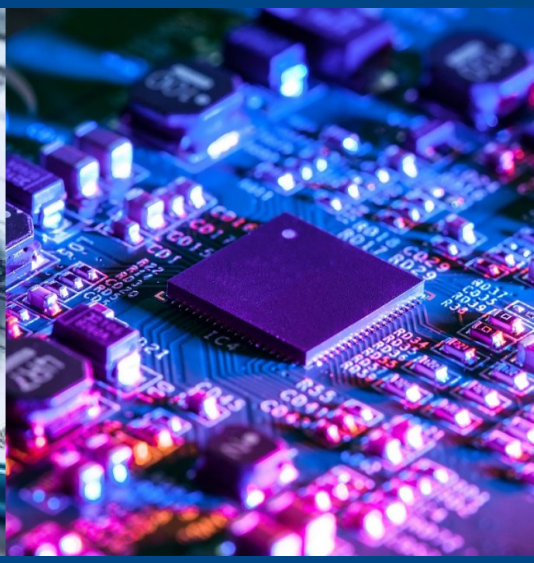
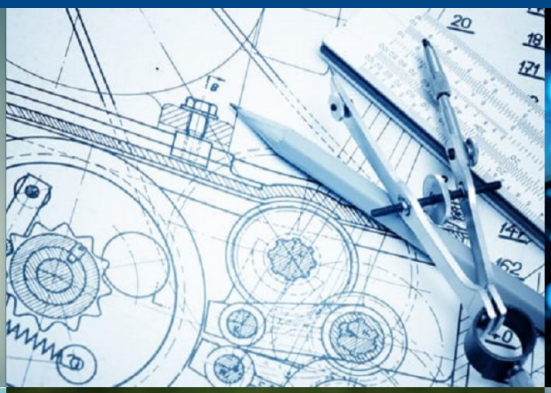
ISSN: 2582-7219

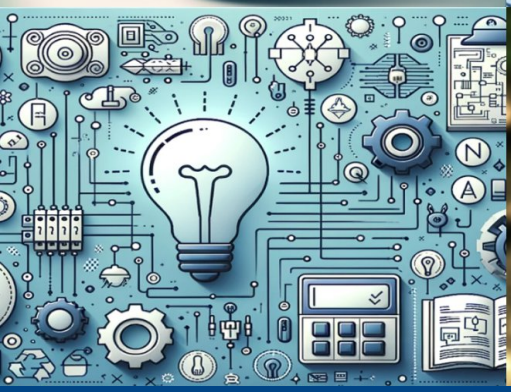




International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206 **Volume 9, Issue 4, April 2026**

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Smart Building Defect Detection and Solution System

S. Amsavalli[1], A. Abdul Hadhi Khan[2], H. Anas Haroon[3]

Assistant Professor, Department of Computer Applications, B.S. Abdur Rahman Crescent Institute of Science and Technology, Tamil Nadu, India[1]

BCA – CTIS, Department of Computer Applications, B.S. Abdur Rahman Crescent Institute of Science and Technology, Tamil Nadu, India[2]

BCA – CTIS, Department of Computer Applications, B.S. Abdur Rahman Crescent Institute of Science and Technology, Tamil Nadu, India[3]

ABSTRACT: Structural defects such as cracks and surface damages in buildings can threaten structural safety and long-term durability if they are not detected at an early stage. Traditional inspection methods mainly rely on manual visual observation performed by engineers or inspectors, which can be time-consuming and prone to human errors. This paper presents a Smart Building Defect Detection and Solution System that uses deep learning and computer vision techniques to automatically detect building cracks from uploaded images. The system employs a Convolutional Neural Network (CNN) model to identify the presence of cracks, while OpenCV-based image processing techniques are used to analyze crack patterns and determine severity levels such as Low, Medium, and High. Based on crack size and severity, the system dynamically estimates the approximate repair cost and provides suitable maintenance solution recommendations. In addition, the system supports before- and-after image comparison, enabling users to visually analyze structural changes and evaluate repair effectiveness. The proposed web-based system improves inspection efficiency, reduces manual effort, and supports smart infrastructure monitoring and preventive building maintenance.

KEYWORDS: Smart Building Inspection, Crack Detection, Convolutional Neural Network (CNN), OpenCV, Image Processing, Structural Defect Detection, Automated Maintenance System.

I. INTRODUCTION

Buildings and civil infrastructures are essential for modern urban development and public safety. Over time, these structures may develop defects such as cracks and surface damage due to environmental conditions, aging, and structural stress. If these defects are not identified at an early stage, they may lead to serious structural problems and increased maintenance costs. Traditional inspection methods mainly rely on manual visual observation by engineers, which can be time-consuming and dependent on human expertise.

Recent advancements in artificial intelligence and computer vision have enabled automated approaches for structural inspection. Deep learning techniques, particularly Convolutional Neural Networks (CNN), can effectively detect cracks and structural defects from building images. By integrating deep learning with image processing techniques, automated systems can provide faster and more reliable analysis. In addition, intelligent systems can assist in estimating repair costs, displaying builder contact details after cost estimation, and providing visual evaluation through before-and-after image comparison.This paper presents a Smart Building Defect Detection and Solution System that automates crack detection and structural damage analysis using image-based techniques. The main contributions of the proposed system include:

A CNN-based detection model to identify crack patterns from uploaded building images.

An OpenCV-based crack analysis module to determine crack severity levels such as Low, Medium, and High.
A repair cost estimation mechanism based on crack size and pixel analysis.
A builder contact display feature that provides builder details after cost estimation.
A before-and-after image comparison module to visually evaluate structural repairs.

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

II. RELATED WORKS

Several studies have explored automated crack detection in concrete structures using image processing and deep learning techniques. Alkannad M. [1] proposed CrackVision, a deep learning-based system that uses transfer learning to detect concrete cracks from structural images with improved accuracy.

Biswarup Yogi [2] presented a method for early surface crack detection and localization in structural components using image-based analysis. The study emphasized the importance of early crack identification to improve structural safety and maintenance planning.

Shalaby M. [3] developed an automated crack detection approach for condition assessment of concrete structures, demonstrating that vision-based inspection systems can assist engineers in monitoring structural health and reducing manual inspection efforts.

Cao X. [4] introduced an automated method for detecting and assessing crack development in Ultra High Performance Concrete (UHPC) structures, highlighting the role of automated monitoring techniques in infrastructure maintenance.

Cha et al. [5] proposed a CNN-based crack detection model that automatically identifies crack patterns from structural images and improves detection performance compared to traditional image processing methods.

However, most existing studies mainly focus on crack detection alone. In contrast, the proposed Smart Building Defect Detection and Solution System not only detects cracks but also performs severity classification, repair cost estimation, and before-and-after image comparison through a web-based platform for efficient building inspection and maintenance.

III. PROPOSED SYSTEM

The proposed Smart Building Defect Detection and Solution System automatically detects structural cracks in building surfaces using deep learning and computer vision techniques. The system processes uploaded building images through steps such as image preprocessing, CNN- based crack detection, severity analysis, and repair cost estimation. This approach improves inspection accuracy and reduces manual effort in building maintenance.

Web-Based Image Upload Interface
A web interface allows users or building owners to upload images of building surfaces for structural inspection. The system receives and stores the uploaded images for further analysis.

Image Preprocessing
Uploaded images are preprocessed using resizing, normalization, grayscale conversion, and noise reduction to improve image quality and ensure consistent input for crack detection.

CNN-Based Crack Detection
A Convolutional Neural Network (CNN) model analyzes the preprocessed images and automatically detects the presence of cracks in building surfaces.

Crack Severity Analysis
OpenCV-based image processing techniques are used to analyze crack characteristics. Edge detection and pixel analysis are applied to classify crack severity as Low, Medium, or High.

Repair Cost Estimation, Builder Contact and Report Generation
Based on the detected crack severity and crack size, the system estimates the approximate repair cost. The system also provides builder contact details to help users connect with repair professionals. In addition, a before-and-after image comparison feature is provided to evaluate structural repair effectiveness. Finally, a detailed inspection report is generated for building maintenance and monitoring.

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IV. SYSTEM ARCHITECTURE

The proposed Smart Building Defect Detection and Solution System follows a three-layer architecture consisting of the Client Layer, Application and Processing Layer, and Data & Storage Layer. This architecture allows efficient interaction between users, processing modules,and the database for automated crack detection and analysis.

The Client Layer includes the Admin and the User (Building Owner). Users can upload building surface images through the web interface and view crack severity results and inspection reports, while the Admin manages login operations and updates builder details.

The Application and Processing Layer performs the main system operations. The Flask Web Server handles user authentication and image handling. The Crack Detection Module uses a CNN model with OpenCV image processing to detect cracks and classify their severity. The Repair Recommendation Engine analyzes crack characteristics to estimate repair cost and provide suitable repair suggestions along with builder contact details.

The Data and Storage Layer stores system data using a MySQL database. The Report Generator creates a PDF inspection report containing crack severity results, repair cost estimation, and before-and-after image comparison for building maintenance and monitoring. Fig. 1 depicts the three-layer system architecture.

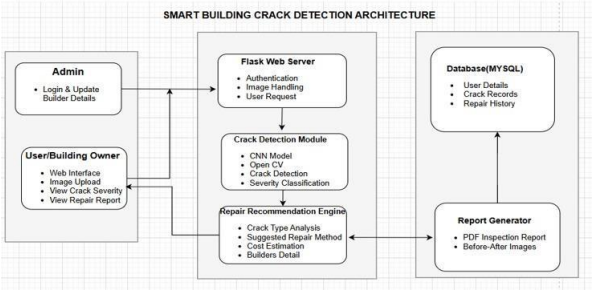


Fig. 1. Smart Building Crack Detection Architecture

V. IMPLEMENTATION DETAILS

The Smart Building Defect Detection and Solution System is implemented using Python-based technologies for automated crack detection and structural analysis. The system allows users to upload building surface images through a web interface, where deep learning and image processing techniques are applied to detect cracks and analyze defect severity. Based on the detected crack characteristics, the system estimates repair cost, provides maintenance recommendations, and generates inspection reports. The major implementation components are summarized below:

Python 3.x – Used for backend system development and processing logic.
Flask Framework – Used to develop the web interface and handle user requests and image uploads.
TensorFlow / Keras – Used to implement the CNN model for crack detection.
OpenCV and NumPy – Used for image preprocessing, crack detection, and severity analysis.
MySQL Database – Used to store user information, crack detection records, and repair history.
ReportLab Library – Used to generate automated PDF inspection reports.

TABLE I
System Implementation Parameters

Parameter	Value / Description
Operating System	Windows
Programming Language	Python 3.x

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Web Framework	Flask
Deep Learning Framework	TensorFlow / Keras
Image Processing	OpenCV, NumPy
Database	MySQL
Report Generation	ReportLab

VI. RESULTS AND DISCUSSION

This section presents the experimental results obtained from the proposed Smart Building Defect Detection and Solution System. The system was tested using multiple building surface images containing different crack patterns. The performance of the system is evaluated based on crack detection accuracy, severity classification, and automated maintenance support.

Crack Detection Results

The trained CNN model successfully detected cracks from uploaded building images. The system accurately distinguishes crack and non-crack regions by analyzing image features and patterns. The detection results demonstrate that the model can effectively identify structural defects from different building surface conditions.

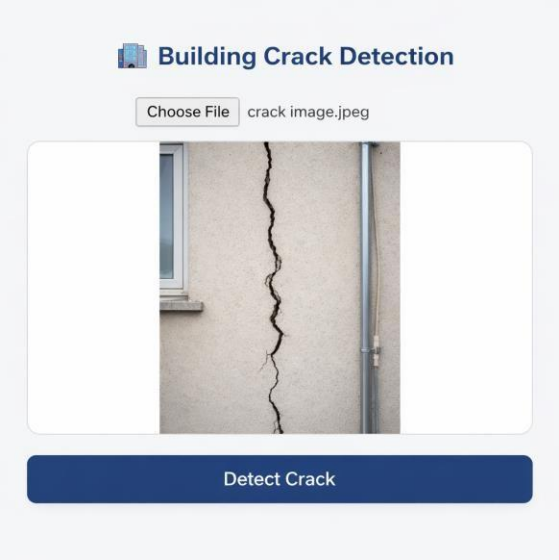


Fig. 2. Crack Detection Results Screenshot

Crack Severity Analysis

After crack detection, OpenCV-based image processing techniques are applied to analyze crack characteristics. The detected crack regions are converted into grayscale and processed to calculate crack pixels. Based on pixelintensity and crack size, the system classifies the severity levels as Low, Medium, and High.

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

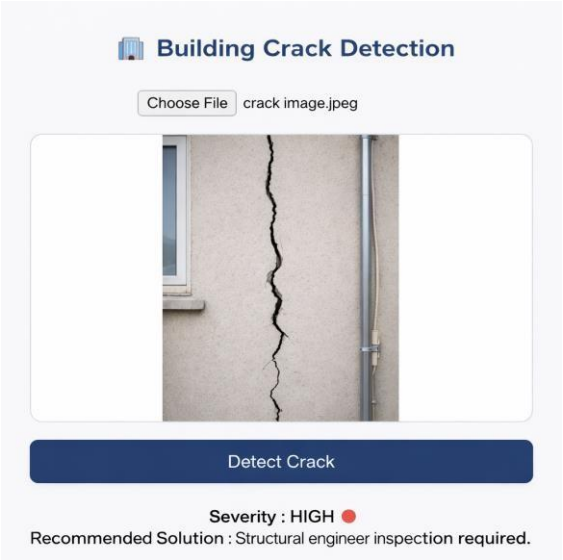


Fig. 3. Crack Severity Analysis Screenshot

Repair Cost Estimation and Recommendation

Based on the detected crack severity and size, the system dynamically estimates the approximate repair cost. In addition, the system provides suitable maintenance recommendations and builder contact details to assist users in planning repair activities.

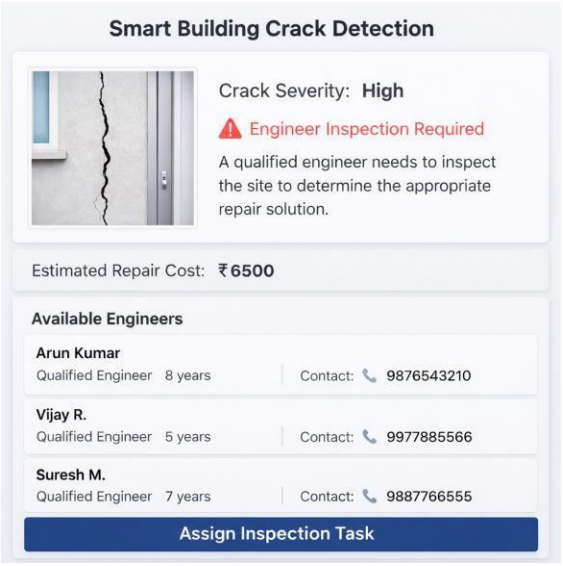


Fig. 4. Repair Cost Estimation and Builder Contact Screenshot

Report Generation and Visualization

The system automatically generates a PDF inspection report containing crack detection results, severity analysis, estimated repair cost, and recommended repair solutions. The report also includes before-and-after image comparison, which helps users visually evaluate structural repair effectiveness.

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

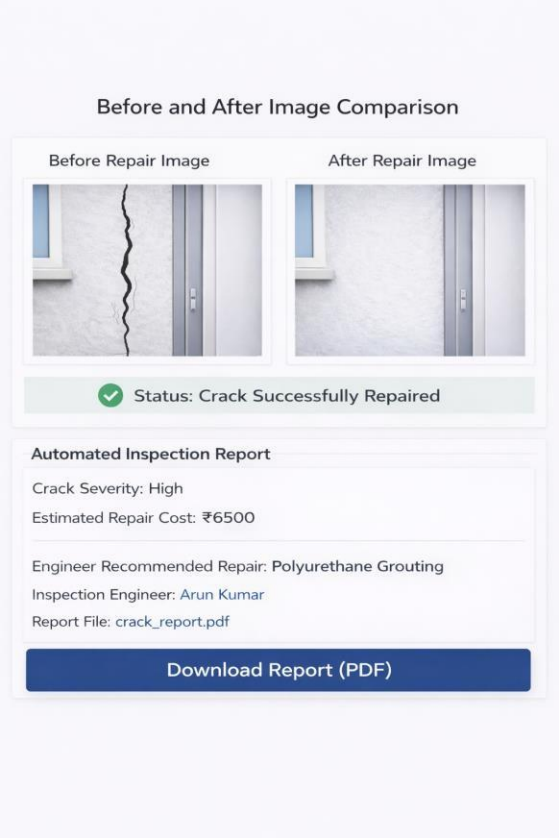


Fig. 5. Generated PDF Inspection Report Screenshot

TABLE II

Crack Detection Results

Image ID	Crack Detected	Severity Level	Estimated Repair Cost
Img-01	Yes	Low	₹1,500
Img-02	Yes	Medium	₹4,000
Img-03	Yes	High	₹8,500
Img-04	No Crack	–	–
Img-05	Yes	Medium	₹5,200

COMPARATIVE ANALYSIS

Table III compares traditional crack inspection methods, existing automated detection approaches, and the proposed Smart Building Defect Detection and Solution System. Traditional inspection mainly relies on manual observation, which is time-consuming and prone to human errors. Some automated approaches detect cracks using image processing or deep learning techniques. However, the proposed system integrates crack detection, severity analysis, repair cost estimation, and automated report generation in a single framework, improving inspection efficiency and decision support for building maintenance.In addition, the proposed system provides a user-friendly web interface that allows building owners to upload images and obtain crack analysis results instantly. The system also enables structured data storage and report management for future reference and maintenance planning. By combining deep learning with image processing techniques, the system improves detection accuracy and reduces the need for frequent manual inspections. Therefore, the proposed approach offers a more efficient, scalable, and intelligent solution for modern building defect monitoring and maintenance management.

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904358

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

TABLE III

Comparison of Crack Detection Approaches

Feature	Traditional Inspection	Automated Methods	Proposed System
Crack Detection	Manual	Automatic	Automatic
Severity Analysis	Limited	Partial	Full
Cost Estimation	No	No	Yes
Report Generation	Manual	Limited	Automatic
Inspection Time	High	Moderate	Low

SECURITY ANALYSIS

Security and reliability are important aspects of the proposed Smart Building Defect Detection and Solution System. The system ensures safe handling of user- uploaded images and reliable crack analysis through several mechanisms.

Secure Image Processing: Uploaded building images are processed within the application server to ensure safe data handling.

User Authentication: Only authorized users can access the system and upload inspection images.

Secure Data Storage: User details and crack detection records are stored securely in the database.

Reliable Detection: CNN-based crack detection combined with OpenCV image processing improves analysis accuracy.

Report Integrity: The system generates reliable inspection reports including crack severity and repair cost estimation.

These mechanisms improve the reliability and security of the system for building inspection and maintenance applications.

VII. CONCLUSION

This research presented an intelligent web-based system for identifying structural defects in buildings using image-based analysis. The proposed framework integrates deep learning and computer vision techniques to support automated building inspection and maintenance planning. By allowing users to upload building surface images through a simple web interface, the system assists in detecting structural cracks and analyzing defect characteristics efficiently.

The developed system not only identifies crack presence but also supports practical maintenance decision-making by providing repair cost estimation, maintenancesuggestions, and inspection documentation. The integration of automated defect detection with maintenance support features demonstrates the potential of smart technologies in modern infrastructure monitoring.

Overall, the proposed system contributes to improving the efficiency of building inspection processes and supports safer and more reliable structural maintenance practices.

VIII. FUTURE ENHANCEMENTS

Future improvements can enhance the system by incorporating more advanced deep learning models for detecting different types of structural defects such as corrosion, surface damage, and structural deformation. The system can also be extended as a mobile-based application to enable real-time crack detection using smartphone cameras.Further enhancement may include improving crack measurement accuracy using advanced image processing techniques. In addition, predictive maintenance methods and intelligent data analytics can be integrated to support better building repair planning and long-term infrastructure monitoring.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

REFERENCES

1. Alkannad M., "CrackVision: Effective Concrete Crack Detection with Deep Learning and Transfer Learning," IEEE, 2025.
2. Biswarup Yogi, "Early Surface Crack Detection and Localization in Structures," Springer Nature, 2025.
3. Shalaby M., "Condition Assessment of Concrete Structure using Automated Crack Detection," Discover Civil Engineering, 2024.
4. Cao X., "Automatic Detection and Assessment of Crack Development in UHPC," Springer Nature, 2024.
5. Y. Cha, W. Choi, and O. Büyüköztürk, "Deep Learning-Based Crack Damage Detection Using Convolutional Neural Networks," Computer-Aided Civil and Infrastructure Engineering, 2017.
6. S. Dorafshan, M. Thomas, and M. Maguire, "Deep Learning- Based Concrete Crack Detection Using CNN," Automation in Construction, 2018.
7. Z. Zhang et al., "Automatic Crack Detection and Measurement Based on Image Processing Techniques," IEEE Access, 2016.
8. Y. Cha and O. Büyüköztürk, "Vision-Based Damage Detection Using Deep Learning," Structural Health Monitoring Journal, 2018.
9. C. Yeum and S. Dyke, "Vision-Based Structural Damage Detection using Machine Learning," Journal of Structural Engineering, 2015.
10. H. Kim et al., "Deep Learning-Based Structural Damage Detection using Convolutional Neural Networks," Structural Control and Health Monitoring, 2019.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com