CHAPTER 7
CONCLUSION

7.1 The sixth C - 'Certification'

The best reason to go for certification of diamonds is insurance. But there is nothing wrong with buying a non-certified diamond. Anyone who is in the trade should have enough confidence in their professional expertise to sell what he claims that non-certified diamond to be and also have the confidence to send the diamond off to be certified by GIA, EGL or AGS [74]. If they are competent the diamond should grade out very close to what it is presented as. GIA is the Gemological Institute of America. IGI is the International Gemological Institute. EGL is the European Gemological Laboratory. All three are respected independent grading laboratories. To obtain a certificate is not quite easy, as it might often take weeks and cost over a hundred dollars for a major gemological institute's evaluation [75]. A certificate from GIA should not be confused with local paperwork by an independent "graduate GIA gemologist" or a retail replacement appraisal. Laboratory conditions and completely unbiased impartial grading is the hallmark of internationally recognized gemological institutions.

GIA Diamond Grading Report, EGL Diamond Certificate, AGS Diamond Quality Report, Sarin Analysis Report, and Sarin Dia-Mension Label are the Common types of Diamond Certificates. The GIA diamond grading report is shown in figure 7.1. The diamond grading reports of IGI, EGL and AGS are shown in figures 7.2, 7.3 and 7.4 respectively. The Sarin analysis report is shown in figure 7.5.

Diamonds and diamond grading in India

Reputed to endow the wearer with purity, love and joy, the diamond is traditionally the emblem of fearlessness. Romantic in history and symbolic of love, diamond is the hardest of all natural substances. Diamonds are about expressions, experience, emotions, impressions and identities. Grading and classification of diamonds are based on the internal features and defects seen in diamond. Diamond grading is based on the qualitative aspects such as clarity, color, cut and carat weight - popularly known as 4-C's [76].
Figure 7.1 GIA Diamond Grading Report [77]
INTERNATIONAL GEMMOLOGICAL INSTITUTE
SCIENTIFIC LABORATORY FOR IDENTIFICATION AND GRADING
OF DIAMONDS AND COLORED STONES

570 FIFTH AVENUE
NEW YORK, N.Y. 10017
TEL: (212) 759-7100
FAX: (212) 759-7709

DIAMOND REPORT

LABORATORY REPORT (ORIGINAL)

TO WHOM IT MAY CONCERN

Certificate Number: 2101703

DATE: NEW YORK

04/11/96

NATURAL DIAMOND

DESCRIPTION:

ROUND BRILLIANT CUT

SHAPE AND CUT:

WEIGHT: 0.36 CARAT

MEASUREMENTS: 4.59 - 4.66 x 2.76 MM.

PROPORTIONS and FINISH

Total depth percentage 59.7 %
Table Diameter percentage 59.0 %
Grown height percentage 14.0 %
Pavilion depth percentage 42.6 %

CUTLET SIZE: NONE

GIRDLE THICKNESS:

FINISH: MODERATE/GOOD

CLARITY GRADE (1 to 5):

SI 1

COLOR GRADE:

G (1)

FLUORESCENCE: NONE

The symbols do not usually reflect the size of the characteristic. Red symbols indicate internal characteristics, green indicate external.

COMMENTS:

Magnificent external details, visible only under high magnification, are not mentioned.

Figure 7.2 IGI diamond grading report [75]
Figure 7.3 EGL diamond grading report [77]
Figure 7.4 AGS diamond Quality document [77]
SARIN ANALYSIS REPORT

<table>
<thead>
<tr>
<th>SHAPE</th>
<th>ROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEIGHT</td>
<td>1.05</td>
</tr>
<tr>
<td>DIAMETER (mm)</td>
<td>6.59 (6.57 - 6.61)</td>
</tr>
<tr>
<td>CROWN ANGLE</td>
<td>34.5°</td>
</tr>
<tr>
<td>CROWN HEIGHT</td>
<td>15.2%</td>
</tr>
<tr>
<td>PAVIL ANGLE</td>
<td>40.8°</td>
</tr>
<tr>
<td>PAVIL DEPTH</td>
<td>42.8%</td>
</tr>
<tr>
<td>CULET</td>
<td>0.9%</td>
</tr>
<tr>
<td>TABLE SIZE</td>
<td>36.0%</td>
</tr>
<tr>
<td>TOTAL DEPTH</td>
<td>60.8%</td>
</tr>
<tr>
<td>GIRDLE THICK%</td>
<td>1.0 - 1.4%</td>
</tr>
</tbody>
</table>

PROPORTION CUT GRADE 0

Does not include Polish or Symmetry

CLARITY  VVS2
COLOR     G
FLUORESCENCE NONE

SARIN TRIPLE-0 CUT H&A-A-LASER INSCRIPTION

Signature

Color, Clarity, Polish, and Symmetry are not machine graded

SARIN ANALYSIS REPORT
AGS LABORATORY STANDARD

Figure 7.5 SARIN analysis report [77]
Diamond certification helps in assessing the correct characteristics of the diamond and classifies it according to rigid parameters, which are based on the four Cs of the diamond. Major gemological laboratories in the country are International Gemological Institute (IGI), Mumbai, Gemological Institute of India (GII), Mumbai and Indian Diamond Institute (IDI), Surat. GII's Gem Testing Laboratory is a service organization working for the benefit of the Indian Gem industry [78]. Diamond certification is still a very new concept in the country. The diamond certification assures the consumer of the quality and worth of diamond and assures a proper resale value. On one carat of diamond, gemological laboratories are charging nearly one per cent for testing and certification. The new high-resolution laser-engraved technology has the ability to mark on mounted or loose stones and will personalize any alphanumeric messages including name, birth date etc [79]. The Gemological Institute of India (GII) is the first non profit research and educational organization in the field of Gemology in India. It is a public institution founded by the Gem and Jewelry Exporters’ Association, Bombay. The Institute was established in the year 1971 for the promotion propagation and development of the science of gemstones and research studies in India. India's share in the world of diamonds in terms of volume is about 80% and in terms of value it is about 55%. In fact it is said that every 8 diamonds out of 10 sold in the world markets today are cut and polished in India.

Gem Testing Laboratory is the backbone of the Gem Industry in India. The Laboratory is also open to the General Public. Gem testing laboratory of the GII extends its services, whenever required, to the Customs department of the Government of India for identifying gemstones in the course of imports and exports. India's premier, impartial and independent gem testing laboratory is located in the heart of the Gemstone market in Bombay. More than 50,000 gemstones have been certified till date. GII's Gem Testing Certificates are of international standard and are valid all over the world.

Diamonds in India are considered to be as part of culture and civilization. From time immemorial diamonds were primarily associated with India. Till 1875 it was assumed that diamonds were only found in India. India has the biggest workforce cutting and polishing of diamonds. Over 10,00,000 artisans are engaged in cutting and polishing of diamonds in India. The sizes ranging from 0.005 cts (carats) to 0.20 cts are the specialization of Indian artisans. No doubt in recent
times India also entered into the manufacturing of large size diamonds as well. The export of diamonds from the country is to the tune of US$ 6 billions as against the world imports of US$ 11 billion in the year 2000. Such an important and massive industry in India needs a proper certification facility. Keeping this need of the industry in mind, GII has started Diamond Grading and certification as per International Standards. GII is also equipped with the most sophisticated instruments that are used by International Laboratories in the World.

Diamond Grading Charges [78]

Full Certificate:
- Diamond upto 0.49 cts.
  Rs. 1,000/-
- Diamond of 0.50 cts. upto 0.99 cts.
  Rs. 1,500/-
- Diamond of 1 cts. upto 1.99 cts.
  Rs. 2,000/-
- Diamond of 2 cts. upto 2.99 cts.
  Rs. 2,500/-
  Rs. 3,000/-
- Diamond of 5 cts. and above
  Rs. 4,000 + Rs. 1,000 per ct.

Written Opinion:
- Diamond upto 0.49 cts.
  Rs. 700/-
- Diamond of 0.50 cts. upto 0.99 cts.
  Rs. 1,050/-
- Diamond of 1 cts. upto 1.99 cts.
  Rs. 1,400/-
- Diamond of 2 cts. upto 2.99 cts.
  Rs. 1,750/-
  Rs. 2,100/-
- Diamond of 5 cts. and above
  Rs. 3,100/- + Rs. 700 per ct.

Diamond Certificate – Methodology

Each and every Diamond is certified after a thorough analysis and study by 3 diamond graders. Each diamond undergoes rigorous and meticulous study and analysis by the experienced, highly qualified and internationally trained diamond graders and their opinion is compiled and codified to decide final grading of a diamond.
Facts about the diamond grading certificate / the lab grading report [25]

1. A lab grading report isn’t a guarantee. The opening line on a GIA lab grading report states, “This report is not a guarantee, valuation, or appraisal”’. No lab wants to guarantee anything or leave anyone with the impression that they do, because if something goes wrong in the transaction they do not want to be held responsible.

2. Grading a diamond can be so subjective some of the labs use four or more graders to get a consensus. In some cases not even four graders can agree so they bring in more people to break the tie!

3. Lab grading reports only represent a snapshot of the opinion of the graders at the time the report was taken.

4. A lab grading report is not a certificate. A certificate would authoritatively confirm the facts and a lab grading report states a few facts but mostly subjective opinions. It was the jewelry industry (not the labs) who started the slang use of the word “certificate” in reference to lab grading reports. GIA categorically states that they do not certify any person, place, or thing. EGL USA does use the word certificate on their grading reports, but they disclaim any responsibility for any errors or omissions in the report.

5. According to Lynn Ramsey, publicist for EGL, EGL USA is the only lab in North America to certify synthetic diamonds.

6. At an additional cost, all the labs allow diamonds to be resubmitted for re-grading if the submitter is unhappy with the original results.

7. None of the labs agree with each other on one standardized system for measuring proportions.

8. GIA uses proprietary Sarin machines to assist in determining measurements.

9. Lab grading reports could become null and void if a diamond is worn.

10. Lab grading reports lose their value (even if the diamond isn’t worn) as they get older.

11. Leverage gauges, Megascopes, Sarin machines, and scales are temperamental. According to the manufacturers, if the equipment is clean and calibrated before each testing the results are 99.9 percent accurate. If hundreds of stones are tested between calibrations then measurements may be off ± or − 3 percent. Since it is financially infeasible for a lab to calibrate their equipment
for every stone, a separate Megascope or Sarin report must accompany or replace the lab grading report to confirm its physical measurements.

12. No one lab grading report provides all the vital information. Therefore, it is possible for a diamond to appear to look good (read well) on its lab grading report when in actuality it is unattractive to the eye.

13. It is not a fact that if a lab grading report “reads” poorly, the diamond must be ugly, because the lab grading report may have judgments which are misleading. Also, beauty is still in the eye of the beholder. There are a lot of diamonds that technically return a poor amount of light, are off color and heavily included, but are loved anyway by their owner.

14. A lab grading report is an opinion on the overall quality of the diamond and does not increase the diamond’s worth.

15. A lab grading report is not a guarantee, valuation, or appraisal.

16. A lab grading report is different from a bonding document which guarantees value. A bonded diamond is a natural diamond that is fully warranted by the jeweler and covers breakage, buy back, and exchange.

17. The price of a GIA lab grading report is based on the size of the diamond. The average cost for a GIA lab grading report is around $177.00.

18. GIA takes four or five business days to give the lab grading report.

19. Diamonds with a lab grading report should not cost more than diamonds without one. If the jeweler is working very tightly on the price of the stone, there is an argument that the diamond would cost approximately $100 more since that is the average cost of the typical lab grading report.

20. Sometimes total depth does not equal crown + pavilion + girdle. There are three possible reasons: (1) The Sarin and Megascope machines have been calibrated to choose just the perfect crown or pavilion angle instead of a large multiple average. Then, taking the tangent of the angles, the machine calculates the crown height or pavilion depth. If the crown angle and the pavilion angle that were chosen were warped angles, the rest of the data will be wrong. (2) Some graders “guesstimate” instead of actually measuring correctly. (3) Some Sarin and Megascope reports are scanned into a computer, altered, and reprinted. The most the totals should be off is one-half of 1 percent.
Top 10 Buying Mistakes

Buying a diamond is a decision that must not be taken lightly. Most consumers have preconceived ideas about diamonds, which are often not true. The 10 biggest mistakes consumers make when shopping for a diamond [5] are given below.

1. Assuming all Diamonds of the same color and clarity are the same.
2. Assuming all Diamonds are well cut.
3. Assuming color and clarity are the major determinants in pricing a Diamond.
4. Assuming that choosing a specific color and clarity grade and then shopping for the lowest price will yield the best Diamond.
5. Assuming that a Diamond that has been graded by a Laboratory is automatically a good stone.
6. Assuming that a Diamond can be purchased "by the numbers" alone.
7. Assuming that extensive shopping will lead to a bargain price on a Diamond.
8. Assuming color is the most important characteristic. Assuming clarity is the most important characteristic.
9. Assuming a Diamond can be bought cheaper...
   ...When the Jewelry show comes to town
   ...When the Diamond goes on Sale
   ...When traveling to another Country
   ...From a Company selling Diamonds on the Internet.
10. Assuming a Diamond can be bought without Professional guidance.

Jewelers cannot be trusted to tell the truth. People were and are buying diamonds every day based on who has the best story to tell. In a jewelry store with its hundred canned spotlights and very good stories the money is laid down. In short, Value of the Diamond = Trust on the Seller. There is no consistent and reliable method for diamond identification. The Certification process is also found to be consuming some extra expense but not a once only process. Therefore, it is true that the method presented in this thesis is a great boon to the sellers as well as buyers of diamonds. The method explained in this thesis was applied for testing samples from several jewelries in Tamilnadu and Karnataka in India, and the results were found to be consistent and reliable. The certificate proposed for the purpose of being issued by the jewelries is given in Appendix I. Some of the certificates issued by the jewelries whose samples were tested are attached in Appendix II.
7.2 Review of Work done

Digital Image Processing has a wide range of applications like Office automation, Industrial automation, Bio-medical, Remote sensing, Scientific applications, Criminology, Astronomy and space applications, Meteorology, Information technology, Entertainment and consumer electronics, Printing and graphic arts, and Military applications. The major aim of the present attempt is to apply Digital Image Processing techniques to another area ‘Gemology’, the result of which is found to be satisfactory. The principle objective of this work is the identification of original diamond from Cubic Zirconia, which is the most dominant simulant / substitute for original diamonds, by using affordable and commonly available hardware and software. The methods used are simple enough for even a layman to understand and apply.

In this thesis an attempt is made to provide a systematic and step-by-step system that is sure to help the buyer as well as the seller to be confident in whether original diamond or Cubic Zirconia is being bought or sold, using digital image processing techniques instead of the conventional methods like the usage of the 10X loupe. The present work is concerned with the acquisition of the image of the diamond under specific conditions, digitizing it, and then processing the digital image using various ‘Image Enhancement’ techniques. The main intention of the research work carried out is to distinguish original diamond from one of its dominantly used simulant CZ, by the application of the non-destructive digital image processing techniques. While carrying out the work the following were set as the objectives.

1. Using digital image processing technique to find the girdle diameter of the given gemstone. The Elliptical Marquee tool in the powerful image editing software Adobe Photoshop is used for this purpose. Study of mass and size relationship is made by the use of Density, Mass and Volume related by the formula Density is the ratio of Mass to the Volume, that is, DENSITY = MASS / VOLUME.

2. Using ‘thresholding’ and ‘histogram’ in the identification of original diamonds from Cubic Zirconia when the gemstones in hand that need to be tested seem to be of same dimensions, to the unaided or naked eye.
3. Using sharpening, edge detection, and blurring techniques in the identification of original diamonds from Cubic Zirconia when the gemstones in hand that need to be tested seem to be of same dimensions, to the unaided or naked eye.

4. Identification of the inclusions in original diamonds by examining it using two methods, method I and method II that apply a newly devised sharpness filter named D-filter (Diamond Filter).

The salient features of the work carried out are now reviewed below.

Years of training and experience are necessary to become a professional gemologist, but with practice and a little hands-on work, it can be found that it takes surprisingly little time before feeling more confident about what is bought and sold. The step-by-step system presented in this thesis is sure to help the buyer as well as the seller to be confident in whether original diamond or Cubic Zirconia is being bought or sold, using digital image processing (DIP) techniques instead of the conventional methods like the usage of the 10X loupe.

The method involved in the present work has been used to test diamonds from different jewelers / sellers and even buyers. It has been found that the DIP result agreed with the result got using conventional methods. The sellers and buyers were surprised to know such a method. The experts in the field of Computer Science and Computer Applications have surely found a new area of application for ‘Digital Image Processing’. The certificates of satisfaction and appreciation about this work have been obtained from different jewelers. A new format of the Certificate that may be issued to the buyers of the diamonds has also been proposed.

A scanner is used for scanning a three dimensional object (diamond) (three different views: table view, pavilion view and culet view). A very simple tool, the elliptical marquee tool is used to find the mass of the gemstone (table view image is used). Study of mass and size relationship by the use of Density, Mass and Volume related by the formula Density is the ratio of Mass to the Volume has been used. The geometric representation of the diamond when placed on the scanner with its pavilion resting on the scanner’s glass is used in finding the volume of the diamond.

The diamond images acquired are processed using the concept of thresholding for identifying original diamonds from Cubic Zirconia (culet view images have been used). Thresholding technique and histogram concept prove to be simple but useful techniques, and are successful in identifying original diamonds from Cubic Zirconia.
The edge detection, sharpening and blurring techniques have been used to further confirm the correctness of the diamond identification process performed using thresholding, by making use of the idea that number of edge pixels is more in the case of original diamonds than Cubic Zirconia (culet view images have been used). This difference is due to the different light properties of the two gemstones (original diamonds and CZ).

An attempt was made to identify the inclusions in the original diamonds, by the application of a new sharpness filter. This new filter devised and found suitable for the present work was named the D-Filter (Diamond filter). The above filter proved itself in making the image look more precise, by enhancing the edges. The inclusions are analyzed in two different methods. In the first method, method I, as the inclusions are seen in shades of white, such areas are alone isolated and displayed against a black background. The second method, method II is simpler than the first. In method II, after the application of the D-filter, the image is embossed at two different angles; say 0 degree and 180 degrees. For every diamond that is examined for inclusions, both the methods are used for better confirmation regarding the presence of inclusions.

Computer models, even though three dimensional, they do not serve to differentiate between the original and simulants, but provide an understanding of how the general principles of light interact with the diamond and what cut parameters will result in maximum light return and fire.

These details may provide useful information to the scientists and researchers, but not to a purchaser or a customer of a diamond who may be a layman. Certificates stating the parameters and quality of the diamond can be obtained only from GIA and GII. Even if they are available, the customer has to pay a fee apart from the cost of diamonds, to get them certified. These certificates are based on the opinion and experience of the gemologist, and therefore, for the same diamond there is possibility to get inconsistent certificates. Hence, the present research work aims at making even a layman to understand what ‘Diamond’ is with his own computer. This work uses ‘Digital Image Processing’ techniques. It is also sure that the methods explained in this thesis provide consistent results.
7.3 Future Research

The present work is basically an attempt to identify / differentiate colorless, unmounted (loose), round brilliant cut original diamond from CZ, based on their optical properties, but does not concentrate on the cut proportions of the diamond. This work is not involved in finding out whether the diamond under study is shallow, deep, or ideal. An attempt has been made to find out the existence of inclusions using the D-filter. Due to the presence of inclusions, the weight of the diamond may vary from its actual weight. This is one of the reasons for allowing a tolerance of +/-15% deviation from the DIP weight, and if the difference is more than or less than this tolerance value, the gem will not be recommended. As the device used for image acquisition is the scanner, which is a more general and common one, it is believed that, by using the pavilion view images and the ratio of the minor and major axis as stated in Chapter 3, it might be possible to find out the pavilion angle, so as to conclude whether the diamond is shallow, deep, or ideal.

This work may be extended to analyze colorless as well as color diamonds of different shapes, namely fancy cut diamonds. Using the same elliptical marquee tool in Adobe Photoshop, it is believed that the table view image of the mounted diamond may be acquired, its diameter found and its mass may be calculated. Also, the present work is limited to identifying / differentiating original diamonds only from Cubic Zirconia. In future, this may be extended to identifying / differentiating original diamonds from other varieties of colorless, round brilliant cut gemstones like Zircon, sapphire, and glass, by studying their optical properties. In future, new software may be developed to automate the entire process.