# Executive Summary of the Project Work Entitled “An Effective Framework for Detection and Diagnosis of Liver Tumour through Image Processing Techniques”

**Done Under the UGC-Minor Research Project**

<table>
<thead>
<tr>
<th>No.</th>
<th>Details</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Project report</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>UGC Reference No.</td>
<td>F.6684/16</td>
</tr>
<tr>
<td>4.</td>
<td>Title of research project</td>
<td>An Effective Framework for Detection and Diagnosis of Liver Tumour through Image Processing Techniques</td>
</tr>
<tr>
<td>5.</td>
<td>(a) Name of the Principal Investigator</td>
<td>Dr. K. Jayanthi</td>
</tr>
<tr>
<td></td>
<td>(b) Dept.</td>
<td>Electronics and Communication Engineering</td>
</tr>
<tr>
<td></td>
<td>(c) College where work has progressed</td>
<td>Pondicherry Engineering College</td>
</tr>
<tr>
<td>6.</td>
<td>Effective date of starting of the project</td>
<td>21-08-2017</td>
</tr>
<tr>
<td>7.</td>
<td>Grant approved and expenditure incurred during the period of the report:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Total amount approved</td>
<td>Rs.5,00,000/-</td>
</tr>
<tr>
<td></td>
<td>(b) Total amount sanctioned</td>
<td>Rs.4,76,250/-</td>
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<tr>
<td></td>
<td>(c) Report of the work done:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Brief objective of the project</td>
<td>The main aim of this research work is to assist doctor in surgical planning by providing an enhanced version of the CT</td>
</tr>
</tbody>
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*Dr. K. Jayanthi,
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image which clearly depicts the presence, location and margin of tumour / tumours in the liver from the screened images.

- To classify the detected tumour as benign, malignant, primary or secondary liver cancer.
- To provide 3D model of liver precisely highlighting the presence of normal and abnormal tissues of liver.

ii. Work done so far and results achieved and publications, if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication)

1. Enhancement of liver CT images from contrast enhanced computed tomography images and plain CT images:
2. Classification of liver tumour:
3. 3D visualization and Volumetry Analysis of liver and liver tumour.

Papers were published in *scopus and SCI indexed journals, approved by UGC. The list is indicated as follows:

**Journals:**

4. **GoogLeNet based Ensemble FCNet Classifier for Focal Liver Lesion Classification** – IEEE Journal of Biomedical and Health Informatics - Communicated


**Conferences:**

9. B. Lakshmi Priya, K. Jayanthi, Biju Pottakkat & G. Ramkumar

10. B. Lakshmi Priya, K. Jayanthi, Biju Pottakkat & G. Ramkumar,

### iii. Has the progress been according to original plan of work and towards achieving the objective? if not, state reasons

**Yes.**

### iv. Please enclose a summary of the findings of the study. One bound copy of the final report of work done may also be sent to the concerned Regional Office of the UGC.

**Progress report Enclosed (Annexure-A)**

### v. Any other information

| Details of Research project contributions provided in Annexure-A |

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**SIGNATURE**

PRINCIPAL INVESTIGATOR

**Dr. K. Jayanthi**

M.Tech, Ph.D, MISTe, PROFESSOR

Dept. of Electronics and Communication Engineering

Pondicherry Engineering College

Praja Chavady, Puducherry 605 014

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**PRINCIPAL**

(Seal)

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Pondicherry Engineering College

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Annexure-A
Summary of Research Contributions

An Effective Framework for Detection and Diagnosis of Liver Tumour through Image Processing Techniques

Project Objectives:
- To assist doctor in surgical planning by providing an enhanced version of the CT image which clearly depicts the presence, location and margin of tumour / tumours in the liver from the screened images.
- To classify the detected tumour as benign, malignant, primary or secondary liver cancer.
- To provide 3D model of liver precisely highlighting the presence of normal and abnormal tissues of liver.

RESEARCH OUTCOMES

This research work has been initiated with an impulse of addressing the challenges faced by the clinicians in the treatment of liver disorders; explored various technological aspects and finally consummated with the development of state – of – the – art algorithms in the areas of enhancement, pattern recognition, classification and 3D volumetric analyses. The outcomes of this research study are categorized as significant contributions and the improvements achieved over the existing algorithms.

Significant Contributions

The following are the significant contributions of this research work addressing most of the healthcare confrontations in the diagnostic and therapeutic practice of liver cancer:
- Successfully demonstrated the feasibility of detection, diagnosis and further therapeutic procedure of most types of liver lesions solely from plain CT images in a non – invasive approach. This kind of non – invasive complete...
• **diagnostic solution is not implemented in literature so far and is not in practice anywhere till now.**

Some of the sample images obtained out of this study is furnished below:

<table>
<thead>
<tr>
<th>Lesion type</th>
<th>Visualization obtained using Simpleware Software Available at PEC</th>
<th>Visualization seen using Myrian Software Available in JIPMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Liver</td>
<td><img src="image1" alt="Normal Liver Visualization" /></td>
<td><img src="image2" alt="Normal Liver Visualization" /></td>
</tr>
<tr>
<td>Abnormal liver</td>
<td><img src="image3" alt="Abnormal Liver Visualization" /></td>
<td><img src="image4" alt="Abnormal Liver Visualization" /></td>
</tr>
</tbody>
</table>

- While most of the research on liver tumour in literature focuses on enhancement and classification, this work additionally implemented **3D analysis of liver related disorders in a cost effective manner.**
- The proposed enhancement strategy resulted in providing coloured output images from the grayscale CT images precisely highlighting the presence of abnormal tissues from the normal ones.
- Implemented fusion of liver CT images for the first time.
- **Demonstrated that focus measures so far claimed for assessing the image quality, can also be used as features in the classification of liver CT images.**
Improvement over State – of – the – Art Algorithms

- Multi-slice and multi-temporal fusion methodologies in NSCT domain resulted in better performance in terms of all the metrics when compared with fusion implemented using DWT and Contourlet transforms and with the existing algorithms implemented in [29], [30] and [34].
- The classification accuracy of 84.85% is achieved in classifying 6 classes of lesions using focus features with multi-temporal fused images as input whereas a classification accuracy of 83.67% is obtained when GLCM features are extracted for similar scenario.
- Classification accuracy of 96.26% in is obtained by varying the activation function of GoogLeNet architecture in classifying six classes of two stage enhanced liver images.
- The proposed GoogLeNet based Ensemble FCNet Classifier records superior performance of 97.37% when compared to GoogLeNet and Alexnet architectures (93.63% and 86.66% respectively).
- Suggested a suitable cost effective alternative for Myrian software for surgical planning.

MAJOR SOCIETAL CONTRIBUTIONS

Since the major cause for liver cancer is high prevalence of alcoholism, the threat of liver cancer can be considered as a predominant medico – social problem. Consequently, the efforts taken in this research to offer a plausible assistance for the medical experts for timely and precise diagnostic impression will greatly benefit the patient community and clinicians as well. The contributions of this research work for the benefit of the society and the other healthcare confrontations are listed below. This research
To whomsoever it may concern

The work carried out under the UGC MRP grant and JSAC project titled “An Effective Framework for Detection and Diagnosis of Liver Tumour through Image Processing Techniques” by Ms. B. Lakshmi Priya and Dr. K. Jayanthi from Pondicherry Engineering College is found to precisely differentiate the tumour portion from the healthy liver parenchyma. The enhancement outcome obtained from the non-contrast CT image has to be greatly appreciated as it contains diagnostic information equivalent to that of contrast enhanced CT images.

The results of 3D analysis done from CECT and non-contrast CT images using Simpleware Scan IP software at PEC procured under UGC MRP Grant clearly portray the presence of tumours within the liver similar to that found in real time. The results obtained using this software are clinically correlated with the Myrian software currently used in JIPMER. It is newly observed and reported that the tumour also contain some normal liver tissue and fat. While Myrian calculates volume based on the perimeter of the tumor, this algorithm calculates the volume based on tissue density. The deviations in the volumetric calculations of the work done by them may be explained in this way.

Based on the above said facts, it can be concluded that the outcome of this collaborative research will provide a cost effective solution for surgical planning and pathology of liver tumor from non-contrast CT images.

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The contributions of this research work for the benefit of the society and the other healthcare confrontations are listed below. This research

• Facilitates medical practitioners in the precise diagnosis of liver pathologies by providing a coloured image from grayscale CT images.

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- Offers an elite solution in the detection, diagnosis and further therapeutic procedure of liver lesions from plain CT images.
- Assists surgeons in their surgical planning by providing a cost effective 3D visualization and volumetric estimation of liver CT images.
- Provides a first step towards non-invasive diagnosis of liver cancer.
- Will offer a next generation radio-diagnosis solution for safe CT screening.

SIGNATURE OF THE PRINCIPAL INVESTIGATOR
( DR.K.JAYANTHI, PROFESSOR, DEPT. OF ECE)

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Annexure C

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

CERTIFICATE

It is certified that executive project summary, outcomes and papers published under UGC (SERO) – Minor Research Project grants obtained for the project entitled “An Effective Framework for Detection and Diagnosis of Liver Tumour through Image Processing Techniques” approved through File No. MRP-6684/16(SERO/UGC) dated June 2017 has been posted and made available in the college website www.pec.edu.

Principal Investigator
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