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# ARTIFICIAL INTELLIGENCE-DRIVEN MEDICAL DIAGNOSTIC SYSTEMS FOR QUALITY SERVICE DELIVERY AND BUSINESS PROSPECTS

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**Abstract**
Artificial Intelligence applications to health care service delivery including medical diagnostic services, is a well-accepted development as it mitigates the problems associated with diagnostic results optimization, diagnostic data processing time, and diagnostic information system availability. This study is therefore aimed at providing insight into the prospects of artificial intelligence–based diagnostic applications. Specifically, the ability of Artificial Intelligence-based diagnostic applications to increase the accuracy of disease prediction, efficiently classify diseases and determine their degrees of presence within the shortest possible time are discussed using exploratory and explanatory methods. In this light, artificial intelligence technologies suitable for the management of large and complex medical variables such as disease symptoms, signs, medical history, imaging results, and laboratory results, in a seamless manner are discussed. The business-oriented benefits as it affects Information Technology practitioners are also discussed. The significance of this study cannot be undermined because it provides an innovative diagnostic business idea for Information Technology Practitioners who wish to grant Information Technology support to Laboratory Technicians while delivering information that enables health care givers to select the right treatment and prescribe appropriate preventive or curative treatments for their patients. Considering the high demand for more effective diagnostic models for diabetes management systems, it is recommended that future work looks at the framework for the development of an adaptive artificial intelligence-driven diabetes diagnostic application

**Keywords:** Artificial Intelligence, Medical Diagnosis, Medical Diagnostic business, Health care Services

## Introduction

Artificial Intelligence applications to health care service delivery including medical diagnostic services, is a welcome development as it mitigates the problems associated with diagnostic results optimization, diagnostic data processing time, and diagnostic information system availability. This study is therefore aimed at providing insight into the prospects of artificial intelligence –based diagnostic applications. Specifically, the ability of artificial intelligence-based diagnostic applications to increase the accuracy of disease prediction, efficiently classify diseases and determine the degree of disease severity are examined with examples.

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are designed to think and act like humans. AI technologies covered in this study as seen in Figure 1 have a variety of applications, including voice recognition, autonomous vehicles, and medical diagnosis, and are becoming increasingly integrated into our daily lives (Heath, 2020). Machine Learning, which deals with vast amounts of data to effectively identify patterns and make predictions accurately and Natural Language Processing, which deals with making the computer understand and respond to human language seamlessly play a significant role in optimizing medical diagnostic processes.


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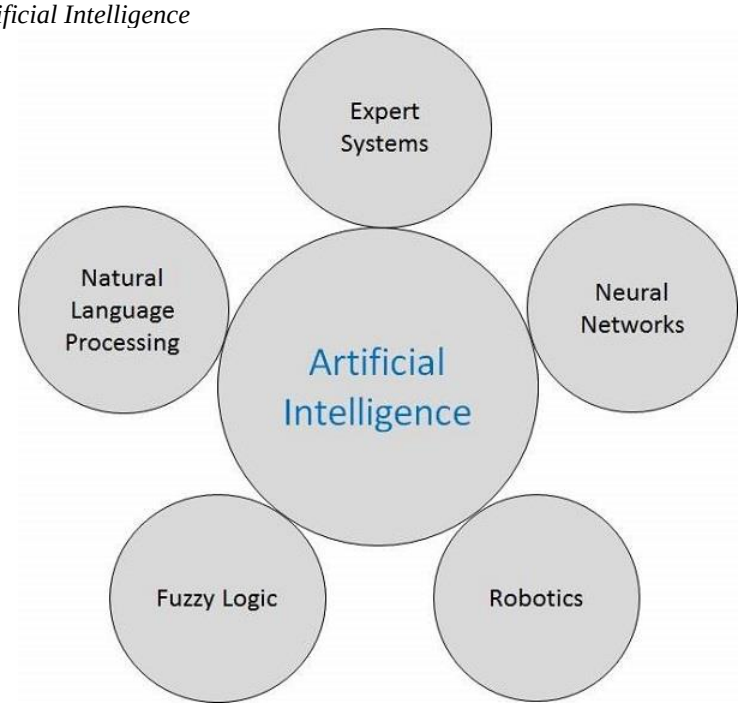
**Figure 1:** *Areas of Artificial Intelligence*




**Note**. The five major branches are a combination of different systems of artificial intelligence. In "*Artificial Intelligence - Research Areas*" by Tutorials point. (2021). Retrieved February 5, 2023, from https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_research_areas.htm

It can be seen from Figure 1 that five major branches of artificial intelligence exist and are a combination of rule-based systems, machine learning, deep learning and cognitive computing. Medical diagnostics is used to describe the process of identifying a disease or medical condition through the use of various tests and examinations including laboratory tests, imaging tests (such as X-rays and CT scans), and physical exams. The results of these tests are used by healthcare providers to make a diagnosis and develop a treatment plan for the patient (National Academies of Sciences, Engineering, and Medicine, 2015). It is, therefore, a critical component of the healthcare system, as it helps to ensure that patients receive appropriate and effective treatment for their medical conditions. Advances in medical technology have led to the development of more sophisticated and accurate diagnostic tools, which are improving the accuracy of diagnoses and leading to better health outcomes for patients (Wadhwa et al., 2018).

A patient is an individual receiving healthcare services for a medical condition. The patient-provider relationship is built on trust, with the patient entrusting their healthcare needs to the provider, who in turn is responsible for diagnosing, treating and managing their health (Bates & Singh, 2018). The patient's role involves actively participating in the decision-making process, providing relevant information about their health history, and following the recommended treatment plan. The ultimate goal is for the patient to achieve optimal health outcomes and improved quality of life (Frampton et al., 2017). Medical service providers are individuals or organizations that offer medical services to patients. These providers can include physicians, nurses, hospitals, clinics, and alternative or complementary healthcare providers, such as chiropractors and acupuncturists. Medical service providers play a critical role in the delivery of care to patients, and the quality and availability of these services can have a significant impact on patient health outcomes. Artificial Intelligence Medical Diagnostic businesses should therefore be seen as an interaction between I.T practitioners and Medical Service Personnel for the provision of diagnostic tools which are beneficial to both the patient and the Medical Service Provider. Medical service providers play a critical role in the delivery of healthcare services to patients. These providers can range from individual practitioners to large healthcare organizations, and offer a wide range of medical services, from preventive care to specialized treatments. Ensuring that patients receive high-quality, safe, and effective care remains one of the main challenges of medical service delivery, and requires ongoing efforts to improve quality, safety, and access to care even as AI tools are introduced into the medical ecosystem.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Optimized medical diagnostics is a crucial component of quality healthcare, as it enables healthcare providers to gather important information about the health of their patients and make informed decisions about the best course of treatment. Without compromising the availability of optimized diagnostic technologies and techniques, medical diagnostics continues to play an important role in improving the health and well-being of patients around the world. However, access to care, particularly for vulnerable populations, such as the elderly, low-income individuals, and those living in rural or remote areas is still a challenge in developing countries. In developed countries, there are initiatives to improve access to care, including expanding healthcare coverage, increasing the number of medical providers, and remote automated diagnosis which are driven by Artificial Intelligence technologies. One of the main goals of AI is to create systems that can reason and solve problems in a way that is similar to human reasoning (Manning & Schutze, 2009) with respect to visual perception, speech recognition, decision-making, and language translation. There are several different approaches to AI applications including:

i. Rule-based approach: This approach uses predefined rules to make decisions and solve problems. They are straightforward and can be highly effective in certain domains, but they lack the flexibility of more advanced AI implementation (Grosan & Ajith, 2011).
ii. Machine learning: This approach involves training algorithms on large amounts of data to enable them to identify patterns and make predictions. There are several different types of machine learning, including supervised learning, unsupervised learning, and reinforcement learning (Char et al., 2018).
iii. Deep learning: Deep learning is a type of machine learning that uses artificial neural networks to model complex relationships between inputs and outputs. It has been particularly successful in areas such as image and speech recognition (Ciresan et al., 2013).
iv. Cognitive computing: Cognitive computing involves the development of systems that can understand, reason, and learn like humans. This involves modelling human cognition and developing algorithms that can perform tasks that typically require human intelligence (Kelly, 2015).

These approaches to Artificial Intelligence implementation have been combined to create the five major branches of Artificial Intelligence which include:

**Expert Systems.** Expert systems in artificial intelligence are computer programs designed to imitate the decision-making abilities of a human expert in a particular field. They use a knowledge base, which consists of a collection of facts and rules, to make inferences and solve problems in a specific domain, such as medicine, finance, or law. The knowledge base is typically developed and maintained by human experts, who have extensive experience and knowledge in the field (Russell & Norvig, 2010).

Expert systems use a variety of techniques, including rule-based systems, which use a set of if-then rules to make decisions, and case-based reasoning, which uses past experiences to make decisions. They also use artificial intelligence algorithms, such as machine learning and natural language processing, to make inferences and respond to user queries (Rich & Knight, 1991). Expert systems have been used in a wide range of applications, including medical diagnosis. They offer several advantages over traditional decision-making methods, including faster and more accurate decision-making, consistency in decision-making, and the ability to make decisions based on a vast amount of information (Chichester, 1994). Despite these advantages, expert systems have some limitations. They can only make decisions within the constraints of their knowledge base, and may not be able to handle new or complex problems. They also require a significant amount of expertise to develop and maintain and can be expensive to implement (Yanase & Triantaphyllou, 2019).

**Natural Language Processing.** Natural Language Processing (NLP) is a subfield of Artificial Intelligence that focuses on the interaction between computers and humans in natural language. The goal of NLP is to create systems that can understand, interpret, and generate human language (Jurafsky & Martin, 2000). NLP is used in a variety of applications, including machine translation, sentiment analysis, text classification and question-answering systems (Bird et al., 2009). NLP has difficulties when a word is used in context, is ambiguous, or is sarcastic (Brownlee, 2017).

**Robotics.** Robotics is the branch of engineering that deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. Robotics involves the integration of mechanics, electronics, and software engineering to create robots that can perform a variety of tasks (Hawking, 2016). Robots are artificial agents that operate in the real world. Robots are designed to manipulate objects by sensing, picking up, moving, altering the physical qualities of the object, destroying it, or having an effect, freeing


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up human labour from boring, distracting, or exhausting repetitive tasks. A disadvantage of robotics is the elimination of jobs that require manual labour by humans.

**Fuzzy Logic.** Fuzzy Logic is a mathematical framework that allows the modelling of uncertainty, vagueness, and imprecision in complex systems. It is an alternative to classical (Boolean) logic, which is based on binary decisions (true/false or 1/0). Fuzzy Logic, on the other hand, uses degrees of truth that can range between 0 and 1, representing the degree of membership of an element in a certain set (Tanaka, 1996). Fuzzy Logic has been applied in various fields, including control systems, decision-making, pattern recognition, and artificial intelligence. Fuzzy Logic systems' accuracy is impaired since they frequently use incorrect data and inputs. Furthermore, Fuzzy logic cannot be used to answer all problems in a single, methodical way and they are not always widely accepted since the results are inaccurate (Ross, 2009).

**Neural Networks.** A neural network is a type of machine learning algorithm modelled after the structure and function of the human brain. Neural networks are composed of interconnected processing nodes, called artificial neurons, which process and transmit information (Goodfellow, 2016). The learning process of a neural network involves adjusting the strengths of the connections (weights) between neurons based on input data and desired output. This allows the network to make predictions or decisions based on input data, and improve its accuracy over time through training (Haykin, 1998). Neural networks have been successfully applied in various fields, including image and speech recognition, natural language processing, and game-playing (Schmidhuber, 2015).

AI has the potential to transform many different industries, and since our focus is healthcare, AI-powered systems can help doctors and medical laboratory practitioners collaborate with I.T practitioners in developing solutions in Medical Diagnostics to the benefit of the Patient and Service Providers. There are also many ethical and societal concerns associated with AI. For example, as AI systems become more advanced, there is a risk that they could be used for malicious purposes, such as cyber-attacks or autonomous weapons (used for cyberransome). There is also concern about the potential impact of AI on employment, as some jobs may become automated, and there is the potential for AI systems to perpetuate and amplify existing biases in society (Sample, 2017).

Medical diagnostics refers to the process of identifying the presence, cause, and extent of a disease or medical condition in an individual. This process plays a critical role in the provision of quality healthcare, as it enables healthcare providers to make informed decisions about the best course of treatment for their patients (Thompson & Dowding, 2009). The medical diagnostic process typically begins with a comprehensive medical history and physical examination of the patient. During the physical examination, the healthcare provider may gather information about the patient's symptoms, conduct a thorough examination of the affected area, and gather information about any other relevant medical conditions (Langlois, 2002). In addition to the physical examination, medical diagnostics often involve various tests and procedures. These can include imaging tests, such as X-rays, MRI scans, and CT scans, which can provide detailed images of internal structures of the body and help detect diseases or conditions that may not be visible through physical examination. Laboratory tests, such as blood tests, urine tests, and stool tests, can also be used to gather information about the patient's health and help diagnose certain conditions (Sushkova et al., 2021).

Diagnostic procedures can also include endoscopic procedures, such as colonoscopies, upper endoscopies, and bronchoscopies, which enable healthcare providers to directly visualize the inside of a patient's body and take biopsy samples if necessary. Other diagnostic procedures can include electrocardiograms (ECGs), which measure the electrical activity of the heart, and pulmonary function tests, which measure lung function. The results of these diagnostic tests and procedures can provide valuable information that helps healthcare providers diagnose and treat various medical conditions. For example, imaging tests can reveal problems such as tumours, broken bones, or damage to internal organs, while laboratory tests can provide information about a patient's overall health and help detect conditions such as infections, anaemia, and diabetes (Coon, 2014).

The importance of medical diagnostics cannot be overstated, as accurate and timely diagnoses are essential for effective patient care. Proper diagnoses can lead to prompt and effective treatment, which can improve patient outcomes, reduce healthcare costs, and prevent the progression of disease. Furthermore, medical diagnostics can help healthcare providers monitor the progress of treatment and adjust as needed.

Medical service providers are individuals or organizations that offer healthcare services to patients. These providers can range from individual practitioners, such as physicians and nurses, to large healthcare organizations, such as


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hospitals and clinics. One of the main types of medical service providers is physicians, who are licensed to diagnose and treat medical conditions. Physicians can specialize in a particular field of medicine, such as paediatrics, cardiology, or oncology, and may work in a variety of settings, including private practices, hospitals, and clinics (Appel, 2009).

Nurses are another important type of medical service provider, who play a crucial role in the delivery of care. Nurses can work in a variety of settings, including hospitals, clinics, nursing homes, and schools, and can specialize in areas such as paediatrics, critical care, and mental health (Lundy, 2014). Hospitals are one of the largest and most complex medical service providers, offering a wide range of medical services, including emergency care, surgery, and inpatient care. Hospitals can be public or private and may be affiliated with a medical school, providing training and education for healthcare professionals (Alight.com, n.d). Clinics are another type of medical service provider, offering a more limited range of services than hospitals, including primary care, preventive care, and minor medical procedures. Clinics can be freestanding or attached to a larger healthcare organization and may provide care on an outpatient basis (Aneni et al., 2013). In addition to these traditional medical service providers, there are also several alternative or complementary healthcare providers, such as chiropractors, acupuncturists, and massage therapists. These providers offer treatments that are not typically part of conventional medicine and may be used in conjunction with other forms of care (Ong et al., 2005).

**Materials and Methods**

Practical applications of AI technologies in the medical field are very verse and implemented using different methods. Some of the AI models used in existing diagnostic solutions are presented in this section and they are seen in the form of:

**Computer-Aided Diagnosis (CAD).** AI algorithms can be trained to analyze medical images such as X-rays, CT scans, and MRI scans to assist doctors in detecting diseases such as cancer and heart conditions. Hinton gave the example of deciding whether a patient has a particular disease and explained that a common approach would be to use a simple logistic regression (using data to predict a binary outcome: the patient has the disease or does not) (Victor-Chmil, 2013).

**Predictive Analytics in Healthcare.** AI algorithms can analyze vast amounts of patient data to predict diseases and health issues before they occur, enabling doctors to intervene early and provide proactive care. For instance, a study by researchers at the University of Pennsylvania Health System used machine learning algorithms to analyze electronic health records of patients with heart failure and accurately predicted readmissions up to 60 days in advance with an AUC (Area Under the Curve) of 0.76. The results showed the potential of AI in improving patient outcomes and reducing healthcare costs (Harlap et al., 2015).

**Natural Language Processing (NLP) for Electronic Health Records (EHR).** AI algorithms can analyze and extract relevant information from electronic health records to support diagnostic processes and improve patient outcomes. Popowich (2008) explained that diagnosis may be made by text mining from patient calls to a telemedicine centre through the analysis of textual information and categorization of textual information

**Disease Outbreak Detection and Response:** AI algorithms can be used to quickly identify outbreaks of infectious diseases and provide real-time tracking and response recommendations to health authorities. For instance, a study by researchers at Imperial College London and Microsoft developed an AI-powered platform for monitoring and predicting the spread of dengue fever. The platform used a combination of machine learning algorithms and geospatial data to analyze the distribution and spread of dengue fever in near real-time and provide predictions about future outbreaks. The results showed the potential of AI to improve disease surveillance and response efforts (Wesseh et al., 2017).

**Discussion**

Information gathered from reliable literature addressed questions such as:

i. Is the value of Artificial Intelligence in medical diagnosis of benefit to the patient?
ii. Is the value of Artificial Intelligence in medical diagnosis of benefit to Medical Providers?
iii. Is the value of Artificial Intelligence in medical diagnosis of benefit to the Service Providers?

The answers to these questions are summarized in Table 1 where the different types of artificial intelligence technologies are listed alongside their prospects and application areas in the health sector.


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**Table 1.**
**A summary of Artificial Intelligence technologies and their prospective application areas in the health sector**

| AI Tech. | Patient | Medical Personnel | Healthcare Institution |
|---|---|---|---|
| Expert Systems | Important | Important | Important |
| NLP | Important | Important | Important |
| Neural Networks | Important | Important | Important |
| Robotics | Important | Important | Important |
| Fuzzy Logic | Important | Important | Important |

Table 1 shows that the Expert System is useful in the business of medical diagnosis in the sense that it collects diagnostic data processes the data and draws inferences from a given premise influenced by the problem under investigation. Communicating the result in the form of a report to the medical practitioner or for keeps in a stress-free manner is an indication of improved productivity which in turn increases patient satisfaction and generate more revenue. NLP technology is useful in making communication between patients and doctors or other medical practitioners effective thereby eliminating language barriers, especially at the point of data gathering. Lack of fluency by either party in the use of language is detrimental to the medical diagnosis process. Neural Network technology also shows value gain. By allowing the medical practitioner to draw similarities to the patients' symptoms from a dataset of existing symptoms, and performing a more reliable symptom classification and accurate prediction of diseases or health-compromising occurrences, quality service can be achieved seamlessly. Robotics helps in remote diagnosis where the medical practitioner is at a remote location. This is very important as it helps in making diagnostic systems accessible irrespective of the location of the patient. Fuzzy Logic technology is also of great importance in the implementation of AI-driven medical diagnostic systems because it allows for a gradation of the diagnostic symptoms in degrees of severity. This is important to the patient, medical personnel and the healthcare institution.

Examples of Artificial Intelligence (AI) propelled Medical Diagnostic businesses with benefits to the patient and Service Provider that can be established through partnerships between Medical Service Providers and I.T practitioners include the following:

**Augmented Reality for Assisted Diagnosis.** Many individuals find it difficult to describe their present medical issues to doctors. While some individuals may overstate their symptoms, others may provide scant details. This could lead to a misdiagnosis and a misguided course of treatment. Augmented Reality (AR) addresses this issue by giving patients a quick and convenient opportunity to independently assess their symptoms and current state of health. To help the patient stay healthy and fit, doctors can also analyze the health reports predicted by AR and provide precise treatments and lifestyle changes. The augmented reality gadget is a camera display that labels symptoms, describes conditions, and provides findings next to each image as seen in Figure 2. From the figure (That is Figure 2), it can be seen that this enables the physician to carefully assess the patient's symptoms while assisting the patient with any communication difficulties (Thomas, 2016).

**Covid-19 diagnosis.** A daily text message with a link to a clinical triangulation system may be sent to residents of a certain area, for instance, asking them about their symptoms. Each respondent receives a customized risk profile and next-step advice after completing the questionnaire, and the artificially intelligent agent uses their anonymized data to produce a heatmap of COVID-19's daily location. This aids in allocating resources, such as medical supplies and COVID-19 tests, and aids physicians, nurses, and the Ministry of Health in making judgments regarding the proper quarantine measures to be taken for the benefit of health personnel and patients in each city.

**Figure 2:** ***Assessing a patients' symptoms with Augmented Reality***


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**Intelligent Diabetes Classification and Prediction Service.** Trained medical data sets (like age and blood insulin level) using neural network (machine learning classifier) offer reliable predictions on new patients as well as a true label indicating the patient's onset of diabetes sometime after the measurements were taken (Torgyn & Khovanova, 2017) as seen in Figure 3. The ethical and societal concerns of Artificial Intelligence (AI) Propelled Diabetes Diagnostic busineses for consideration are discussed in the following subsections.

***Job displacement***

As the intelligent diagnostic system becomes more advanced, there is a risk that it could automate many jobs and lead to widespread unemployment in the healthcare sector. Such social onnsequence can be detrimental to the well-being of the society.

***Privacy***

The widespread use of intelligent diagnostic systems can lead to the collection and analysis of vast amounts of personal data, raising concerns about privacy and the potential misuse of this information.

***Responsibility and Accountability***

As intelligent diagnostic systems become more advanced, it can become unclear who is responsible for their actions and decisions. This can make it difficult to hold individuals or organizations accountable for the impact of the system on patients' well-being.

***Ethical Considerations***

There are also broader ethical considerations associated with intelligent diagnostic systems, such as the potential for the systems to compromise human autonomy for the medical practitioner instead of being a reliable assistant, and the need to ensure that the systems are aligned with human values and ethical principles.


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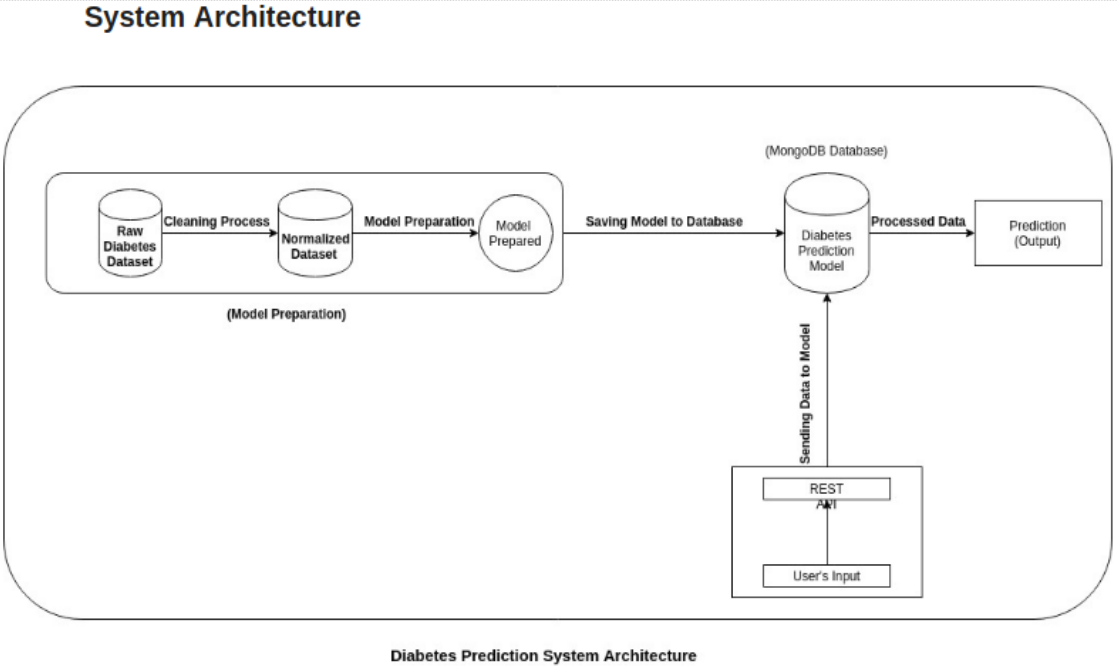
**Figure 3:** ***An illustration of a Diabetes Classification and Prediction System (own diagram)***




Note. The system predicts the user input based on the model from the dataset.
From Figure 3 it can be seen that the user input is transformed by the neural network into a suitable output based on the values submitted by the user.

**Conclusion**

Artificial intelligence-propelled Medical Diagnostic businesses are a profitable field for prospective Information Technology entrepreneurs. This may be embarked upon by the Information Technology practitioners and Medical personnel working together to develop medical diagnostic tools for the benefit of the patient and the Healthcare delivery experts. It is a viable source of revenue with the capacity to engage professionals in research for continual improvement and innovation. However, it is important to address ethical and societal concerns as AI technology continues to evolve and become more widely adopted. This may involve the development of ethical frameworks and regulations to ensure that AI systems as such, are used responsibly and in a manner that benefits society as a whole. This paper has contributed to the body of knowledge by:

i. providing insight meaning of "health care delivery" and "medical diagnostic" service
ii. identifying innovations in medical diagnostic ventures,
iii. demonstrating the application of a variety of AI technologies in healthcare delivery systems and
iv. highlighting the benefits of innovative medical diagnostic service delivery.

Considering the high demand for a more effective diagnostic model for diabetes management systems, it is recommended that future work looks at the framework for the development of an adaptive artificial intelligence-driven diabetes diagnostic application.

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