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Expert medical diagnostic system for the estimation of foetal parameters

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Abstract
The goal of this study is to design and implement an expert Medical Diagnostic System for Estimation of Foetal Parameter [Foetal Weight, Foetal Age or Gestational Age, Conception Date and Delivery Date], 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 Estimation of Foetal Parameter [Foetal Age, Foetal Weight, Conception and Delivery Dates].

Keywords: Expert system, Medical diagnosis, early pregnancy, foetal parameters, conception, gestational age

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 Estimation Foetal Parameters.

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**,** *Estimation of Foetal Age or Gestational Age, Estimation of Conception Date, Estimation of Delivery Date, Estimation of Foetal Weight.*

1. Statement of the Problem

In the Medical profession, there have been instances where symptoms of illness are misunderstood or misinterpreted by health workers. Misinterpretations could result from inability of the health worker to comprehend the symptoms, or inattentiveness of the health worker due to much job pressure and dependence on human sense and memory for the analyses of the details involved in these symptoms. As a result of these misinterpreted symptoms, wrong diagnoses are made. Consequently, Harmful, and/or Non-Effective therapy or treatments may be administered.

In all professions, including the Medical profession, there are experts as there are quacks. Where the absence of the experts is the case, clinical exercise may become a suicide journey. Also In the course of clinical apprenticeship, there are stages when trainees and students feel overwhelmed by the details of the practice and would need an expert to consult, the absence of whom may hinder the intended exercise.

Also, oral interview has a very important advantage as a method of clinical diagnosis. It allows the clinician an opportunity to hear the details of the situations directly from the patient involved. However, the patients' account of the intensity of the situation might not suffice, because the patient might attempt to withhold some facts which he or she assumes not respectable or shameful, or even unnecessary to effect a reliable conclusion as it might be an evasive one.

A woman wants to know if she is pregnant evenbefore she sees her menses. Also she wants to know how old the pregnancy is and consequently determine due date of delivery. Pregnancy related studies have basic signs and approaches, all or some of which the patient can give account of, depending on the presentation and its developmental stage. But there are multiplicities of such pregnancy related cases obtainable now. The multiplicity and complexity of such pregnancy related attentions have rendered the human sense or memory insufficient of their accruing characteristics, symptoms, diagnosis and treatment

Some Medical dispensary units as well as affiliate health centers are remotely located and out of reach of qualified specialist or clinicians. The available health officers in such remote places would need a detailed reference and consultation guide in order to face with difficult or unfamiliar cases and presentations. It is therefore hoped, that this project would be a very good supplement and also bring the diagnoses to the door step of individuals.

2. Aim and Objectives

The aim of this study is to develop an expert medical diagnostic system for estimation of foetal parameters. The specific objectives are to:

1. Estimation of Foetal Age or Gestational Age
2. Estimation of Conception Date
3. Estimation of Delivery Date,
4. Estimation of Foetal Weight

3. Significance of the study

This study is designed to benefit fathers and mothers to be. The researcher hopes that Students, Medical Practitioners and other healthcare workers will also find the information useful. Our system however, should in no way be a substitute for professional medical care or attention by a qualified practitioner.

Literature Review

This section discusses some key components of the study.

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. +clearly defined the general architecture of an Expert System to involve two principal components namely:

1. A problem dependent set of data declarations called the knowledge base or rule base, and
2. 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:

1. The end-user; the individual who uses the system for its problem solving assistance
2. The problem domain expert who builds the knowledge base, and
3. 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.

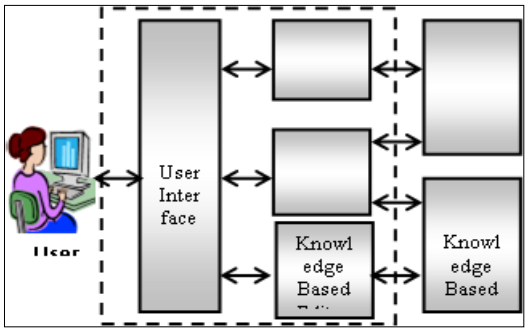

Fig 1: Expert System Shell

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:

1. If Age <11. Or. Age>50, Then "Patient Is Not Within Reproductive Age".
2. 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.

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.

1. Applications of Artificial Intelligence

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

1. **Computer Science:** 5th Generation Computers, Parallel Processing, Symbolic Processing, Neural Networks.
2. **Cognitive Science:** Expert System, Knowledge Base System, Learning Logic System, Fuzzy Logic System.
3. **Robotics:** Visual Perception, Tactility, Dexterity, Locomotion, Navigation.
4. **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. 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.*

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 and gives very accurate estimation of the gestational age. 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.

Diagnosis of Foetal Malformation

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 foetal hydrops.

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, foetal hydrops, Rh isommunization and severe intrauterine growth retardation can also be assessed.

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.

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, hydrops foetalis or renal dysplasia.

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.

Determination of Foetal Age or Gestational Age

Alternate Names for Gestational Age are Foetal Age, or Gestation. Gestation is the period between conception and birth of a baby, during which the fetus grows and develops inside the mother's uterus. Gestational age is the time measured from the first day of the woman's last menstrual cycle to the current date and is measured in weeks. A pregnancy of normal gestation is approximately 40 weeks, with a normal range of 38 to 42 weeks. Infants born before 37 weeks are considered premature. Infants born after 42 weeks are considered postmature. Strictly speaking, gestational age of the fetus or infant is a measurement of time in utero (inside of the uterus). Gestational age can be determined prior to birth or at birth. Prior to birth, intrauterine foetal growth can be determined using ultrasonography by taking serial determinations of the biparietal diameter of the head and the head-to-abdomen circumference ratios. Following birth, assessing all 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 gestational 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. Gestational age determination involves procedures and tests used to check the age of a fetus during pregnancy.

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:

1. date of the last menstrual period
2. an early pelvic exam
3. measurement of the size of the uterus
4. quickening, or feeling the baby's first movements

Konje*et 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 based on the following variables

Kidney Length,

a. Biparietal Diameter,
b. Head Circumference,
c. Femur Length and
d. Abdominal Circumference

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.

Predicting Foetal Weight at Birth
Today, there are two predictable formulas for weight at birth. One was developed by Schild, [14]. These authors developed a formula for sonographic estimation of foetal weight respectively from 84 singleton fetuses with a birth weight of 1600g, examined sonographically within 1 week before delivery. Exclusion criteria were multiple pregnancy intrauterine death and major structural or chromosomal anomalies. The new formula for Estimated Foetal *weight [efw]* is given by *Efw*= 5381.193 + 150.324 X HC + 2.069 X FL^3 + 0.0232 X AC^3 - 6235.478 X, log (HC).
Where: *Efw= Estimated Foetal weight*
HC = Head circumference
FL = Femur Length
*AC = Abdominal circumference (*Equ. 2.2)
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This new formula was then compared prospectively in an evaluation group of fetuses (n = 87) with six currently available equations for estimating weight in the preterm fetus. Stepwise regression analysis with gestational age (in days) and foetal biometric parameters was employed to yield the best-fit formula for predicting foetal weight at birth.
This formula by Schild, [14] is proved to be superior to established equations. The lowest mean ± SD absolute error was 66.2 ± 59 g and the lowest mean absolute percentage error was 7.1 ± 5.9% SD when studied prospectively in the evaluation group. With the new formula, 48.3% of estimates fell within ±5% of the actual weight at birth, 73.6% fell within ±10%, 90.8% fell within ±15% and 95.4% fell within ±20%. This formula has been proved to be relatively easy to use and needs no adjustment to weight centiles or to foetal lie. It allows reliable weight estimation in the fetus 1600g. Therefore the researcher will implement the said formula in the system while predicting Foetal weight at birth.
The second formula was developed by Mertz [15] at the Department of Gynecology and Obstetrics of the University of Mainz, the foetal weights were estimated in 196 fetuses between 24 and 42 weeks of gestation. All estimates were based on sonographic determination 0-6 days prior to delivery.
The formula which was derived from own data for the estimation of foetal weight [fw] was as follows:
Fw (g) = -3200.40479 + 157.07186 AC (cm) + 15.90391 (BPD) 2 (cm).
Where
Fw = Foetal weight
AC = Abdominal circumference
BPD = Biparietal Diameter

According to the authors, this formula we guarantees 71.4% reliability in predicting foetal weight with a mean absolute weight difference of 221g for the complete study group. Again, they claimed that the validity for this formula could be defined as follows:
BPD 7.0-10.5 cm AC 21.8-36.5 cm (all measurements from outer to outer margin)

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.

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.

Objectivesof the Existing System

The following are some of the objectives of the existing 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.

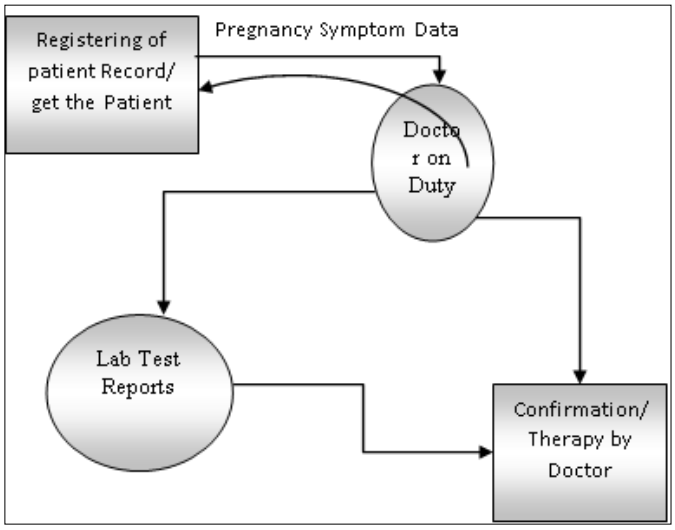

Fig 2: Process flow diagram of the existing System

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?

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.

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 and foetal estimation data.

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, and Foetal Estimation Results such as Foetal Weight, Age, Conception Date, and Delivery Date.

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.

Mathematics Specification

1. 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) 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

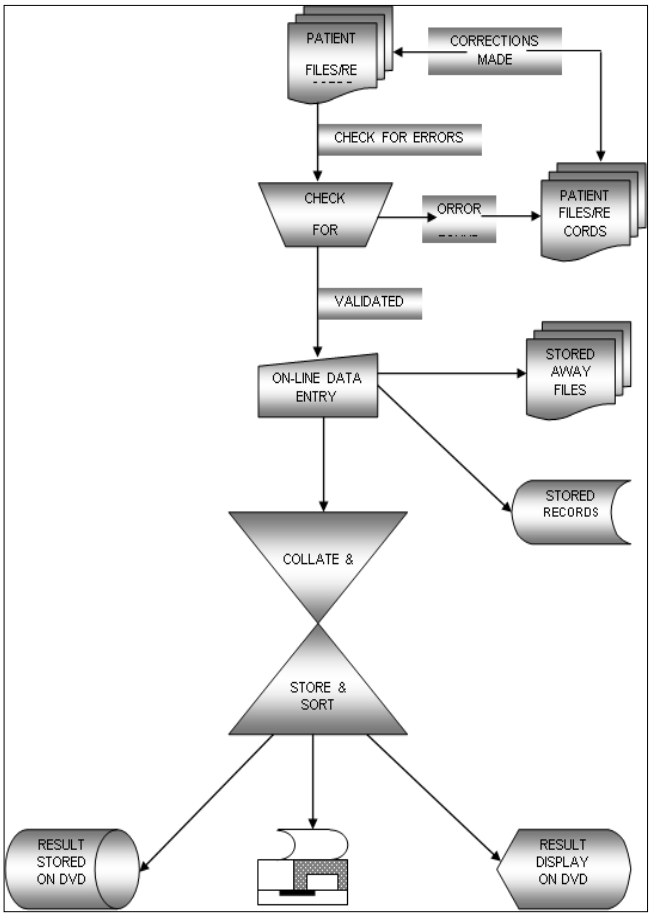

Fig 3: Database Specification

2. 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) wks

Where DD = Delivery Date (dd/mm/yy)

Equ. 4.2

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

T = Gestational Age in weeks

3. Input and Output Specification

Output Specification and Design

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

1. Confirmation of Pregnancy Report
2. Estimation of Foetal Age Report
3. Estimation of Foetal Weight Report
4. Estimation of Conception Date Report
5. Estimation of Delivery Date Report
6. Personal Data Symptoms Report
7. Personal Data Ultrasound Results

3.1 Their output specifications are given below

Advantages of the Proposed System

1. The proposed system incorporated ANN algorithm to train the input data and the evaluation of the data training showed high accuracy results.
2. The proposed system was developed with a user-friendly interface that can be easily navigated without any technical knowledge.
3. The appraisal of non-academic staff was the focus of this study, which is an area that has been grossly neglected by other researchers.
4. 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

Table 2: Confirmation of Pregnancy Report

S/no	Field name	Description	Field type	Field width	Dec.
1.	Cadnum	Patients card number	Character	8	
2.	Name	Patients name	Character	20	
3.	Age	Age	Numeric	3	
4.	Sex	Sex	Character	1	
5.	Ddress	Address	Character	25	
6.	Date	Transaction date	Date	8	
7.	Mestrual	Cessation of menses	Character	1	
8.	Breast	Breast enlargement	Character	1	
9.	Morn	Morning sickness	Character	1	
10.	Bladder	Enlarged blabber	Character	1	
11.	Tired.	Feels tired often	Character	1	
12.	Quick	Quickining	Character	1	
13.	Areola	Nipples darker/broader	Character	1	
14.	Moodsw	Mood swings	Character		
15.	Hcg	Hcg [positive/negative)	Character	1	
16.	·labresult	Pregnancy confirmed	Character	1	
17.	,malignant	Malignant resil t	Character	1	
18.	"cyst	Cyst present?	Character	1	
19.	Bodyout	Body out of uterus?	Character	1	
20.	Nothing	. No observations?	Character	1	
21.	Ultrarst	Ul trasound resul t	Character	1	

Fig 4 confirmation of pregnancy report file

Implementation

The construction and testing of a new database will be required for this activity. The primary inputs for this activity are the database design that was performed in OUTPUT and INPUT file designs (Data & Database Analysis) which includes the Pregnancy Symptoms Test Data, Patients' Personal Data, and Ultrasound Data for estimation of foetal parameters and normalized database schema. The systems users will provide the test data.

The researcher will need to purchase Microsoft's VISUAL BASIC [OOBASIC] Microsoft Office package in order to implement the proposed plan (Input/Output Specifications) for the Expert System. Since the software is compatible with Windows, installation is not a major problem for this activity. Also, it will be necessary for the researcher to purchase recovery system software for inevitable system crashes.

This is a major activity for the construction phase. In order for all the interface screens or specifications to work, programming in FoxBASE and Microsoft Access is essential. The inputs for this activity are the Expert System transition and Master data and structured charts developed in Chapters 3 and 4. After the preliminary coding of the new system, several levels of testing are to be conducted. First, we would use a stub testing approach to verify each of the main menu options (File Diagnoses, Knowledge Base, Perform Inference Engine, Perform Report" Generation Help) subroutines and subprograms. Next, a program test is performed to ensure that each menu option works independently. Finally, a program test is performed to ensure that all modules including security login and main program work together as an integrated unit. The final step of this activity is to develop an Expert System acceptance plan. The researcher performs a test on the overall performance of the system using simulated data (Verification Testing or Test Running). Next, a Validation Test should be performed using real data - the Validation Test must check details like system performance, peak workload processing, human engineering, methods and procedures, and backup and recovery. An Audit Test is not required, but however if the researcher wants to ensure the reliability of the system, the researcher may hire external agents to perform this test.

Fig 4: Login page

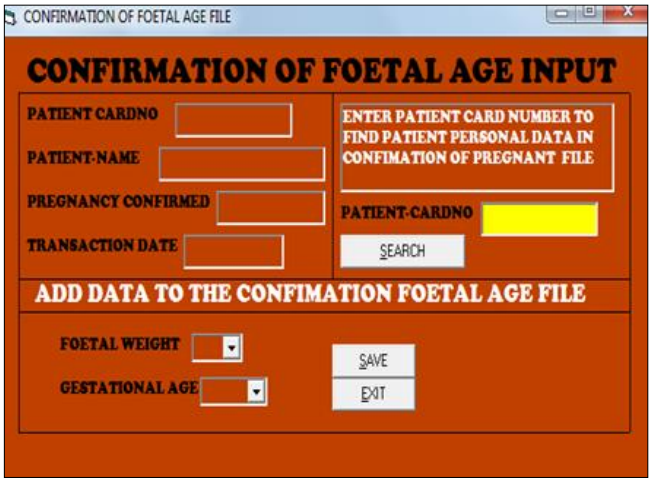

Fig 5: Foetal age confirmation page

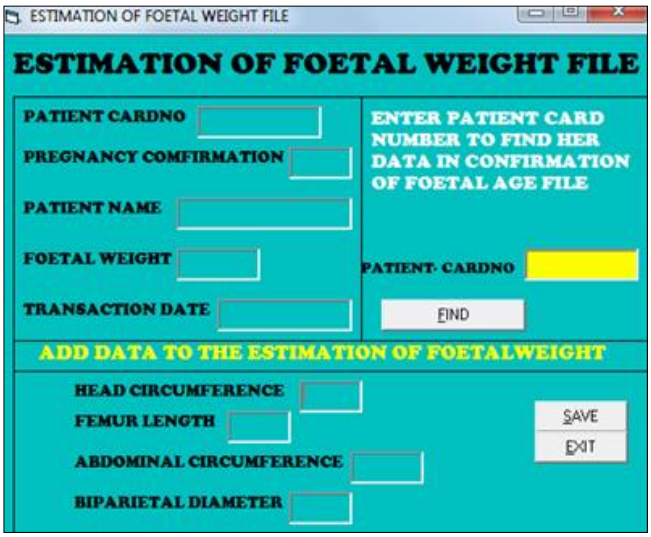

Fig 7: Estimation of foetal weight file

System Appraisal

The completed Expert System work has a great improvement over the old and conventional manual system. The system's efficiency is examined to see where improvement can be made. The outputs from the Expert System are compared with the results obtained in the old system, and also compared with the objectives for which the system was originally set.

The following can be said concerning the new designed Expert System

1. The Expect System designed is user friendly. The System is Menu Driven with an inbuilt help tutorial and error message facilities capable of guiding and giving the user adequate assistance.
2. The system is very easy to use with simplified navigator buttons and with good screen background/design.
3. The System is correct and appropriate in terms of meeting the users' needs, and also meeting the objectives of the manufacturer (the researcher). It offers complete medical diagnosis system for Estimation of Foetal Age or Gestational Age, Conception Date, Delivery Date" Foetal Weight, during the first trimester There is production of high accurate results
4. The System produces the same result or output for the same inputs any time any day. It Cannot Fail
5. The System is flexible and efficient. Same results can be achieved by two or more alternative methods or approaches.
6. The System is adaptable to changes and improvements. Modules can be added or removed without affecting the entire system performance.

The system is therefore robust. There is good documentation plan, and packaging for ease of learning and improvements

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:

1. Estimation of Foetal Age
2. Estimation of Foetal Weight
3. Estimation of Conception Date
4. Estimation of Delivery Date
5. Documentation, Analyses and Retrieval of Personal Data Symptoms
6. 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 obtain accurate estimation of foetal Weight, Age, Conception Date, and Delivery Date.
4. 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.
5. 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.
6. To help make Medical practitioners more efficient and profitable.
7. 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.
8. To enhance performance of “Junior Doctors, Medical Students and their Clinical Trainees" at the outset of Clinical training.
9. To Train Parents, medical officers and the general public on how to use the developed Medical Diagnostic Expert System or any other similar system.
10. 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 Estimation of Foetal Parameters, the speed and efficiency of medical diagnoses and information production in the society, with no controversy, will be highly achieved.

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