describe or list measurable and fundamentally mastered content knowledge, reflecting skills, competencies, and knowledge that students have achieved and can demonstrate upon successfully completing the project. Outcomes express higher-level thinking skills that integrate the course content and the activities that can be observed as a behavior, skill, or distinct useable knowledge upon completion of the course. In this project, the course outcomes can be verified in terms of the knowledge of the students in the field of image acquisition, image processing and object recognition in images as well as the detailed knowledge of the hardware implementations required to achieve the desired results. During the course of the project, the members of the group understand the needs of work distribution and time management for the successful completion of the project.

**1.4 Design Checkpoints**

The product design passes through several phases. Each phase in turn is separated into various steps. For the purpose of proper execution and evaluation of these steps, checkpoints are used. These checkpoints prove to be apt points of evaluation to ensure systematic and strategic progress of the project. Table 1.3 shows the checkpoints for each chapter to be fulfilled by the design team and the table 1.4 shows the timeline set for the checkpoints set in each chapter.

**Table 1.3. Design checkpoints & student outcomes**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Checkpoints** | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Customer needs |  |  |  |  |  |  |  |  |  |  |  |
|  | Recognition |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Function |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  | Decomposition |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Engineering |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  | Specification |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Product architecture |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Concept generation |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Concept selection | **√** |  | **√** | **√** | **√** |  |  |  | **√** | **√** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Product embodiment |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | Product metric model | **√** |  | **√** | **√** | **√** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | DFM, DFA, DFE |  |  | **√** | **√** |  | **√** |  | **√** | **√** | **√** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | Analytical and |  |  |  |  |  |  |  |  |  |  |  |
|  | numerical solution |  |  | **√** | **√** | **√** | **√** |  |  |  |  | **√** |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Physical prototype |  |  | **√** | **√** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Testing and |  | **√** | **√** | **√** |  |  |  |  |  |  |  |
|  | Improvement |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Final product and |  |  |  | **√** |  |  | **√** |  |  |  |  |
|  | Final Report |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 1.4. Timeline for design checkpoints**

|  |  |  |
| --- | --- | --- |
|  | **Checkpoints** | **Set time line** |
|  |  |  |
| 1 | Customer needs recognition | 02/10/2019 – 14/11/2019 |
|  |  |  |
| 2 | Function decomposition | 14/11/2019 – 15/11/2019 |
|  |  |  |
| 3 | Engineering specification | 17/11/2019 – 21/11/2019 |
|  |  |  |
| 4 | Product architecture | 01/12/2019 – 01/12/2019 |
|  |  |  |
| 5 | Concept generation | 15/12/2019 – 22/12/2019 |
|  |  |  |
| 6 | Concept selection | 05/01/2020 – 10/03/2020 |
|  |  |  |
| 7 | Product embodiment | 15/03/2020 – 17/03/2020 |
|  |  |  |
| 8 | Product metric model | 17/03/2020 – 21/03/2020 |
|  |  |  |
| 9 | Design for Manufacture, Assembly and | 28/03/2020 – 31/03/2020 |
|  | Environment |  |
|  |  |  |
| 10 | Analytical and numerical solution | 01/04/2020 – 03/04/2020 |
|  |  |  |
| 11 | Physical prototype | 04/04/2020 – 06/04/2020 |
|  |  |  |

**1.5 Design Team Selection**

At the outset the internal design panel (IDP) will divide students into small teams, specify or approve the design problem and will allot a guide for each team. This is given in Table 1.5.

**Table 1.5. Team allocation and problem selection for design team**

|  |  |
| --- | --- |
| Member 1: ABINASH PANDA  Member 2: ABHILASH KAR | Design Problem:  BEMD with Filter based image denoising of bio-medical images. |
| Name of Guide: LALIT MOHAN SATAPATHY | |

**1.6 Team Charter**

The Team Charter was prepared given in Table 1.6 with the signatures of the respective team members. The document would be attached as an Appendix in the Project Report.

**Table 1.6. Team charter**

|  |
| --- |
| **Team Charter of Team Number ‘Group 4’ of Section ‘B’** |
| **Our Objectives:** BEMD with Filter based image denoising of bio-medical images. |
| **We Are Involved :-**  Member 1: ABINASH PANDA (1641014033)  Member 2: ABHILASH KAR (1641014069) |
| **Our Project Guide:-**  Name of Guide: LALIT MOHAN SATAPATHY   |  |  | | --- | --- | | Designation: | ASSISTANT PROFESSOR | |
| **Our Goals :** Our goal is to denoise and enhance a noisy image by using BEMD with a filter |
| **Declaration**: We, the members of the Design Team ‘Group-4’, Section ‘B’, Department ‘EEE’, ITER, Siksha ‘O’ Anusandhan (Deemed University), hereby declare that we have created our own Team Charter, understood it, and agree to abide by it.  Member 1: ABINASH PANDA (1641014033)  Member 2: ABHILASH KAR (1641014069) |

**Chapter 2**

**Literature Survey**

**2.1 Introduction**

Customer need for recognition is the first and most important step. A purchase cannot take place without the recognition of the need. When someone perceives a gap between their current circumstance and an ideal or desired circumstance Need recognition occurs. Before they begin searching for an answer people need to understand they have a problem. Hence all the team members collected the information about the customer requirements by using various techniques like Questionnaire, Conducting Interview and Group Discussion so as to have better understanding of the needs and demands. The final verified outcome was properly organized and prioritized and then a suitable problem statement was decided. The required arrangements and constraints were finally listed.

**2.2 Task Distribution and Monitoring**

After the topics under the chapter were decided all the specified tasks were distributed among all the members of the group. These tasks involved making questionnaire, doing a market survey with the help of these questionnaires, conducting interviews with different customers and then a group discussion. According to the survey, organizing the project, according to the customer needs and prioritizing the needs of the customer which should be taken care off. Finally, the problem statement and the required constraints were decided. The table below describes the task distribution of all the members of the group.

**Table 2.1. Work done by each team member**

|  |  |  |
| --- | --- | --- |
| **Work Done by Each Member of Team Number ‘Group-4’ of Section ‘B’** | | |
| **Team member :-** ABINASH PANDA (1641014033)  ABHILASH KAR (1641014069) | | |
| **Task No.** | **Tasks to be performed** | **Task Assigned To** |
| Task 1. | Deciding topic | All |
| Task 2. | Market survey | All |
| Task 3. | Discussing questions for questionnaires | Abhilash Kar |
| Task 4. | Discussing questions for interviews | Abhilash Kar |
| Task 5. | Conducting questionnaires | Abinash Panda |
| Task 6. | Conducting Interviews | All |
| Task 7. | Discussing questions for group discussion | Abinash Panda |
| Task 8. | Conducting group discussion | All |
| **Signature of Members:-**  **Member 1 : Abinash Panda**  **Member 2 : Abhilash Kar** | | |

**2.3 Questionnaire Method**

A set of questionnaires were prepared and were circulated among different people in order to perform a market survey. This was performed through e-mails and even by paper and pen method (physically). The questionnaire were as following as depicted in the below table.

**Table 2.2. Questionnaire for the product**

|  |  |
| --- | --- |
| **Sl. No.** | **DESCRIPTION** |
| 1. | Is image processing important in the medical diagnosis?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 2. | Is image processing going help the doctors in finding out the problems in the scanned body image?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 3. | Is this image processing better than the other image processing found in the markets?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 4. | Does it significantly reduce the noise of the image?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 5. | Can this image processing be applied on coloured images?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 6. | Can it process every bio-medical images of different frequency?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 7. | Does any modification or changes required to be made to the current denoising image technique?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 8. | Can it process satellite captured images?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 9. | Can it be used in other images other than bio-medical images?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |
| 10. | Are there any cheaper methods available for bio-medical image processing?  (a) Strongly Agree (b) Agree (c) Disagree (d) Strongly Disagree |

**2.4 Interview Method**

An interview was conducted at the places where the customer uses the product. Their requirements and suggestions were noted for future improvement of the product.

**Table 2.3. Interview form for product**

|  |  |  |
| --- | --- | --- |
| Customer Name : Sanjay Kumar Sahu  Address :  Kharavela Nagar, bbsr | | Interviewer :  Abinash Panda  Abhilash Kar  Date : 12/01/2020 |
| **Question** | **Customer Statement** | **Interpreted need** |
| Typical Uses | Analysis of Digital Image | Good |
| Removal of Noise | Good |
| Performance Analysis | Good |
| Likes | Cost | Cheap |
| Ease Of Operation | Easy |
| Usage Limit | No limits |
| Dislikes | Time Taken | 2-3 mins |
| Suggested Improvements |  |  |

**2.5** **Focus Groups**

A group of customers were arranged, and a moderate discussion was conducted so that the customer needs can be better understood so as to provide a better solution for it.

|  |  |  |
| --- | --- | --- |
|  | **Table 2.4. Focus group form for the product** |  |

|  |  |  |
| --- | --- | --- |
| Customer Name : Sanjay Kumar Sahu  Address :  Kharavela Nagar, bbsr | | Interviewer :  Abinash Panda  Abhilash Kar  Date : 12/01/2020 |
| **Question** | **Customer Statement** | **Interpreted need** |
| Typical Uses | Analysis of Digital Image | Good |
| Removal of Noise | Good |
| Performance Analysis | Good |
| Likes | Cost | Cheap |
| Ease Of Operation | Easy |
| Usage Limit | No limits |
| Dislikes | Time Taken | 2-3 mins |
| Suggested Improvements |  |  |

**2.6** **Organizing and Prioritizing Customer Needs**

**Organizing:**

According to the survey and the group discussion performed different review and suggestions of the customers were collected and organized such that the needs of the customer can be fulfilled in the best possible way. The above organization is done using an affinity diagram which helps in better understanding of the product.