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Expert Medical Diagnostic System for The Confirmation Of Early Pregnancy

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ABSTRACT
The goal of this study is to design and implement an expert Medical Diagnostic System for the Confirmation of Early Pregnancy in the first trimester. Survey and analysis were carried out on users, patients, manager, technical and professional experts, while relevant forms and literature were reviewed, the purpose being to transform system objectives, analysis and input into a structured specification. This is achieved using functioning diagrams and tools such as Data Flow Diagrams, Data Dictionary, Input and Output Format, Program Module Specification, System Flowchart, etc. required to produce programs that imitate human performance in a wide variety of "intelligent" task [Expert System]. Foetal Weight was found to be a function of foetal Head Circumference (HC), Femur Length (FL), Abdominal Circumference (AC) and Biparietal Diameter (BPD) and Predictable with a polynomial equation. Again, foetal age or gestational age was found to be a function of Foetal weight and predictable with an equation. The equations for determination of Conception and Delivery Date were derived by using the fact that pregnancy typically last 40 weeks or 9 months and it is counted from the first day of a woman's last period, implying that at conception the unborn child is already considered two weeks old. The output from the system is the ultimate design and implementation of an intelligent machine or Expert System which can mimic human thought, understanding logic, and can handle the range of problems which are coextensive with the range of problems to which human mind has been applied to medical diagnosis for the Confirmation of Early Pregnancy in Women.
Keywords: *Expert system, Medical diagnosis, early pregnancy, foetal parameters, conception, gestational age.*

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I. Introduction

Due to the emergence of Computers and the Internet, coupled with the large volume of data and records to be processed, and the speed at which such Data and Information are expected to be stored, retrieved, processed, and disseminated, the use of computers and the internet have increased over the years and have undergone series of developmental changes.

For any Nation in particular and the Society at large to be productive, there is an urgent need to effectively and efficiently face the ever-increasing technological challenges before it. Hence, the design and implementation of an Expert System in the areas of Education and Training, Health and Medicare, Commerce and Industry, Business and Entertainment, Transport and Aviation, Legal Practice, Military, Religion and the Gospel, etc., is inevitable.

To this end, there is yet a positive advancement towards creating Expert Systems with the functions that are normally associated with human intelligence, such as, reasoning, inference, and problem solving among others. This has to do with the designing and implementation of an intelligent computer program built for commercial applications using the programming techniques of Artificial Intelligence.

An Expert System (ES), also called a Knowledge Based System (KBS), is a computer program designed to simulate the problem solving behavior of an expert in a narrow domain or discipline.

In the context of this study, an Expert System is defined as a system that units the accumulated expertise of individual disciplines such as gynecology, ultrasonography, Computer Software Design & Engineering, into a framework that best addresses the specified, on-site needs of patients. In other words, Expert Systems combine the experimental and experiential knowledge with the intuitive reasoning skills of multitude specialists to aid doctors, patients, parents and homes in making the best decision.

This research attempts to create a Knowledge Based System (KBS) otherwise known as Expert Systems (ES) which can mimic human thought, understand logic and can handle the range of problems, which are coextensive with the range of problems to which the human mind has been applied. Typical example of such system is An Expert Medical diagnosis System for the Confirmation of Early Pregnancy in Women.

Many families desire to know if the woman is pregnant even before she sees her menses. Even when a woman learns that she is pregnant, it is important to find out how old the pregnancy is. Knowing the age of the Fetus is a key to good healthcare during pregnancy. Following birth, assessing an infant's weight, length, head circumference, condition of skin, hair, reflexes, muscle tone, posture, and vital signs can provide a 'relative' or 'developmental' gestational age. The 'developmental' gestational age may not match the calendar gestational age. For example, an infant born with a gestation age of 36 weeks may actually have a developmental gestational age of 38 weeks, and therefore behave more like a term infant than a premature infant.Determination of gestational age is an important factor in planning appropriate care for the fetus or infant. It provides important information regarding expected or potential problems and directly impacts the medical treatment plan for the baby.

Both low birth weight and excessive foetal weight at delivery are associated with an increased risk of newborn complications during labour and the puerperium. The prenatal complications associated with low birth weight are attributable to preterm delivery, intrauterine growth restriction (IUGR), or both. For excessively large fetuses, the potential complications associated with delivery include shoulder dystopia, brachial plexus injuries, bony injuries, and intrapartum asphyxia. The maternal risks associated with the delivery of an excessively large fetus include birth canal and pelvic floor injuries and postpartum hemorrhage. The occurrence of cephalopelvic disproportion is more prevalent with increasing foetal size and contributes to both an increased rate of operative vaginal delivery and cesarean delivery for macrocosmic fetuses compared with fetuses of normal weight.

The Expert System has been developed with detailed Knowledge Base [from Medical Consultants, Clinicians and Patients], and Inference Engine [Good and efficient programming facts and rules] to incorporates the basic concepts of clinical practice in ordered steps.

This includes, Pregnancy and the accompanying tests as ultrasound, Human Chorionic Gonadotropin [hCG] (a hormone present in women's urine during pregnancy) test etc. which provides an Expert System with the following specific objectives namely ***Identification and Confirmation of Early Pregnancy.***

II. Literature Review

This section discusses some key components of the study.

2.1 Expert System [Concepts]

An Expert System (ES), also called a Knowledge Based System (KBS), is a computer program designed to simulate the problem-solving behavior of a human expert in a narrow domain or discipline. In this study, Expert Systems (ES) will be seen to unite the accumulated expertise of individual disciplines such as gynecology, ultrasonography, Computer Software Design & Engineering, into a framework that best addresses the specific, on-site needs of patients. It shall combine the experimental and experiential knowledge with the intuitive reasoning skills of a multitude of specialists to aid doctors, patients, parents and homes in making the best decisions.

An Expert System (ES) consists of

1. Knowledge Base (Facts)
2. Production or inference rules ("if.., then...")
3. Inference engine (controls how "if.., then .. " rules are applied towards facts)

Wikipedia [1] defines Expert System as a class of computer programs developed by researchers in artificial intelligence during the 1970s and applied commercially throughout the 1980s. In essence, they are programs made up of a set of rules that analyze information (usually supplied by the user of the system) about a specific class of problems, as well as provide analysis of the problem(s) and, depending upon their design, a recommended course of user action in order to implement corrections.

According to James [3] Real experts in the problem domain (which will typically be very narrow, for instance "diagnosing skin diseases in human teenagers") are asked to provide "rules of thumb" on how they evaluate the problems, either explicitly with the aid of experienced system developers, or sometimes implicitly, by getting such experts to evaluate test cases and using computer programs to examine the test data and (in astrictly limited manner) derive rules from that. Simple systems use simple true/false logic to evaluate data, but more sophisticated systems are capable of performing at least some evaluation taking into account real-world uncertainties, using such methods as fuzzy logic. Such sophistication is difficult to develop and still highly imperfect. Hence, while Expert Systems have distinguished themselves in AI research in finding practical application, their application has been limited. Expert Systems are notoriously narrow in their domain of knowledge. As an amusing example, a researcher used the "skin disease" Expert System to diagnose his rust bucket car as likely to have developed measles and thus prone to making errors that humans would easily spot. Additionally, once some of the mystique had worn off, most programmers realized that simple Expert Systems were essentially just slightly more elaborate versions of the decision logic they had already been using.

Therefore, some of the techniques of Expert Systems can now be found in most complex programs without any fuss about them. In his own contribution **Joseph** [3] enumerated the principal distinction between Expert Systems and traditional problem solving to include:

(a) Programs as the way in which the problem related expertise is coded. In traditional applications, problem expertise is encoded in both program and data structures. In the Expert System approach all of the problem related expertise is encoded in data structures only. Several benefits immediately follow from this organization. E.g. in the Expert System approach, the information about taxpayers and tax computations is again found in data structures, but now the knowledge describing the relationships between them is encoded in data structures as well.

(b) The programs of an Expert System are independent of the problem domain (taxes) and serve to process the data structures without regard to the nature of the problem area they describe. For example, there are programs to acquire the described data values through user interaction, programs to represent and process special organizations of description, and programs to process the declarations that represent semantic relationships within the problem domain and an algorithm to control the processing sequence and focus.

Torsun, I. S. [4] clearly defined the general architecture of an Expert System to involve two principal components namely:

i. A problem dependent set of data declarations called the knowledge base or rule base, and
ii. A problem independent (although highly data structure dependent) Program which is called the inference engine.

Thus there are generally three individuals having an interaction with Expert Systems. Primary among these are:

i. The end-user; the individual who uses the system for its problem solving assistance
ii. The problem domain expert who builds the knowledge base, and
iii. A knowledge engineer who assists the experts in determining the representation of their knowledge and who defines the inference technique required to obtain useful problem solving activity.

Turbanand Louis [5] however identified the most important modules that make up a rule-based Expert System on what they called Expert System Shell shown in Figure 1. These include user interface, which may use Menus, Natural Language or any other style of interaction. Then an Inference Engine used to reason with both the expert knowledge (extracted from our friendly expert) and data specific to the particular problem being solved.

The expert knowledge will typically be in the form of a set of IF-THEN rules. The case specific data includes both data provided by the user and partial conclusions (along with certainty measures) based on this data. In a simple forward chaining rule-based system the case specific data will be the elements in working memory. Almost all Expert Systems also have an explanation subsystem, which allows the program to explain its reasoning to the user. Some systems also have knowledgebase editor which help the expert or knowledge engineer to easily update and check the knowledge base. One important feature of Expert Systems is the way they (usually) separate domain specific knowledge from more general purpose reasoning and representation techniques. The general purpose bit (in the dotted box in figure 1) is referred to as an Expert System shell.

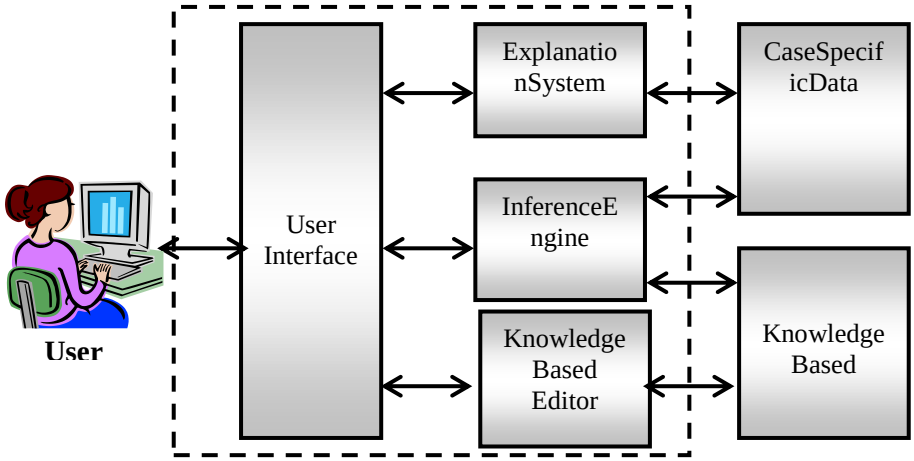

Fig.1 Expert System Shell

As shown in the figure, the shell will provide the inference engine (and knowledge representation scheme), a user interface, an explanation system and sometimes a knowledge base editor. Given a new kind of problem to solve (say, medical diagnoses design), we can usually find a shell that provides the right sort of support for that problem, so all we need to do is provide the expert knowledge. An understanding of the "inference rule" concept is important to understand Expert Systems.

An inference rule is a statement that has two parts, an if-clause and a then-clause. An example of an inference rule is:

i. If Age <11 .Or. Age>50, Then "Patient Is Not Within Reproductive Age".
ii. If Menstrual = "Y" .And. Breast = "Y" .And. Morn = "Y" .And. Bladder = "Y" .And. Skin = "Y" .And. Quick = "Y", Then "Pregnancy is Highly Suspected, Go for Lab Test".

An Expert System's rule base is made up of many such inference rules. They are entered as separate rules and it is the inference engine that uses them together to draw conclusions. Because each rule is a unit, rules may be deleted or added without affecting other rules (though it should affect which, conclusions are reached). One advantage of inference rules over traditional programming is that inference rules use reasoning which more closely resemble human reasoning.

Thus, when a conclusion is drawn, it is possible to understand how this conclusion was reached. Furthermore, because the Expert System uses knowledge in a form similar to the expert, it may be easier to retrieve this information from the expert.

Walkerand Richard [6]enumerated FOUR CHARACTERISTICS known to be appropriate to a good Inference Technique or Rule namely:
1.A good inference technique or rule is independent of the problem domain. In order to realize the benefits of explanation, knowledge transparency, and reusability of the programs in a new problem domain, the inference engine must not contain domain specific expertise.
2.Inference techniques may be specific to a particular task, such as diagnosis of hardware configuration. Other techniques may be committed only to a particular processing technique.
3.Inference techniques are always specific to the knowledge structures.
4.Successful examples of rule processing techniques or two methods to make conclusions include:
a) Forward chaining [data driven or facts driven] Usually used to find new ideas
b) Backward chaining [goal driven or hypothesis driven] Usually used for diagnosis

Weiss, and Casimir[7] also concluded that there are two main methods of reasoning when using inference rules namely backward chaining and forward chaining. They claimed Forward chaining starts with the data available and uses the inference rules to conclude more data until a desired goal is reached. An inference engine using forward chaining searches the inference rules until it finds one in which the if-clause is known to be true. It then concludes the then-clause and adds this information to its data. It would continue to do this until a goal is

reached. Because the data available determines which inference rules are used, this method is also called data driven or facts driven.

2.2 **Artificial Intelligence (Concept)**

Anigbogu[8]concluded that intelligence must include highly refined sight and sound perception, thought, imagination, as well as the ability to converse, read, write, drive, memorize, recall facts, express and feel emotions. The dictionary meaning of the word "Artificial" is "not natural or real", "Made by the art of man".

Artificial Intelligence [AI] can be defined as the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent. It is the ability to create intelligent machines. In his own contribution**, Anigbogu[8]** saw AI to involve developing a computer System with the functions that are normally associated with human intelligence, which includes reasoning, inference, hearing and problem solving among others. It is all about building an intelligent thinking machine.

There are basically two reasons for public's over-confidence in Artificial Intelligence.
First, AI theories are often ingenious and subtle even fictional, implying much futuristic applications.
Second, AI, being incorporated with computer technology, is often expected to progress as fast as the computer technology.

2.2.1 **Applications of Artificial Intelligence**

The following are four main domains of Artificial Intelligence and their areas of application.

i. **Computer Science** – 5^{th} Generation Computers, Parallel Processing, Symbolic Processing, Neural Networks.
ii. **Cognitive Science** – Expert System, Knowledge Base System, Learning Logic System, Fuzzy Logic System.
iii. **Robotics** – Visual Perception, Tactility, Dexterity, Locomotion, Navigation.
iv. **Natural Language** – Language Understanding, Speech Recognition and Language Translation.

Robotics: this is the branch of AI that is concerned with the design and implementation of computer-controlled mechanical devices. It is the technology of building machines with computer intelligence and computer-controlled human-like physical capabilities, such as visual perception, tactility, dexterity, locomotion and navigation.

Natural-language processing offers the greatest potential rewards because it would allow people to interact with computers without needing any specialized knowledge. You could simply walk up to a computer and talk to it. There are voice recognition systems that can convert spoken sounds into written words, but they do not understand what they are writing; they simply take dictation.

2.3 **Pregnancy [Definition]**

Pregnancy occur as the result of the female gamete or "oocyte" merging with the male gamete "spermatozoon", in a process referred to in medicine as "fertilization", or more commonly known as "conception". After the point of fertilization, it is referred to as an "egg". The fusion of male and female gamete which, usually occur through act of sexual intercourse, result in spontaneous pregnancy.

Babson et al[9] claimed that pregnancy (Latin 'graviditas') is the carrying of one or more offspring, known as a fetus or embryo, inside the uterus of a female. In pregnancy, there can be multiple gestations, as in the most studied of all mammalian pregnancies. Childbirth usually occurs about 38 weeks after conception, i.e. approximately 40 week from the Last Normal Menstrual Period (LNMP) in humans. The World Health Organization (WHO) defines normal terms for delivery as between 37 weeks and 42 weeks. The calculation of this date involves the assumption of a regular 28 day menstrual cycle.

Pregnancy is a natural process involving big changes in a woman's body. **According to Egipee Online Pregnancy Resources for Women** [10] Pregnancy typically lasts 40 weeks, or 9 months. That time is divided into three periods called trimesters (three-month intervals), during which different things happen to the woman and to the baby. *It is noted that Pregnancy is counted from the first day of a woman's last period. This means that at conception, the unborn child is already considered two weeks old.*

2.4. **Pregnancy Symptoms**

Understanding the stages and symptoms of pregnancy is important because each symptom may be related to something other than pregnancy. Some women experience signs or symptom of pregnancy within a week of

conception. For other women, pregnancy symptoms may develop over a week or may not be present at all. Below is a list of some of the most common pregnancy sign symptoms. However, only a pregnancy test will confirm this for sure.

i. **Delay/Difference in Menstruation**: - A delayed or missed menstruation is the most common pregnancy symptom leading a woman to test for pregnancy. When you become pregnant your next period should be missed.
ii. **Nausea**: - Nausea and vomiting, starting few weeks after conception or even earlier may be one of the most common early symptoms of pregnancy. The popular term 'morning Sickness' is a misnomer through as the symptoms are felt pretty much throughout the day.
iii. **Swollen/Tender Breasts**: - Swollen or tender breast is a pregnancy symptom which may begin as early as 1- 2 weeks after conception.
iv. **Darkening of the Nipples/Areolas**: - If you are pregnant, the skin around your nipple may get darker.
v. **Headaches:** - The sudden rise of hormones in your body can cause you to have headaches early in pregnancy.
vi. **Frequent Urination**: - Around 6-8 weeks of conception, you may find yourself making a few extra trips to the bathroom.
vii. **Odd Food Cravings**: - A sudden and inexplicable craving for certain foods is another potential, though not always reliable.
viii. **Fatigue/Tiredness**: - Feeling fatigue or more tired is a pregnancy symptom which can also start as early as the first week after conception.
ix. **Backaches:** - Lower backaches may be a symptom that occurs early in pregnancy; however, it is common to experience a dull backache throughout an entire pregnancy.

2.5 Early Pregnancy Tests

The following methods were used to find or estimate the age of the fetus:

1)**Pregnancy Calendar or Calculator**: - Normally women are pregnant 280 days or 40 weeks from their last normal period. Healthcare providers use a wheel that calculates due date based on the last menstrual period.

2)**Size of the Uterus**: during the first trimester, the length of a pregnancy can be determined by a pelvic exam. At 8 weeks, the uterus is felt just at the pubic bone. At 12 weeks, it grows over the pubic bone into the abdomen. At 20 weeks, the top of the uterus lies at the level of the belly button. After that point, it is measured in centimeters. Each centimeter corresponds to the week of pregnancy. Twenty-six centimeters, for example, equals 26 weeks gestation. If there is more than one fetus this calculation does not apply.

3)**Quickening:** Usually first-time mothers first feel the fetus move between 18 to 20 weeks. For women who have already had a child, quickening generally occurs at 16 weeks.

4)**Foetal Heart Tones:** A small hand-held ultrasound unit usually picks up foetal heart tones by 10 weeks.

Today Eva Martin and Carlos Herrera has offered two varieties of reliable, early-detection pregnancy tests: namely:

(a) The pregnancy test strip (the same style of test used in clinics) and
(b) The midstream test (the same style sold in drugstores).

These pregnancy tests could be done six to eight days after conception and over 99% accurate. To use the pregnancy test strip simply till a container with urine and dip the test strip in the container in a vertical position. Your results appear within five minutes.

To use the midstream tests, simply take the cap off the test stick, hold it in your stream of urine for at least 10 seconds, and re-apply the cap. In two to five minutes, you have your results.

Results:

Pregnant - Two Pink Lines in the Result Window [indicating Positive Result]
Not Pregnant - One Pink Line in the Result Window [indicating Negative Result]

Both tests are capable of detecting Human Chorionic Gonadotropin or hCG, (a hormone present in women's urine during pregnancy) at levels of just 20 mlu/ml. That means you can begin testing accurately as early as six to eight days after conception - well before your first missed period. Now a woman doesn't have to wait to miss her period before pregnancy can be determined. Human Chorionic Gonadotropin or hCG (a hormone present in women's urine during pregnancy) can be detected 5 days sooner than the day of her missed period. However

Ultrasound scan is currently considered to be the most recent, safe, non-invasive, accurate and cost effective investigation in the fetus. It has progressively become an indispensable obstetric tool and plays an important role in the care of every pregnant woman. Obstetric Ultrasound is the use of ultrasound scans in pregnancy.
Currently used equipment is known as real-time scanners, with which a continuous picture of the moving fetus can be depicted on a monitor screen. Very high frequency sound waves of between 3.5 to 7.0 megahertz (i.e. 3.5 to 7 million cycles per second) are generally used for this purpose. They are emitted from a transducer which is placed in contact with the maternal abdomen, and is moved to "look at" (likened to a light shined from touch) any particular content of the uterus. Repetitive arrays of ultrasound beams scan the fetus in thin slices and are reflected back onto the same transducer. The information obtained from different reflections is recomposed back into a picture on the monitor screen (a sonogram, or ultrasonogram). Movements such as foetal heart beat and malformations in the fetus can be assessed and measurements can be made accurately on the images displayed on the screen. Such measurements form the cornerstone in the assessment of gestational age, size and growth in the fetus.

Ischild [11] enumerated the main use of ultrasonography to include the following areas:
1.**Diagnosis and Confirmation of Early Pregnancy**
They claimed that with Ultrasound, the gestational sac can be visualized as early as four and a half weeks of gestation and the yolk sac at about five weeks. The embryo can be observed and measured by about five and a half weeks. Ultrasound can also very importantly confirm the site of the pregnancy is within the cavity of the uterus.

2. **Vaginal Bleeding In Early Pregnancy**
The viability of the fetus can be documented in the presence of vaginal bleeding in early pregnancy. A visible heartbeat could be seen and detectable by pulsed Doppler ultrasound by about 6 weeks and is usually clearly depictable at 7 weeks. If this is observed, the probability' of a continued pregnancy is greater than 83 percent. Missed abortion and blighted ovum will usually give typical pictures of a deformed gestational sac and absence of foetal poles or heartbeat.

3.Determination of Gestational Age and Assessment of Foetal Size
Foetal body measurements reflect the gestational age of the fetus. This is particularly true in early gestation. In patients with uncertain last menstrual periods, such measurements must be made as early as possible in pregnancy to arrive at a correct dating for the patient. In the latter part of pregnancy measuring body parameters will allow assessment of the size and growth of the fetus and will greatly assist in the diagnosis and management of intrauterine growth retardation.

To ascertain this, the following measurements are usually made:
a)**The Crown-Rump Length (CRL):** This measurement can be made between 7 to 13 weeks. Dating with the CRL can be within 3-4 days of the last menstrual period.

b)**The Biparietal Diameter (RPD):** The diameter between the two sides of the head. This is measured after 13 weeks. It increases from about 2.4 cm at 13 weeks to about 9.5 cm at term. Different babies of the same, weight can have different head size, therefore dating in the later part of pregnancy is generally considered unreliable.

c)**The Femur Length (FL):** Measures the longest bone in the body and reflects the longitudinal growth of the fetus. Its usefulness is similar to the BPD. It increases from about 1.5 cm at 14 weeks to about 7.8 cm at term.
d)**The Abdominal Circumference (AC):** The single most important measurement to make in late pregnancy. It reflects more of foetal size and weight rather than age. Serial measurements are useful in monitoring growth of the fetus.

4.Diagnosis of FoetalMalformation
Many structural abnormalities in the fetus can be reliably diagnosed by an ultrasound scan, and these can usually be made before 20 weeks. Common examples include hydrocephalus, anencephaly, myelomeningocoele, achondroplasia and other dwarfism, spina bifida, exomphalos, Gastroschisis, duodenal atresia and foetalhydrops.

5.Placental Localization.
Ultrasonography has become indispensable in the localization of the site of the placenta and determining its lower edges, thus making a diagnosis or an exclusion of placenta previa. Other placental abnormalities in conditions such as diabetes, foetalhydrops, Rh isommunization and severe intrauterine growth retardation can

also be assessed.

6.**Multiple Pregnancies**
In this situation, ultrasonography is invaluable in determining the number of fetuses, the chorionicity, foetal presentations, evidence of growth retardation and foetal anomaly, the presence of placenta previa, and any suggestion of twin-to-twin transfusion. This is not covered in this study.

7.Hydramnios and Oligohydramnios
Excessive or decreased amount of liquor (amniotic fluid) can be clearly depicted by ultrasound. Both of these conditions can have adverse effects on the fetus. In both these situations, careful ultrasound examination should be made to exclude intrauterine growth retardation and congenital malformation in the fetus such as intestinal atresia, hydropsfoetalis or renal dysplasia.

8.Other areas.
Ultrasonography is of great value in other obstetric conditions such as:
a)Confirmation of intrauterine death.
b)Confirmation of foetal presentation in uncertain cases.
c)Evaluating foetal movements, tone and breathing in the Biophysical Profile.
d)Diagnosis of uterine and pelvic abnormalities during pregnancy e.g. fibromyomata and ovarian cyst.

Once a woman learns that she is pregnant, it is important to find out how far along she is in the pregnancy. Knowing the age of the fetus is a key to good healthcare during pregnancy. Traditionally, the due date was based on the following:

i. date of the last menstrual period
ii. an early pelvic exam
iii. measurement of the size of the uterus
iv. quickening, or feeling the baby's first movements

Konjeet al [12] in their article "Determination of gestational age after the 24th week of gestation from foetal kidney length measurements; developed a model described as the best model for estimating gestational age in late pregnancy.

This model accurately predicted gestational age with a standard error of ± 8.48 days. A model including kidney length, biparietal diameter, head circumference, and femur length accurately predicted gestational age with a standard error of ± 8.57 days. These models were slightly more accurate than models derived from the biometric indices of biparietal diameter, head circumference and femur length (± 9.87 days), biparietal diameter, head circumference, femur length and abdominal circumference (± 9.45 days) and biparietal diameter and femur length (± 9.9 days). Kidney length and femur length were the most accurate single parameters for predicting gestational age using simple linear regression models (± 10.29 and 10.96 days, respectively); the abdominal circumference was the least accurate (± 14.54 days). They concluded that Kidney length is a more accurate method of determining gestational age than the foetal biometric indices of biparietal diameter, head circumference, femur length and abdominal circumference between 24 and 38 weeks' gestation. When combined with biparietal diameter, head circumference and femur length, the precision of dating is improved by 2 days. This measurement is easy to make and could therefore be easily incorporated into the model for dating pregnancies after 24 weeks of gestation, in particular when measurements of the biparietal diameter and head circumference are difficult.

The authors **Suzuki et al., [13]** determined gestational age from foetal weight, examined the range in conception dates, and classified the external foetal development process in Sika Deer of Eastern Hokkaido. According to these authors, Gestational age (T) can be estimated from foetal weight (W) with the equation:
T = (3 square root of W + 2.730)/0.09 1.e.
T = (3/W +2.730)/0.091…… Equ.1
Where W = weight
They also claimed that conception date can then be calculated back from date of pregnant female, using gestational age.

III. Methodology

Prototyping methodology was adopted in this approach.
Prototyping is the creation of incomplete versions of a software program being developed (prototype). The process involves:
(a) identifying basic requirements such as input and output information needed;
(b) Developing initial prototype including user interfaces, review with customers, revise and change or enhance the prototype using a feedback both from specifications and customers to improve the prototype.

Prototyping is of different types which majorly include the following:
(1) Throwaway;
(2) Evolutionary,
(3) Incremental, and
(4) Extreme,

The benefits of prototyping include:
(1) It provides proof of concept to attract funding,
(2) It encourage active participation of users/developers,
(3) Development cost is reduced,
(4) It increases systems development speed,
(5) It identifies any problem with the efficacy of earlier design, requirement analysis and coding activities.
(6) It detects faults early enough to avoid project abandonment,
(7) Delivers product's quality easily,
(8) Best developed for project like on-line systems, transaction processing where the use of screen dialogs is demanded. Any software that demands extensive interaction between the computer and the user will require building a quick system and let the user play with it.

IV. Architecture of the Existing System

The current system is the manual method of operating hospital out patients' management system where all their operations are done by hand (manually).
The research was carried out with data sourced and collected from ***Niger Delta University Teaching Hospital (NDUTH), Okolobiri in Bayelsa State.*** The Doctors, Nurses and other Personnel were the people interviewed during the data collection process and they were helpful and assisted in insuring that a reasonable and valuable data was collected. The study of the existing system was done basically to understand the problems associated with the operation of the existing system and as well objectively criticizing the existing system and recommending remedies or corrective measures which will be represented in a revised system.

4.1 Objectivesof the Proposed System

The following are some of the objectives of the proposed system.
1.To eliminate or reduce the occurrences of potential complications associated with the birth of both small and excessively large fetuses.
2.To diagnose illnesses through oral interview.
3.Getting the doctor informed of his sole duty to be competent and consistent, knowing fully well that his sole duty is to save the life of patients.
4.To create an avenue for an expert to fully utilize his expertise.
5. Furnish patients on information/ideas of how to handle and manage their pregnancy and pregnancy related illnesses through doctor's advice.
6.To estimate foetal parameters such as foetal weight, Age, Conception Date, and delivery date, required for accurate clinical management of delivery cases
The input to this system design is the guidance of history taking which includes a patient's personnel data e.g. Name, Age, Occupation etc., family health details, drugs and allergies, past health/medical records, foreign travels and social history (residence) occupation, physical reaction, habits etc). The general technique of clinical examination is then applied in questioning. Symptoms (pregnancy), and complaints, time of occurrence and frequency. Further interrogation can be taken to ascertain why and how the symptoms affect the patient and will emphasize disease attributes and characters. This is to enable the cultivation of the critical interpretation and judgment. The patient record process begins when the patients comes to the hospital to see the doctor.

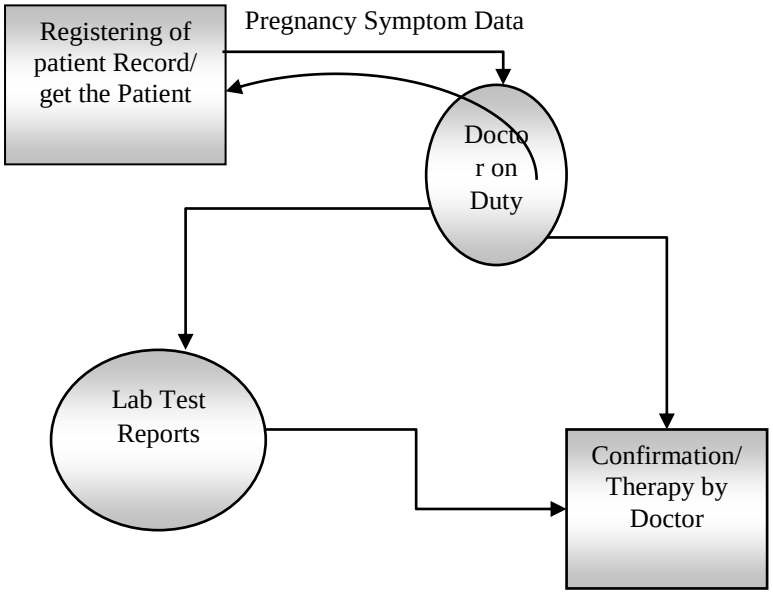

Figure 2: Process flow diagram of the existing System

4.2 Disadvantages of the Existing System

1.The time taken from the oral interrogations to interpret and diagnose or prescribe drugs is too much.
2.The work is sometimes tiresome to medical doctors. They tend to use some shortcuts to certain routine diagnosis in order to save time. Most might not consult their encyclopedia as at when due.
3.In some instances, pregnancy symptoms are misinterpreted by health officers (even some accomplished ones) and inference made to an unrelated disease. Therefore any treatment administered in this direction proves either harmful or ineffective.
4.Due to the fact that some illnesses are misinterpreted, it gives rise to drug abuse and eventual death if care is not taken. Most of our numerous patients have gone to the world beyond due to the moral laxity of our doctors and other health workers.
5.The multiplicity of disease obtainable now renders the human brain/senses (such as that of the doctors) insufficient enough for memory of their accruing characteristics
6.The complexity and numerous ailments that are in existence make the medical profession tedious and professionals tend to run away.
7.Affiliate health officer in remote areas might not be blessed with the presence of qualified specialist. Therefore how would, the available health officers be referred and consulted?

V. Analysis of the Proposed System

1.The intended system is such that will help to alleviate and correct the loopholes of the anomalies created by the existing system as enumerated in section 3.2.6
2.Computers can be programmed to access patient file or analyze patient's symptoms results and give the required "diagnoses and treatment promptly, thereby eliminating the problem of untimely production of reports.
3.Computerized system has data security advantage. Unauthorized person cannot get access to pass-worded information and records.
4.It will be a kind of on-set or on-line training scheme for junior medical officers as well as a databank for reference and consultation.
5.The intended system will serve as an electronic “house doctor” for common illness that can be handled without the attention of a specialist.
6.The system of intended design will produce patients medical report system and report processing facility.
7.The answers to common health discomforts are within the reach of the patient of anybody available, given enough details about the patient's condition. Note that this is not an attempt to advocate arbitrary self-medication.
8.Addressing the needs of the clinician/trainer and the patients, as discussed above will make the medical profession less tedious and more efficient, with good health closer to the home.

Therefore, this system provides clinical and private solutions to these problems with little or no strenuous efforts and with accompanying accuracy, effectiveness and efficiency.

A variety of techniques have been developed for module specification. A functional specification identities the operation that the modules makes available and provides an individual specification for each operation, typically in the form of an input-output specification describing the mapping that the operation provides from a set of input values to a set of output values. In the typical case where a module has local data, a simple functional specification will need to refer to this local data when specifying each individual operation. This tends to obscure the specification, and also violate the principle that a specification should state what a module does but not how this is done.

The system designed, basically comprised Six Modules as shown in Fig. 4.3 above, and they include:

1. **The File Maintenance Module**

This module is expected to effect File Creation, Append, Deletion, Modification and insertion.

2. **Data Entry Module**

The software in this module, when implemented causes the execution of data entry and storage for patients' pregnancy symptoms.

3. **The Knowledge** Base **Module**

This module brings into effects results centering on Problem Domain, Knowledge Domain, and Signs of Pregnancy, Information Based, Definition of Terms, and Ultrasound/Lab. Tests.

4. **Inference Engine Module**

Executes programs involving Program Logic, File Structure, Pseudo Codes, and Expert System Shell Code

5. **Report Generation Module**

This Module handles the programs that bring about report generation of the system, which included Patient case file, Pretest results, Lab. Test results, Ultrasound Results.

6. **Help Module**

The Help Module programs, when executed results in the display of Readme Files concerning the Author, the Software (i.e. the System), documentation, and a complete Dbase Tutorial.

5.1. **Mathematics Specification**

5.2. **Determination of Conception Date**

Pregnancy typically lasts 40 weeks, or 9 months. Pregnancy is counted from the first day of a woman's last period. This means that at conception, the unborn child is already considered two weeks old.

The researcher therefore makes the following submissions concerning equation for estimating the Conception Date.

If the gestational Age is T wks for instance, and measured on a date DM, we are looking for a conception date (CD) such that (DM-T) = 2 wks.

Therefore CONCEPTION DATE [CD] is given by the equation:

$$CD = DM - (T-2) \text{ wks}$$

Where CD = Conception Date (dd/mm/yy) Equ. 4.1

DM = Date Gestational Age was measured (dd/mm/yy)

T = Gestational Age in weeks

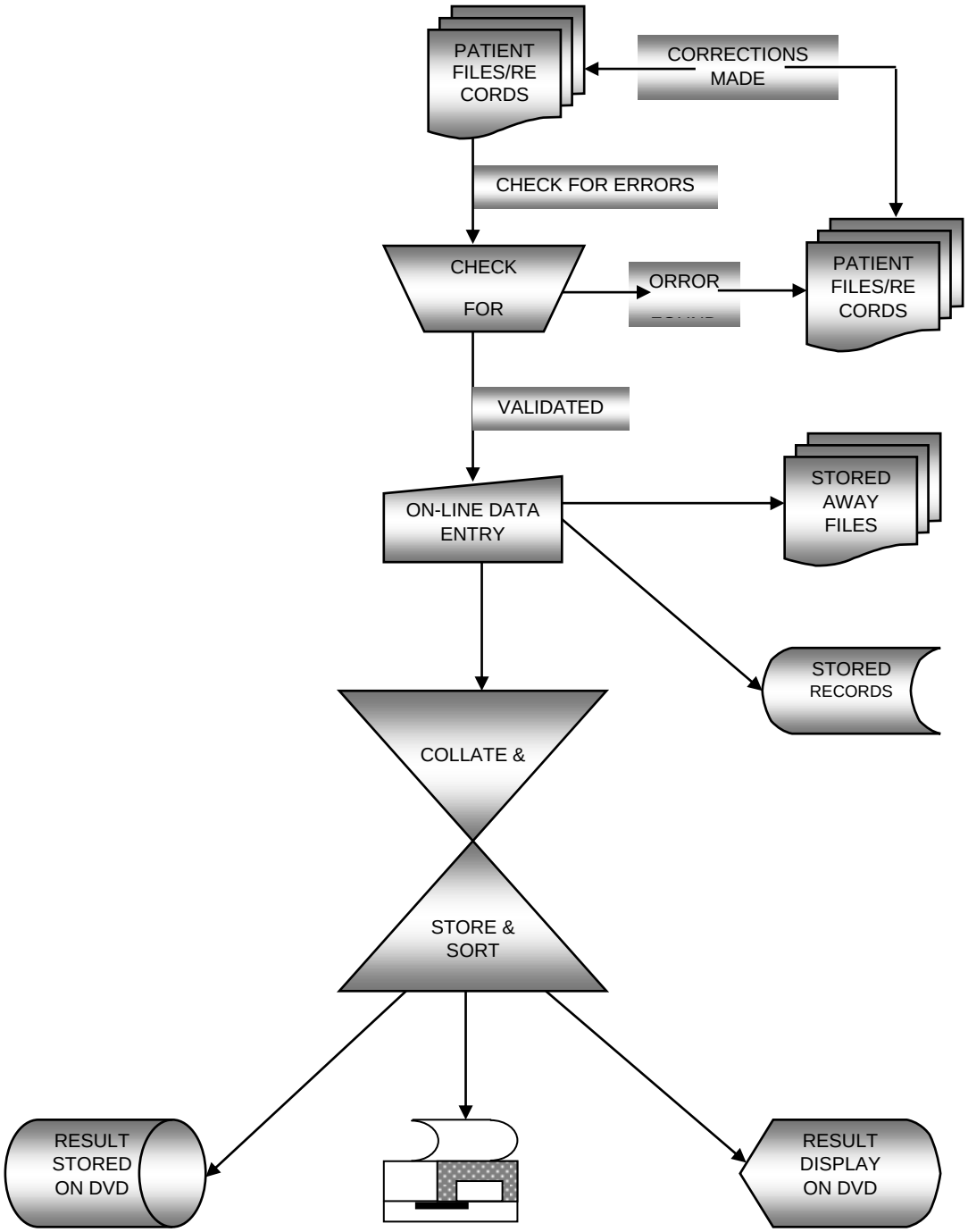

Figure 3: Database Specification

5.3.**Determination OF Delivery Date**

We can mathematically estimate the DELIVERY DATE [DD] if we know the Gestational Age by using the following equation:

$$DD = DM + (40 - T) \text{ wks} \quad \text{Equ. 4.2}$$

Where DD = Delivery Date (dd/mm/yy)
DM = Date Gestational Age was measured (dd/mm/yy)
T = Gestational Age in weeks

5.4. **Input and Output Specification**

5.4.1.**Output Specification and Design**

There are three basic reports generated by the system. These are:

i. Confirmation of Pregnancy Report
ii. Personal Data Symptoms Report
iii. Personal Data Ultrasound Results

Their output specifications are given below.

5.1 Advantages of the Proposed System

i. The proposed system incorporated ANN algorithm to train the input data and the evaluation of the data training showed high accuracy results.
ii. The proposed system was developed with a user-friendly interface that can be easily navigated without any technical knowledge.
iii. The appraisal of non-academic staff was the focus of this study, which is an area that has been grossly neglected by other researchers.
iv. All performance criteria were covered in the fuzzy rule base development.

The proposed system is fast, gives accurate performance prediction in small time, and cost effective to develop

VI. Conclusion

Based on the objectives of this study and the proceeding systems analyses, Designs, implementation, and documentation, including a vast literature review, and enormous knowledge based acquisition, and the outputs generated from the system, one can conclude that an Expert System capable of generated reports, among others, such as:

i. Confirmation of Early Pregnancy in the first Trimester
ii. Documentation, Analyses and Retrieval of Personal Data Symptoms
iii. Documentation, Analyses and Retrieval Personal DATA and ULTRASOUND RESULTS has been developed.

Having said that this work has come to a successful end, it has become necessary to resort to the use of the developed Expert System, otherwise called [FOETALES 2011] in order to achieve the following among others:

1. To remove or minimize errors due to human memory lapses and the resultant wrong diagnoses and therapy.
2. To give speed to clinical diagnoses and therapy with greater accuracy, efficiency and effectiveness.
3. To provide quick and readily available results and decisions to expertise and technicians who need answers quickly. There is never enough expertise to go around - certainly it is not always available at the right place and the right time.
4. To make the knowledge-based applications of Artificial Intelligence available which in turn, enhances productivity in other disciplines, like business, science, engineering, and the military.
5. To help make Medical practitioners more efficient and profitable.
6. To reduce the time it takes to diagnose and solve problems, and to perform routine tasks, thus freeing experts for more important work thereby increasing productivity.
7. To enhance performance of “Junior Doctors, Medical Students and their Clinical Trainees" at the outset of Clinical training.
8. To Train Parents, medical officers and the general public on how to use the developed Medical Diagnostic Expert System or any other similar system.
9. To provide an on-line data bank for references and consultancy. To continuously update the database required for patients' medical report generation system and report processing facility that will enable previous medical records about a patient to be recalled any time during pregnancy test.

It is believed that this study will benefit fathers and mothers, including students, medical practitioners and other healthcare workers. Therefore then, with an Expert Medical Diagnosis System for the Confirmation of Early Pregnancy, the speed and efficiency of medical diagnoses and information production in the society, with no controversy, will be highly achieved.

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