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Contribution of Recent Machine Learning Techniques in Healthcare and other Applications

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ABSTRACT: Machine Learning has emerged as a significant trend in the market in recent years because it is a cutting-edge technological application that is also extremely difficult to implement. There are three primary areas in which machine learning is being put to use: genetic information, medical imaging, and natural language processing of published medical research. A good number of these fields are concerned with diagnosing, locating, and forecasting issues. Applications of machine learning in health care are gaining traction at a rapid rate, and they have the potential to make a significant impact on the industry.

KEYWORDS: Machine learning; Healthcare; Bio Medicine; Prediction.

I. INTRODUCTION

The ability of the healthcare industry to provide high-quality treatment and services has been put under a significant amount of strain as a result of the ever-increasing population around the world. Now, more than ever before, people are looking for smart healthcare services, software, and wearables in the hopes that it will help them live better lives and live longer[1]. As a result of machine learning, the healthcare industry is gaining intelligence. This powerful subset of artificial intelligence is familiar to a large number of people. It is used in applications such as speech recognition for voice assistants and the development of personalised online shopping experiences by virtue of its capacity to learn associations. Other applications of artificial intelligence include facial recognition and robotics. On the other hand, it has been demonstrated that machine learning has the potential to completely revolutionise healthcare, particularly in the field of medical diagnostics [2].
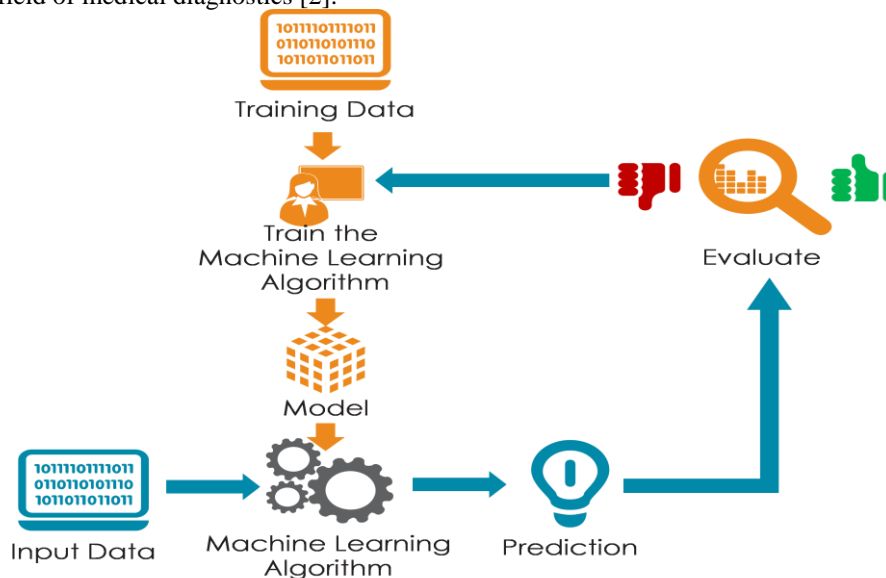

Fig. 1. Flow diagram of Machine learning based system

It is common knowledge that the healthcare industry was among the first to adopt new technologies and has reaped the greatest benefits from these developments. It should come as no surprise that the healthcare industry was one of the first to adopt these paradigm-shifting technologies because both artificial intelligence (AI) and its subset machine learning (ML) are the most talked-about topics in the technical world. [3]. These days, machine learning is playing an essential part in a wide range of health-related fields, and healthcare professionals are collaborating with businesses that develop healthcare software to come up with innovative medical treatments for patients who are afflicted with conditions that are either terminal or ongoing[4-8]. According to computer scientist Sebastian Thrum, in the same way that machines made human muscles a thousand times stronger, machines will make the human brain a thousand times more powerful in the future[5].

How ML Is Transforming Healthcare
- Assist medical professionals, specifically pathologists, in more accurately and rapidly diagnosing patients.
- Has the ability to anticipate illnesses based on a patient's medical history, which enables the development of a treatment plan that is more effective.
- Performs multiple analyses of data in order to forecast potential health risks for a particular section.
- Provides significant assistance with healthcare records and the workflow of the facility.
- Assists in making an accurate diagnosis and choosing an appropriate course of treatment by determining whether a tumour is benign or malignant.
- Finds opportunities for clinical trials; identifies gaps in healthcare; reduces the cost of researching new drugs; assists physicians and pathologists in making diagnoses more quickly and accurately[6]

Several different applications of machine learning are currently being developed within the healthcare industry. By analysing a substantial quantity of patient data, machine learning software can provide clinicians with assistance that will speed up the process of developing a treatment plan that is individualised to the person being treated and the characteristics displayed by that person[7]. According to Fatima Paruk, the Chief Medical Officer of Allscripts Analytics in Chicago, "machine learning will have an impact on physicians and hospitals because it will play a crucial role in clinical decision support. This will make it possible for early disease detection as well as individualised treatment regimens to ensure optimal results." [7]. It has the potential to improve hospital and health care system efficiency while lowering costs, and it can also be used to show and educate patients about possible illness pathways and outcomes based on various treatment options[8].

II. LITERATURE SURVEY

Using EHR data, the authors analysed the Seattle heart failure model for the purpose of making predictions about heart failure. In order to calculate the survival score, samples from 5044 different patients were taken and features were extracted. Using a Cox proportional regression model, the authors determined the survival score of heart patients who had survived for one, two, or five years[9]. Patients who had passed away within the first five years of the study were subsequently removed from consideration, and the surviving patients were then put through a series of machine learning models including random forest, logistic regression, support vector regression, decision tree, and ada boost. The results of the test showed that logistic regression performed the best, with an increase in the AUV curve value of 11%[10].

According to the authors, "it is believed that a computer virus can learn from both previous experience as well as from certain tasks and a few performance on, as measured by." The vast majority of machine learning algorithms are centred on locating and/or exploiting correlations and associations, in addition to recognising and/or exploiting interrelationships between datasets[11]. When Machine Learning Algorithms have found specific relationships, the model can either use the data to predict future observations or generalise it to find interesting patterns[12]. Both of these options are available once the specific relationships have been found. Regression, linear regression, logistic regression, the Naive Bayes Classifier, Bayes theory, KNN (K-Nearest Neighbor Classifier), Decision Trees, Entropy, ID3, SVM (Support Vector Machines), K-means Algorithm, Random Forest, and other methods are used in Machine Learning. Other methods include: Random Forest, K-means Algorithm, and others[13].

1. Healthcare Machine Learning Applications
a. Pattern Imaging Analytics

For the purpose of improving image analytics and pathology, healthcare organisations all over the world are actively utilising various techniques and algorithms that are part of machine learning. Radiologists can use machine learning algorithms to detect subtle changes in scans, which assists them in identifying and diagnosing health concerns

at an earlier stage[14]. One such innovative creation is the machine learning technology developed by Google to detect potentially dangerous tumours in mammograms [15]. [Citation needed] Researchers at Indiana University-Purdue University Indianapolis have made a significant advancement by developing a machine learning system that is able to accurately predict the recurrence rate for myelogenous leukaemia. This is a significant step forward for the field (AML). In addition to these achievements, researchers from Stanford have developed a system that uses deep learning to identify and diagnose skin cancer [16].

b. Individualized Psychological Counseling and Behavioral Alterations

Between the years 2012 and 2017, the percentage of hospitals and medical practises that used electronic health records rose from 40 percent to 67 percent. As a direct consequence of this, there will be improved access to the particular health data of individual patients[17]. By collecting the personal medical data of individual patients and analysing it with the aid of machine learning tools and algorithms, health care providers (HCPs) are better able to detect and diagnose a variety of health problems. By using supervised learning, professionals in the medical field are able to anticipate the threats and hazards that could affect a patient's health based on the symptoms and genetic information contained in the patient's medical history[18].

This is precisely what IBM Watson Oncology aims to achieve in its research and treatment of cancer. Utilizing patients' medical information and medical histories, it provides clinicians with assistance in developing more effective treatment plans that are based on the best possible selection of treatment options[19]. It is impossible to overstate the significance of adjusting one's behaviour as part of preventative medical care. The use of ML technologies is helping to advance the field of behaviour modification by having a positive influence on the positive behavioural reinforcements experienced by patients. For example, the B2B2C data analytics company Somatix recently released an app powered by machine learning that can monitor and identify a wide range of emotional and physical states without the user's active participation[20].This provides clinicians with assistance in determining the types of changes in behaviour and lifestyle that are necessary for a healthy body and mind[21].

Apps powered by machine learning are being used by healthcare industry startups as well as established businesses to encourage users to adopt healthier behaviours. One useful illustration of this is the data analytics B2B2C software platform known as Somatix. Its machine learning programme uses something called "hand-to-mouth gesture detection" to help people comprehend and evaluate their behaviour. This enables people to be more open with one another and to make decisions that are beneficial to their lives[22].

c. The Research and Production of New Medicines

The screening of a medicine's components and the calculation of its success rate based on biological characteristics are two examples of areas in which ML techniques have found a place in the field of drug discovery. This is especially true in the early stages. The sequencing of the next generation is the foundation for this [23].The process of developing new medications and manufacturing them also involves the use of ML by pharmaceutical companies. This is now restricted to forms of machine learning (ML) that do not require human supervision and can find patterns in raw data. The goal is to provide precision medicine by utilising unsupervised learning, which will enable clinicians to discover the factors that contribute to "multifactorial" illnesses. The MIT Clinical Machine Learning Group is one of the participants in the industry that has the greatest amount of name recognition [24].
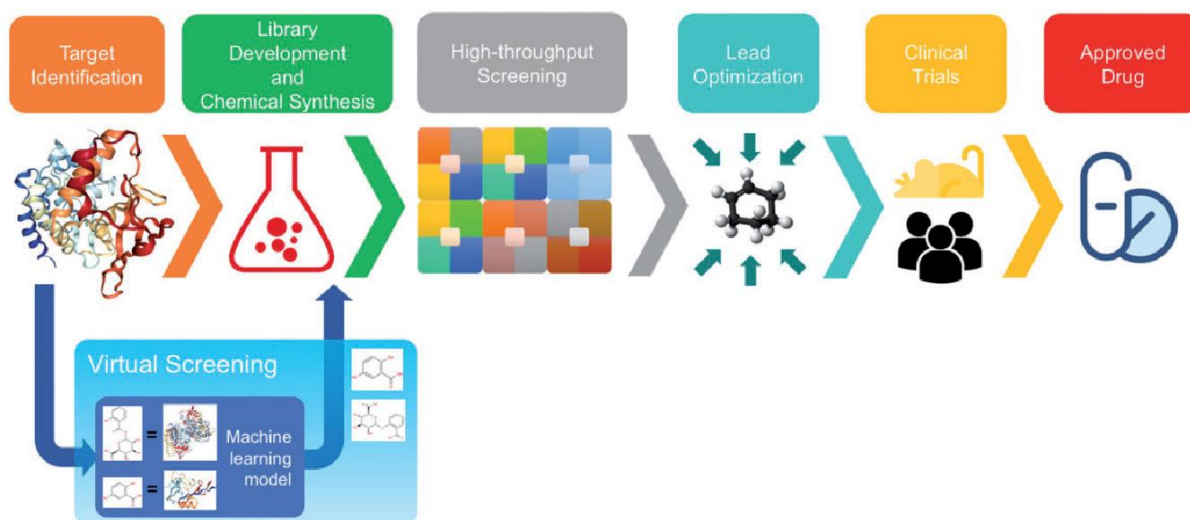
Fig. 2. Methodology diagram of Proposed healthcare system

Through its research in precision medicine, the company aims to develop algorithms that can contribute to a better understanding of disease processes and, as a result, the creation of effective treatments for a variety of health conditions, including Type 2 diabetes [25]. In addition, research and development technologies such as next-generation sequencing and precision medicine are being utilised in order to ascertain whether or not there are alternative treatment options for complex diseases. The goal of Microsoft's Project Hanover is to develop precision medicine by utilising technologies related to machine learning. Google is the latest company to join the race to discover new medicines [26]. According to the Royal Society of the United Kingdom, machine learning has the potential to assist in the optimization of bio-manufacturing processes for pharmaceuticals. Data collected during the manufacturing process could be used by pharmaceutical companies to speed up the process of developing new medications, thereby lowering the overall cost of production [27].

d. Surgery Using Robots

The advent of robotic surgery has made it possible for surgeons to perform operations that are both effective and precise, even in the most difficult of circumstances. Consider an example such as the Da Vinci robot. The use of this robot gives surgeons the ability to move and control robotic arms with greater accuracy and fewer tremors, which enables them to perform surgery on specific areas of the human body [28]. Because hair transplantation requires such pinpoint accuracy and careful outlining, robotic surgery is frequently utilised in the procedure. The use of robotics is quickly becoming the standard practise in the field of surgery. Real-time surgery measurements, data from previous operations that were successful, and data from pre-operative medical records are incorporated into the surgical process by robotics that are powered by AI and ML algorithms. This increases the surgical precision that can be achieved. Accenture found that the average amount of time spent in surgery following robotic surgery was cut down by approximately 21 percent [29]. [30] Surgical procedures involving complex anatomy, such as those involving the spine, can benefit from the application of artificial intelligence developed by Mazor Robotics. This helps improve personalization and reduce invasiveness.

e. Recognizing Illnesses and Making a Diagnosis

The process of diagnosis has seen significant progress thanks to the combination of Deep Learning and Machine Learning, both of which have been utilised. As a result of technological advancements, medical professionals are now able to diagnose conditions that could not be identified in the past. These conditions include inherited diseases and cancers in their earlier stages[32]. IBM Watson Genomics, for example, utilises cognitive computing in conjunction with genome-based tumour sequencing to expedite the process of diagnosis and enable earlier treatment to be initiated. Then there is the Microsoft Inner Eye project, which began in 2010 with the intention of developing innovative diagnostic tools for improved image analysis. This endeavour's beginning year was 2010 [31].

f. Research Involving Clinical Trials

When it comes to the study of clinical trials, technologies that use machine learning have a lot of untapped potential. By applying sophisticated predictive analytics to individuals interested in participating in clinical trials,

medical professionals have the ability to examine a greater variety of data, which would, of course, reduce the amount of money and time needed to carry out medical experiments[33]. According to McKinsey, there are many different applications of machine learning (ML) that can help improve the efficiency of clinical trials. Some of these applications include assisting in the selection of optimal sample sizes for increased efficacy and reducing the risk of data errors through the use of electronic health records (EHRs) [34].
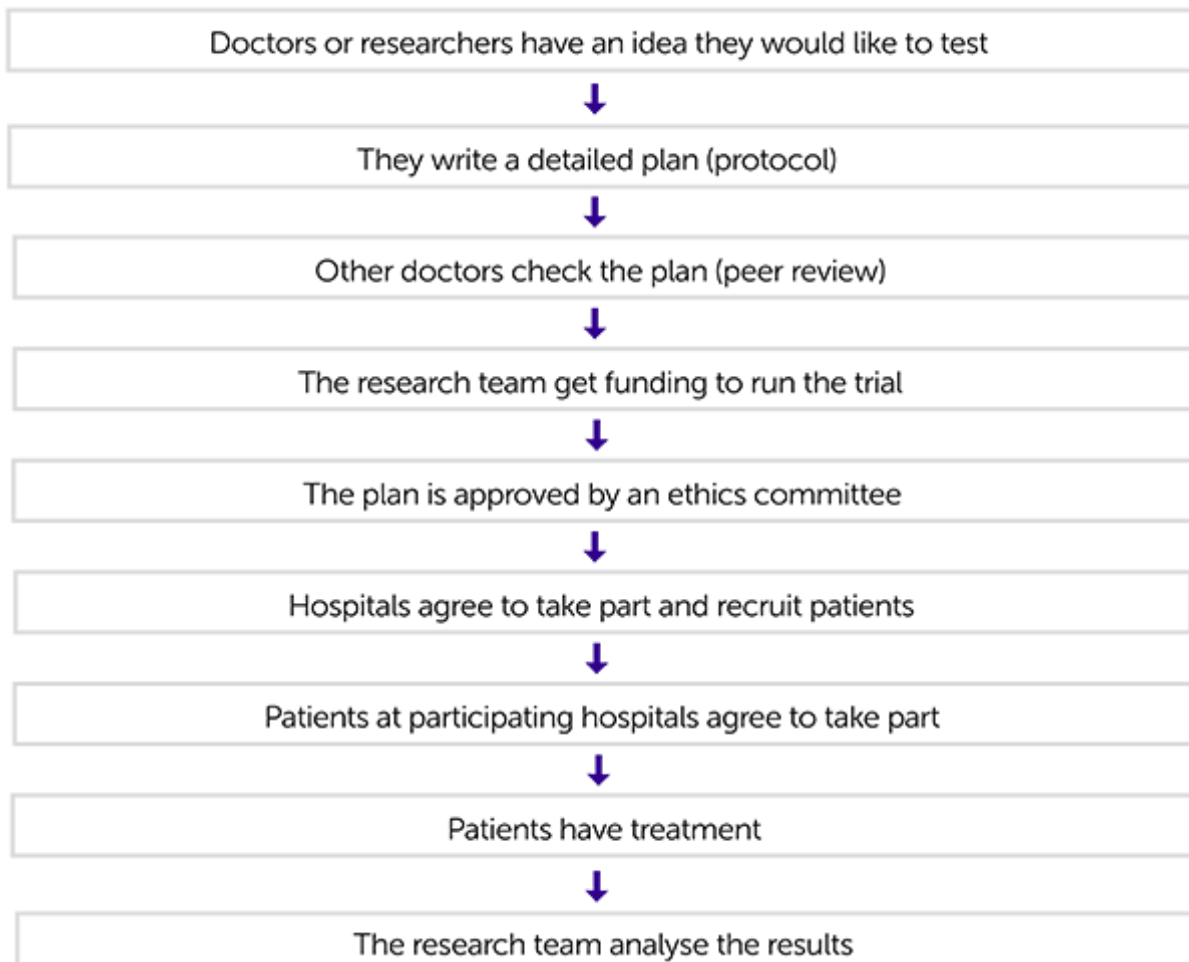
Fig. 3. Flow diagram of Proposed System

g. Individualized Course of Care

Utilizing a patient's medical history in conjunction with machine learning technology can facilitate the development of individualised treatments and medications that are directed toward the treatment of specific diseases in specific individuals. It is possible to derive even further advantages from this when predictive analytics are incorporated. When diagnosing a patient, clinicians can use machine learning rather than selecting a disease from a list or determining the patient's risk based on the patient's clinical history. IBM Watson Oncology is a particularly noteworthy illustration of the provision of individualised treatment to cancer patients on the basis of the patients' previous medical records [35].

h. The Ability to Anticipate Epidemic Outbreaks

The monitoring and forecasting of potential epidemic outbreaks is currently being done by healthcare organisations all over the world with the assistance of ML and AI processes. These digital systems are able to predict the occurrence of disease outbreaks because they compile data from satellites, real-time updates on social media, and other essential information gleaned from the internet. This is particularly helpful for developing countries because those countries typically lack adequate medical services[36]. Even though these are just a few examples of how machine learning is being utilised in the healthcare industry at the moment, it is anticipated that in the near future significantly more intricate and ground-breaking ML applications will be developed. Because machine learning is constantly advancing, we should be prepared for a great many more surprises

in the not-too-distant future that will revolutionise the lives of people, help prevent illnesses, and contribute significantly to the improvement of healthcare services.

Support vector machines and artificial neural networks, for example, have aided in the prediction of malaria outbreaks by taking into account characteristics such as temperature, average monthly rainfall, and other such factors. These machines and networks are trained to take these factors into account[37]. A piece of software called ProMED-mail that runs on the web makes it possible for health organisations to monitor illnesses and forecast epidemics in real time. ProMED is an integral part of HealthMap's ability to monitor and notify countries about possible disease outbreaks through the use of automated categorization and visualisation[38].

i. Advancements in Radiotherapy

In the field of radiology, it has been demonstrated that ML is extraordinarily effective. There are a number of discrete variables that are utilised in medical image analysis, and any one of these variables may be activated at any given time. In a circumstance like this, machine learning algorithms may prove useful. Because they are taught from a variety of different data samples, machine learning algorithms are superior when it comes to diagnosing and locating the necessary variables. In medical image analysis, for example, ML is used to classify things like lesions into categories such as normal, aberrant, lesion or non-lesion, benign, malignant, and so on and so forth. Other examples include cancerous and benign lesions. Researchers from UCLH and Google's DeepMind Health are working together to develop algorithms that will be able to differentiate between healthy and diseased cells. This will make it possible to treat cancer cells with radiation more effectively[39].

j. Data Collection Through Crowdsourcing

The medical industry is currently making significant investments in crowdsourcing medical data from a variety of sources (mobile applications, healthcare platforms, and so on), but only with the permission of patients and other individuals. On the basis of this collection of real-time medical data, physicians and other medical professionals are able to provide patients with prompt and appropriate treatment (no time wasted in fulfiling formal paperwork). IBM and Medtronic have recently formed a partnership in order to use data gathered from crowdsourcing to collect and analyse data related to diabetes and insulin in real time. Consumers can use Apple's ResearchKit to gain access to interactive applications that use machine learning to treat conditions such as Parkinson's disease and Asperger's syndrome [40].

k. Keeping Healthcare Records Alive and Well

It is common knowledge that maintaining and updating patient medical histories and data pertaining to healthcare can be a time-consuming and expensive process. Machine learning technologies are contributing to the resolution of this problem by cutting the amount of time, effort, and money spent on record-keeping. This is helping to speed up the process. The organisation and classification of healthcare data is simplified with the use of VMs (vector machines) and OCR recognition techniques that are based on machine learning, such as Google's Cloud Vision API. Smart health records connect patients, physicians, and other healthcare professionals in order to improve research, service delivery, and the overall health of the public[41]. We are on the cusp of a technological advancement in medicine as a result of advances in machine learning and artificial intelligence. However, putting all of one's faith in modern technology is not going to improve medical care. Outstanding developments in technology, such as artificial intelligence and machine learning, require the contribution of minds that are both inquisitive and self-driven in order to be given meaning[42].

2. The Importance of Machine Learning in the Healthcare Industry

The following is a list of some of the most important applications in the healthcare industry where machine learning is already having an impact or is expected to have an impact in the not too distant future:

a. Pharmaceuticals

In the pharmaceutical industry, machine learning is being put to extensive use for the purpose of discovering new medications and developing new treatments. Large pharmaceutical corporations are increasingly turning to machine learning in order to assess and forecast how various patients will react to medications for a variety of conditions, as well as to identify which patient groups are most likely to benefit from a given drug. This is an important step in the development of personalised medicine.The Food and Drug Administration (FDA) in the United States has given its approval for the use of artificial intelligence (AI) and machine learning in certain types of medical devices. The Food and Drug Administration (FDA) is responsible for ensuring the safety, efficacy, and security of human and veterinary pharmaceuticals, biological products, and medical devices in the United States. This responsibility falls under the umbrella of the FDA's mission to protect the public's health. [43]

Healthcare providers are also using machine learning to predict illness, which could help with early intervention and treatment of the disease. In addition, machine learning is being used to forecast the health risk of a population by discovering patterns that could lead to the identification of individuals who are at a high risk for specific

diseases. This is being done by using data collected from individuals who are already known to be at a high risk.Here are a few of the most important applications of machine learning in the healthcare industry, as well as some of the ways that reputable suppliers of machine learning development services are assisting businesses in capitalising on the technology's potential to enhance the quality of patient care.

b. Aids in Medical Diagnosis

A study conducted by Global Market Insights suggests that the number of medical imaging and diagnosis procedures that are powered by AI and ML could reach 3 billion by the year 2024, representing an increase of 40 percent. One area where machine learning has been put to use is in the field of radiology, specifically MRI scans, where it helps medical professionals make more accurate diagnoses based on the images[44].

c. Finding Diseases at an Earlier Stage of Development

Machine learning is able to assist in the identification of patterns that can be used to detect early indicators of debilitating disorders such as heart attacks because machine learning performs in-depth analyses of the data. There is a wide variety of AI-based wearable technology available on the market that can be worn on the hand and is used to monitor a variety of ailments, such as a person's heart rate, sleep cycle, breathing rate, activity level, blood pressure, and so on [45].

III. CONCLUSION

Patients are associated with a massive amount of information that can be accessed online. This enormous amount of data has a multidimensional nature and a wide variety of attributes. Machine learning is applied to complicated algorithms in order to make the processing of these algorithms more effective and to extract meaningful information from them. The medical community has been able to develop better care for patients as a direct result of this. In addition, ML is useful for the earlier diagnosis of diseases and the improved interpretation of MRI and CT scans. Precision medicine is made possible by ML, in particular the early diagnosis and treatment of diseases with the potential to be fatal, such as cancer.

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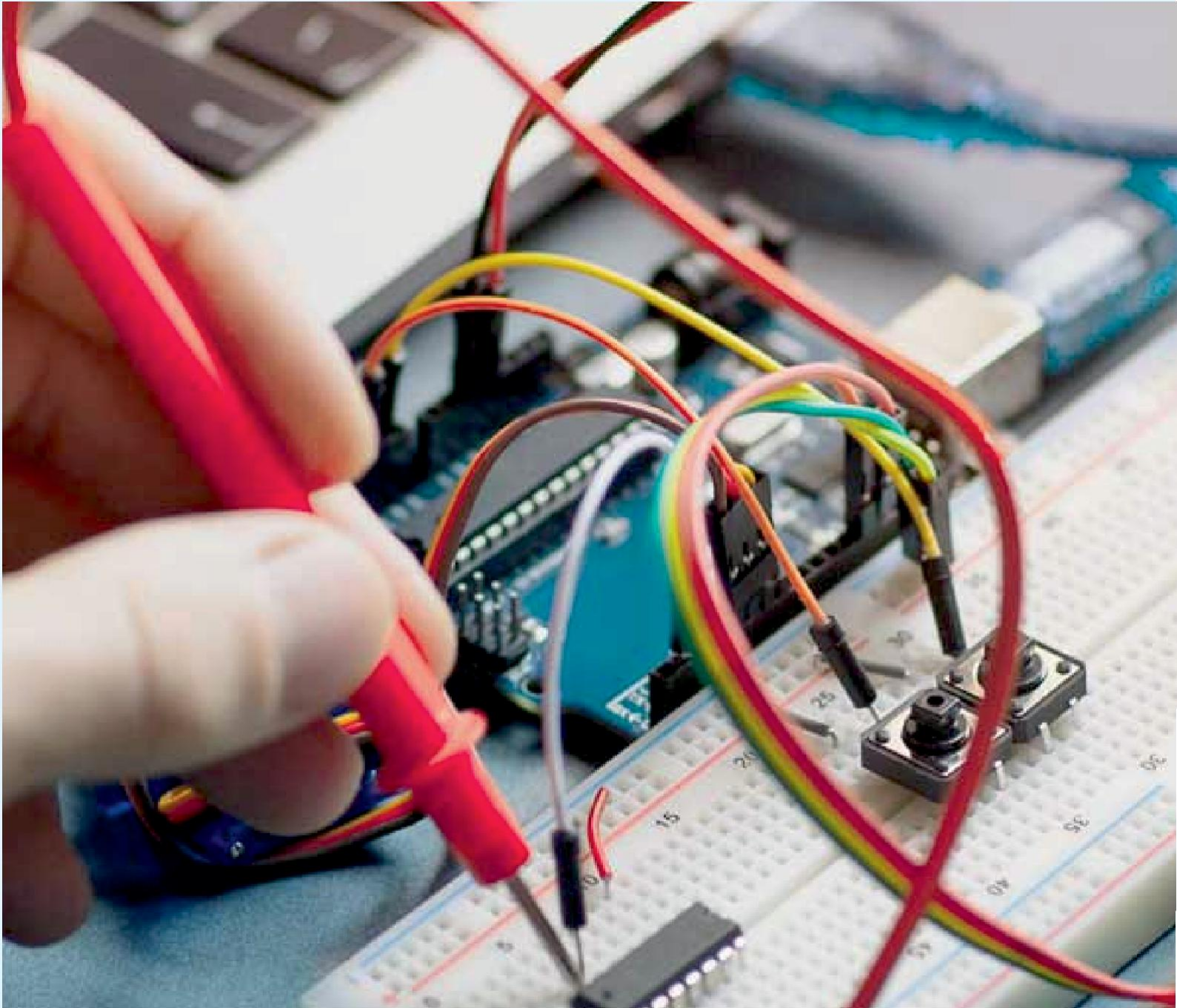
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