CHAPTER 1

INTRODUCTION

The steady increase in population correspondingly increases the number of diseases people are prone to. The early diagnosis of a disease is of paramount importance, which is a major challenge faced by the medical experts. Health information, especially, clinical information increases on a daily basis and is extremely variable and is also complicate to assess. As a result, there is a demand for finding the criteria that can be used to evaluate the quality of hidden information. One of the most important problems of medical diagnosis, in general, is the subjectivity of the specialist. All these factors have resulted in the use of computers to assist the experts in their diagnosis.

Computers play a strategic role in eliminating medical errors using medical alerts and protocols that make healthcare professional aware of the possibility for a miscalculation. The basis for a valid diagnosis also depends on the sufficient number of varieties of cases. However, the experience in analyzing the complications is acquired only in the middle of physician’s career. Humans can recognize objects or patterns very easily but failed when probabilities have to be applied to observations. Computer assisted information retrieval may assist to support quality decision making and avoid human error. Although human decision-making is often optimal, it is poor when huge amounts of data are involved for classification.
1.1 AN OVERVIEW OF HEALTHCARE INDUSTRY IN INDIAN SCENARIO

Computer Aided Diagnosis (CAD) is a fast growing research field that has set a new horizon in the medical domain. It has increased the quality of current medical imaging technologies by bringing in new developments in medical imaging technology. CAD works by using different learning to compare new medical images to past ones that have already had abnormalities.

CAD has already been successfully implemented for a number of medical problems which includes cancer, fractures etc. The diagnostic interpretation of medical images is a multi-faceted task. The objective is the accurate detection and precise characterization of potential abnormalities which is a crucial step towards an effective treatment. The CAD is a technology designed to decrease observational oversights. It identifies suspicious features on the medical images and indicates them to the attention of sonologists or the radiologists in order to decrease false negative readings.

These computer programs describe a procedure that supports the doctor’s interpretations and findings. Analysis of medical images is essential in modern medicine. With an increasing amount of patient data, new challenges arises opportunities in developing computer programs to assist in medical diagnosis.

Recently, CAD has become a part of the routine clinical work for the detection of breast cancer on mammograms at many screening sites and hospitals in India. This seems to indicate that CAD is beginning to be applied widely in the detection and differential diagnosis of many different types of
abnormalities in medical images obtained in various examinations by the use of different imaging modalities.

Even though CAD software’s were developed for uncovering many diseases like micro calcification in mammograms, chest, colon, brain, liver, skeletal and vascular systems, is lacking application to ultrasound obstetrics and gynecology domain. CAD has been established by taking into account equally the roles of physician and computer.

In a classical, early study conducted in 1972 depicted few basic facts in the medical area of diagnosis. In the University Clinic of Leeds, UK, 472 patients with acute abdominal pain were examined and diagnosed. With simple, probability-based methods like Baye’s classification, the diagnostic decision probabilities were computed based on a database of 600 patients. Additionally, a second set of probabilities were computed by using a synthetic database patients build on the interviews of experts and questionnaires about ‘typical’ symptoms. Then, the 472 cases were diagnosed [195] by an expert round of three experienced and three young physicians. The results of the experiment are as follows:

- Best human diagnosis with most experienced physician is 79.7%
- Computer with expert data base is 82.2%
- Computer with 600 patient data is 91.1%

Medical domain makes use of databases to store information about the patients like patient’s history, surveys and medical investigation from several other services. The medical databases contain data in a variety of formats like images, textual information, psychology reports, medical articles or various signals like ECG, EEG, etc. which are called features.
The healthcare environment is generally perceived as being ‘information rich’ yet ‘knowledge poor’. There is a wealth of data available within the health care systems. Nevertheless, the ability to effectively analyze, discovering relationships is a major issue. Valuable information can be discovered from application of image fusion techniques in health care systems.

For the past several decades, research in the medical imaging field has focused on bringing new imaging modalities to radiologists while improving the performance of existing systems. Now, software engineers are making the next move by introducing software improvements, enabling computers to assist doctors in interpreting the acquired medical information using CAD.

The basic concept of CAD is to provide a computer output as a “second opinion” to assist a radiologist’s image readings. Highly specialized tools are necessary to assist the experts in diagnosing the diseases. Therefore, for the development of a successful CAD scheme it is necessary not only to develop compute algorithms, but also to investigate how useful the computer output would be for radiologists, and how to maximize the effect of the computer output on their diagnosis. As a result, the research and development of CAD has involved a team effort by investigators from different backgrounds involving physicists, radiologists, computer scientists, engineers, psychologists and statisticians.

The analysis and interpretation of medical images represent two of the most responsible and complex tasks and usually consist of multiple processing steps. The medical images [193] are analyzed in several steps:
1. **Preprocessing:**
   a. For reduction of artifacts.
   b. Image noise reduction.
   c. Leveling of image quality for making the images more clear.

2. **Segmentation:**
   a. For a differentiation of different structures in the image.

3. **Structures/ROI Analysis:**
   a. Every detected region is analyzed individually for special characteristics.
   b. Compactness.
   c. Form, size and location.
   d. Reference to class-by-structure / ROI’s.
   e. Average gray level value analyze within an ROI.
   f. Proportion of gray levels to border of the structure inside the ROI.

4. **Evaluation / Classification**

   After the structure is analyzed every ROI is evaluated individually for the radiologists. Depending on the CAD system, markings can be permanently or temporarily saved.

1.2 **GESTATIONAL DIABETES MELLITUS**

   The human placenta is a fetus’s lifeline during gestation, providing nutrients and antibodies, while eliminating waste products via the mother’s blood supply. The placenta is an integral part of the child’s development, but
is generally disposed of, after delivery. The relatively new field of placenta analysis within the field of prenatal pathology investigates the possibility of learning important health information about the fetus from the placenta. The general opinion on the placenta is its use in the exaction of stem cells. Beyond that the placenta holds vital information that can contribute to clinical practice and the growth of the fetus in the womb.

The placenta is connected to the uterine wall and exchanges nutrients and waste through the placental blood barrier. The Figure 1.1 represents the human placenta [198] during the pregnancy. The placenta connects to the fetus by the umbilical cord containing two arteries and one vein. The cord inserts itself into the chorionic plate, or fetal side of the placenta, where the vessels branch into a network covered by a thin layer of cells. This vascular network is one area that placenta analysts continue to research. Similar to the root system of a plant, the vascular network must effectively and efficiently provide nutrients for the fetus as it grows larger. Intuitively, the optimal network would have the base of the umbilical connection in the center where vessels branch evenly and thoroughly in all directions. Previous studies have found that the average placenta is in fact structured optimally with round placentas having the umbilical cord centrally inserted.

Additional studies have found that the directional growth of the vascular network influences the final shape of the placenta. For example, if the uterine environment limits the growth of vessels, the placental shape will reflect the obstacle. Currently, the causes of placental shape irregularity are not fully understood. Furthermore, medical understanding of the effects of irregularly shaped placentas and poor vascular coverage is also limited. Gestational Diabetes or Gestational Diabetes Mellitus (GDM) is a condition
in which women without previously diagnosed diabetes exhibit high blood glucose levels during pregnancy.

Figure 1.1 Placenta and fetus during pregnancy

About 80% of the diabetes [1,193] in the world will be present in developing countries like India. India accounts for the largest number of people, about 50.8 million [4] suffering from diabetes in the world, followed by China with about 43.2 million and the United States with 26.8 million, as per the new figures released by the International Diabetes Federation in the year 2009. As per the reports of World Health Organization [2], the number of diabetics throughout the world was 171 million in the year 2000 and expected to reach 350 million by 2030. The diagnosis of GDM is an important public health issue. Gestational diabetes is much more common than pre-existing [9] diabetes as it complicates about 2-5% of pregnancies.

Gestational diabetes is formally defined as “any degree of glucose intolerance with onset or first recognition during pregnancy. Gestational diabetes is caused when the body of a pregnant women does not secrete excess insulin [49] required during pregnancy leading to increased sugar levels. This definition acknowledges the possibility that patients may have
previously undiagnosed diabetes mellitus or may have developed diabetes [50] coincidentally with pregnancy. Babies born to mothers with gestational diabetes are typically at increased risk of problems such as being large for gestational age.

A random survey by a team of doctors under Dr.V.Seshiah (Diabetes Care and Research Institute) showed [28] a statistics (2002) that about 16.2% of pregnant women in Chennai were found to have GDM.

1.3 DIABETES AND PREGNANCY

During pregnancy there are many changes that take place in the mother's metabolism. One of the changes is a rise in insulin resistance. The placenta supplies a growing fetus with nutrients and produces a variety of hormones to maintain the pregnancy. Some of these hormones have a blocking effect on insulin. The effect of placental hormones leads to higher levels of maternal blood glucose after eating which is called as postprandial levels that may aid fetal growth. Normally, the mother's beta cells can produce additional insulin to overcome the insulin resistance of pregnancy. As the placenta grows, more hormones are produced, and insulin resistance becomes greater. The precise mechanisms underlying gestational diabetes remain unknown. The hallmark of GDM is increased insulin resistance. Since insulin promotes the entry of glucose into most cells, insulin resistance prevents glucose from entering the cells properly. As a result glucose remains in the blood stream, where glucose levels rise. More insulin is needed to overcome this resistance. About 1.5 to 2.5 times more insulin is produced than in a normal pregnancy. The gestational diabetes mellitus results when the mother's production of insulin is not enough to overcome the effect of the placental hormones. The GDM poses risk both to the mother and the child. The complications include growth abnormalities in the baby, chemical
imbalances which interfere with the maturation, causing dysmature babies, congenital abnormalities and so on. The Whites Classification [49] named after Priscilla White who pioneered in research on the effect of diabetes types on prenatal outcome is widely used to assess maternal and fetal risk. It distinguishes between gestational diabetes and diabetes that existed prior to pregnancy. These two groups are further subdivided according to their associated risks and management. There are two subtypes of gestational diabetes.

**Type A1:** It is due to abnormal Oral Glucose Intolerance Test (GTT) but normal blood glucose levels during fasting and two hours after meals. Diet modification is sufficient to control glucose levels.

**Type A2:** It is due to abnormal GTT compounded by abnormal glucose levels during fasting and or after meals. Additional therapy with insulin or other medications is required.

Insulin resistance is a normal phenomenon emerging in the second trimester of pregnancy which progresses thereafter to high levels seen in non-pregnant patients with the types two diabetes. It is thought to secure glucose supply to the growing fetus. Women with GDM have an insulin resistance. They cannot compensate with increased production in the beta-cells of the pancreas. Placental hormones and to a less extent increased fat and deposits during pregnancy seem to mediate insulin resistance during [51] the pregnancy.

As glucose travels across the placenta the fetus is exposed to higher glucose levels. This leads to increased fetal levels of insulin, a situation when insulin cannot cross the placenta. The growth stimulating effects of insulin can lead to excessive growth and a large body. GDM poses a risk to mother
and child. This risk is largely related to high blood glucose levels and its consequences. The risk increases with higher blood glucose levels. The main risk GDM imposes on the baby is growth abnormalities like Down’s syndrome. Birth defects usually originate sometime during the first trimester before the 13th week [52] of pregnancy. Whereas, the GDM which gradually developed, is least pronounced in the ultrasound during the first trimester. Studies have shown that the offspring of women with GDM are at a higher risk for congenital malformations. Special fetal testing and monitoring may be needed for pregnant diabetics. These tests can include the following:

a) **Fetal Movement Counting:** Counting the number of movements or kicks in a certain period of time and watching for a change in activity.

b) **Ultrasound:** A diagnostic imaging technique which uses high-frequency sound waves and a computer to make images of blood vessels, tissues and organs. Ultrasound is used to view internal organs as they function and to assess blood flow through various vessels.

c) **Non-stress testing:** A measurement of the fetal heart rate in response to the fetus movements.

d) **Biophysical profile:** A test that uses the non-stress test and ultrasound to examine fetal movements, heart rate and amniotic fluid amounts.

e) **Doppler flow studies:** A type of ultrasound which uses sound waves [54] to measure blood flow.
1.4 PLACENTA

The placenta is a fetal organ which provides the physiological link between a pregnant woman and the fetus. Placenta is a membranous vascular organ which holds the embryo. The Figure 1.2 gives the picture [199] of the mature human placenta.

![Image of the human placenta](image)

**Figure 1.2 Human Placenta in Diabetes**

Its main function is to provide [14] the embryo with nourishment, eliminate its wastes and exchange respiratory gases. It is expelled after the birth. The placenta develops from the chorionic villi at the implantation site at about the fifth week of gestation and by the ninth or tenth week the diffuse granular echo-texture [58] of the placenta is clearly apparent at sonography. The placenta is a complex and so far poorly understood organ which plays the central metabolic role in pregnancy. In addition to synthesizing various hormones it regulates the transport of maternal fuels to the fetus and facilities
maternal [55] metabolic adaptations to different stages of pregnancy. The placenta of the diabetic women has attracted much interest largely because it is thought that placental damage may be partially responsible for the unduly high incidence of fetal [56] complications. As a result of which the placenta structure and functional changes depend on the gestational period of the diabetic insult and by inference on the type of diabetes. There is heaviness of placenta in the case [48] diabetic pregnancy.

1.4.1 Placenta in Ultrasound

Screening examinations during pregnancy are an essential part of prenatal care. Among the various screening tests that are now offered to pregnant women, ultrasound has the broadest diagnostic spectrum. There is no modality that can detect as many abnormalities [76] throughout pregnancy as ultrasound. Another important advantage of ultrasound is its low cost. Besides the early detection of a nonviable pregnancy ultrasound at the end of the first trimester can detect gross fetal anomalies or at least show initial signs that are suggestive of complications. The examination of the placenta appears to be treated with less attention than the fetus or the pregnant uterus. A methodical sonographic evaluation of the placenta plays a foremost role in the assessment of normal and abnormal pregnancies.

There are different ways in which the ultrasound [79] technology can be used in pregnancy related diagnosis.

1. Abdominal ultrasound: Abdominal Ultrasound is the most common used in pregnancy related diagnosis. In this ultrasound the sonologists moves the transducer over the abdomen to scan the uterus and examine the development of the baby and several other conditions of the uterus. This
research uses ultrasound images of placenta obtained by abdominal scan.

2. Vaginal Ultrasound: In vaginal ultrasound, a sterilized probe is gently placed in the vagina but outside the cervix. The probe is covered with a thin plastic sheath. This technique helps sonologists to minutely observe the women’s uterus.

3. Doppler Ultrasound: Doppler ultrasound is used to examine the blood flow in the vessels. This technique is performed in the same way as abdominal ultrasound.

![Figure 1.3 An ultrasound image displaying a normal placenta (long and thin) on the left and abnormal (small and thick) placenta on the right](image)

The ultrasound examination done between 19 to 22 weeks determines the location and size of the placenta and its maternal blood supply. The placental ultrasound tests done later than twenty two weeks, result in a poor assessment of potential problems in placental functions.

Placental Morphology refers to the description of the placental size, shape and texture determined through ultrasound scanning at 19 to 22 weeks.
The placental morphology [194] is said to be normal if the placenta should appear long (>10cm in length) and thin (<4cm in width) in size. It should also be a smooth, consistent texture. Figure 1.3A and Figure 1.3B represent an ultrasound image displaying a normal and abnormal placenta. The placenta morphology is said to be abnormal if the placenta is thick and small. The texture appears to be consistent. The Figure 1.4 represents an ultrasound image displaying abnormal placental texture.

![Figure 1.4 An ultrasound image displaying abnormal placental texture](image)

Other abnormalities can be determined through ultrasound scanning are:

- **Abnormal umbilical cord insertion**: The umbilical cord inserts into the placenta somewhere other than the centre.
  - **Marginal cord insertion**: The cord inserts into the edge of the placenta.
  - **Velamentous cord insertion**: The cord inserts into the membranes, not into the placenta. If this occurs, the woman is at risk of developing vasa previa.

- **Abnormal number of blood vessels in the umbilical cord**: The umbilical cord has only two, instead of three, blood vessels.
During pregnancy, the placenta supplies a growing fetus with nutrients and water as well as produces a variety of hormones to maintain the pregnancy. In early pregnancy hormones can cause increased insulin secretion and decreased glucose produced by the liver. In later pregnancy, some of the hormones like estrogen, cortisol and human placental lactogen can have a blocking effect on insulin, a condition called insulin resistance. As the placenta grows more of these hormones are produced and insulin resistance becomes greater. Under normal condition pancreas secretes insulin to overcome insulin resistance but when the production of insulin is not enough to overcome the effect of the placental hormones, gestational diabetes results or there may be worsening of pre-existing diabetes.

The central question has been whether the placenta adapts to the diabetic environment with the ultimate result of protecting the fetus from the adverse diabetic environment or whether the placenta contributes to the adverse fetal outcome [57] associated with diabetic pregnancies despite improvement in the case of diabetic women.

1.5 EFFECT OF DIABETES ON PLACENTA

The following are the adverse effects of GDM on placenta.

a. Abortions.
b. Large placenta and fetal size.
c. Congenital anomalies where, Sacral dysgenesis is a specific anomaly related to diabetes.
d. Intrauterine death of fetus is 5% especially in the last four weeks due to
   • Ketosis
   • Hypoglycemia
Placental development is a complex process of various coordinated differentiation steps that are mostly completed at the end of the second trimester. Thereafter, placental growth is predominantly characterized by mass expansion. Thus, development of placenta precedes fetal development and growth, the latter being pronounced in the third trimester. Any increase of the diabetes in maternal environment during the critical period of placental differentiation during the first and second trimester, introduces changes in the placenta morphology which has a profound effect on subsequent fetal growth and this is the focus point of this research. The human placenta undergoes a number of structural [57] changes which ultimately will facilitate the development of the fetus. A novel study [197] conducted in Tamil Nadu by a team of doctors in the year 2012 suggested the screening of pregnant women for gestational diabetes as early as at 16 weeks of gestation.

1.6 CLINICAL CHARACTERISTICS OF PLACENTA

The number of women affected [20, 17] by GDM is 3 to10% of pregnancies. Certain factors that contribute to placental abruption [16] are women having gestational diabetes and preeclampsia. The miscarriages of 44% and neural tube defects occur thirteen to twenty times more frequently in diabetic pregnancy and preeclampsia is 12% in the case of diabetic [17] pregnancy. The intrauterine growth restriction is 25% for non healthy population.
The normal placenta has a diameter of about 22.0 cm and thickness is about 2.0 to 2.5 cm. The Table 1.1 below shows the clinical characteristics of placenta with respect to various [14] complications.

**Table 1.1 Clinical Characteristics of Placenta**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Length</th>
<th>Thickness</th>
<th>Clinical Class</th>
<th>Class Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>2-2.5</td>
<td>Normal</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>&lt;22</td>
<td>4</td>
<td>IUGR</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>&gt;22</td>
<td>&gt;4 and &lt; 5</td>
<td>GDM</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>&gt;22</td>
<td>&gt;5.1</td>
<td>Beckwith Wiedemann Syndrome</td>
<td>0</td>
</tr>
</tbody>
</table>

### 1.7 COMPLICATIONS OF GDM ON PLACENTA

Diabetes Mellitus, when untreated, complicates the pregnancy by affecting the growth of the placenta. The complication includes fetal demise, intra-uterine growth retardation and placental abruption. Some of the few complications include intrauterine growth restriction, placental abruption and fetal demise. Undiagnosed GDM causes spontaneous and premature expulsion of a nonviable embryo or fetus from the uterus. Diabetic pregnancy shows increase in the size of the placenta. The architecture [189,190,191,192] of the placenta also undergoes several changes under conditions of GDM.

Placental volumes vary in dimensions depending on the ethnic backgrounds of women universally. Taking into consideration of this vital factor, the present study focuses on the Dravidian race, a sub-division of the
great Negroid race. The Caucasian, Mongoloid and Australoid races exhibit different qualities of placental characteristics and are beyond the scope of the present research.

1.8 NEED AND IMPORTANCE OF THE STUDY

In a routine pregnancy screening, importance is given only to monitor the growth of the fetus and the least preference is given to the placenta. In the case of pregnancies complicated by GDM, the growth of the placenta is hindered in a variety of ways from the onset of GDM. In a worst case, the clots are formed on the placenta which causes pregnancy loss. The need of this study is to evaluate the effect of GDM on the development of placental growth. Diabetic pregnancy shows increase in the size of the placenta. This affects the growth of the fetus, which may even lead to death if untreated. The evaluation of the volume of placenta at fifteen to twenty weeks of gestation can identify placenta complicated by diabetes mellitus. This would help to diagnose complications at the earliest, which would minimize the loss, birth defects and placenta abruption. Considering the placenta, size alone may be sufficient to identify a subset of women at a higher risk in the initial ultrasound examination. An increase or decrease in the size of the placenta is a strong indication to an approaching complication in the placenta. The gestational age can be prolonged only if the problem in the placenta is identified in the initial phases of pregnancy.

1.9 HYPOTHESIS OF THE STUDY

This study focuses on the ‘Classification of Ultrasound Placenta Complicated by Gestational Diabetes Mellitus can employ Wavelet Image Fusion Approach’.
To resolve this problem, the issues to be addressed involve:

- **Decomposition** of the ultrasound placenta image: The image obtained by scanning the placenta at various positions needs to be fused to retain the essential characteristics of the ultrasound placenta image which would result in a synthesized image.

- **Relevant** attributes of the synthesized ultrasound placenta image are identified and extracted.

- **Pelvic** ultrasonography image taken during first and second trimester of pregnancy shows the fetus, placenta and cervix. There is need to **segment** the region of interest, which is the placenta, from the ultrasound.

- **Estimating** the volume of the segmented ultrasound placenta at fifteen to twenty weeks of gestation, helps in identifying women at higher risk and thus, minimizes the fetal loss.

Finally, the segmented image is to be classified either as normal placenta or abnormal placenta. The abnormal placenta is characterized by few parameters, which include size of the placenta and increased calcification. During this stage, the influence of gestational diabetes mellitus may be traced.

### 1.10 OBJECTIVES

The objective of the study is

- To identify the placental complications in women with GDM.

- To understand the risk of miscarriage associated with untreated GDM.
To explore the influence and perturbations caused by GDM on the growth of the placenta.

To evaluate the effect of GDM as one of the adverse outcomes of pregnancy.

The ultrasound images are usually poor in quality as it includes noise in the form of speckles. This may lead to the loss of characteristic features of the ultrasound images, a major reason of classification inaccuracy. It is found that in literature the focus is only on the grading of placenta and leaving out the complications that reflected on the fetus. The work attempts to retain the key features of the ultrasound placenta by employing wavelet image fusion of transverse scans of abdominal ultrasound of the placenta which is displayed on the left and right of the monitor during the screening. The ultrasound placenta is reconstructed and used to study the complications rendered by GDM on the growth of the placenta. The reconstructed ultrasound placenta is classified as normal or abnormal placenta. It is found that there is an increase in classification accuracy when a wavelet decomposition and image fusion technique is applied on the ultrasound placenta.

1.11 OUTLINE OF THE THESIS

The thesis is organized into eight chapters:

The chapter one highlights on the need and importance of this study. It also focuses on the complications rendered on the placenta due to GDM.
The chapter two deals with the literature review of image decomposition techniques, image fusion methods, medical imaging and imaging modalities. This chapter also deals with the different feature extraction techniques. Some image segmentation techniques are also analyzed. This chapter throws light on the role of wavelets in medical image processing and decomposition of images. The basic concept of ultrasound imaging is also discussed. It also projects the clinical applications of ultrasound on the placenta.

The chapter three discusses the application of wavelet decomposition techniques to assess the complication in the ultrasound placenta. It also highlights how effectively this technique captures the unique features of the placenta complicated by gestational diabetes mellitus and distinguishes from it the normal and healthy placenta without any complications.

The chapter four foregrounds a novel algorithm ‘Wavelet Based Image Fusion’ in which wavelet decomposition and image fusion techniques is collated for assisting in the diagnosis of gestational diabetes complications in placenta.

The chapter five highlights the extraction of the features of placenta using Haralick features. It generates few features which clearly distinguished the peculiar characteristics of the placenta complicated by gestational diabetes mellitus and the healthy placenta.

The chapter six studies in deal the segmentation of ultrasound placenta to extracts the region of interest from the input ultrasound placenta. The statistical features obtained from this phase are clearly explained.
The chapter seven explains the modeling of segmented placenta using the statistical features generated previously. It highlights the importance of estimation of volume in identifying the complications at the earlier stages of the placenta. The segmented ultrasound placenta is modeled using the convex-concave hull model. It highlights the application of neural network in the classification of features of the placenta as normal or abnormal. The different classifiers are compared to identify the suitable classifier for the placenta images. The suitability of radial basis classifier is clearly explained.

The chapter eight concludes with the primary findings from the research carried out for the efficient classification of ultrasound placenta complicated by gestational diabetes mellitus. It is revealed that the wavelet based image fusion as a suitable technique for the identification of placenta complications.