Disease Detection using IOT from Urine

Major project report submitted in partial fulfilment of the requirement for the degree of Bachelor of Technology.

ELECTRONICS AND COMMUNICATION ENGINEERING

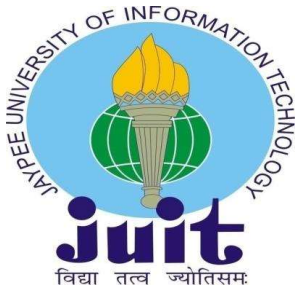
Submitted by

PRAJJWAL SHUKLA (191048)

SHREYANSH SRIVASTVA (191044)

UNDER THE GUIDANCE OF

DR. NAFIS UDDIN KHAN



Department of Electronics and Communication Engineering

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

MAY 2023

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Name: PRAJJWAL SHUKLA SHREYANSH SHRIVASTAVA Department: ECE Enrolment No 191048 & 191044

Contact No. 7271015647/9026119266 E-mail. PrajjwalShukla20001@gmail.com

Name of the Supervisor: DR. NAFISUDDIN KHAN

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DECLARATION

We hereby declare that the work reported in the B.Tech Project Report entitled **"Disease detection using IOT from Urine"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of Dr. Nafis uddin khan**.** We have not submitted this work elsewhere for any other degree or diploma.

Prajjwal shukla
191048

Shreyansh Srivastava
191044

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Signature

Dr. Nafis uddin khan sir.

Date:

Head of the Department/Project Coordinator

ACKNOWLEDGEMENT

First and foremost, I would want to give Almighty God my sincere gratitude and appreciation for his divine grace, which enabled the project to be successfully completed. My supervisor, Dr. Nafis Uddin Khan, Assistant Professor (SG), Department of ECE Jaypee University of Information Technology, Wakhnaghat, has my deepest gratitude and gratitude. My supervisor is well-versed in the "Internet of things" and has a great interest in completing this project. This endeavour was made possible by his never-ending patience, academic leadership, persistent encouragement, constant and vigorous supervision, constructive criticism, insightful counsel, reading numerous subpar versions, and fixing them at all levels.

I want to extend my sincere appreciation to Dr. Nafis Uddin Khan, Department of ECE, for his kind assistance in seeing my research through to completion.

A warm welcome would also be extended to everyone who has directly or indirectly assisted me in making this project successful. In this circumstance, I would want to express my gratitude to all of the staff members—teaching and non-teaching—who have provided me with practical assistance and made my task easier.

Finally, I must respectably appreciate my parents' unfailing help and tolerance.

PRAJJWAL SHUKLA 191048 **SHREYANSH SRIVASTAVA 191044**

LIST OF ABBREVIATIONS

1. IOT: internet of things.
2. Turb sensor-: Turbidity sensor.
3. TDS sensor.
4. Dipstick.
5. Ph sensor- Potential of Hydrogen.
6. RGB: red, green, blue.
7. analog electrical conductivity meter.

LIST OF FIGURES

FIGURE 1.1: Colour

FIGURE 1.2: Dipstick

FIGURE 1.3: Pressure sensor

FIGURE 1.4: Proximity Sensors

FIGURE 1.5: Temperature Sensors and humidity Sensor

FIGURE 1.6: Flow Sensors

FIGURE 1.7: Ph sensor

FIGURE 1.8: What is Urinalysis

FIGURE 1.9: Pictorial image of project

ABSTRACT

regular medical evaluations can lead to early illness identification, speed up the provision of healthcare, and significantly better patient outcomes a wide range of illnesses that have an impact on public health. Technologies that can change the current emergency medical services system preventive, based on evidence, individual-cantered care still have a significant unmet need. Platforms that discover a variety of indicators for health and disease and are convenient to include into people's daily lives are preferred with this goal in mind. However, pee, a biological fluid that is produced in vast amounts every day, can be collected painlessly, doesn't interfere with people's everyday lives, and has the most biologically diverse material, is frequently dumped into sewers without being processed or Pee, on the other hand, is regularly discarded the sewers without being processed or observed despite being a substance produced by living things enormous quantities each day, there collected painlessly, doesn't interfere with people's daily lives, and has the most biologically rich composition. Smart toilets, which are toilet-based health monitoring devices, might provide preventative continuous health monitoring at home for the early disease detection and be associated with data servers via the ability of the Internet of Things user health condition data gathering. Additionally, machine learning techniques can help therapists categorise, calculate and interpret gathered info more precisely and quickly than they were able to in the past. In the meanwhile, difficulties privacy along with user acceptance concerns, as well as test frequency optimization. taken into consideration to the encourage societal acceptance of intelligent toilets.

The hospital is the centre of health care in the modern world, however, what society really needs is a shift leave this reactive alone mindset toward a more determined one. Such proactive measures comprise the creation, dissemination, and use of preventative, evidence-based, and individualised care as opposed to retroactive medical interventions. There is a gap in the market for the creation of transformational technologies that can help this change from a disease-centred to a well-being-oriented perspective.

The advancements are growing in the modern nonetheless, our country's cleanliness is also in danger. The goal of this paper's abstract is to provide hygienic, clean restrooms. All public restrooms have to be hygienic and tidy. Our nation's government has implemented the "Swachh Bharat" programme (“Clean India”). Only one goals of the “Clean India” initiative is to maintain clean restrooms. This essay may help to spread the word about the “Clean India” programme. In the future, it may have a big impact on the “Clean India” initiative. They mostly are concerned with recognising the filth in the toilets under the current system. In our suggested approach, we focused on maintaining clean restrooms, utilising IOT to diagnose renal disorders after collecting a patient's urine sample. It can avoid a variety of syndromes. It could raise people's awareness of proper restroom maintenance.

CHAPTER 1

INTRODUCTION

People in our nation lack sufficient information about where to use the restroom. Numerous illnesses, including malaria, the flu, cholera, streptococcus, typhoid, etc. are brought on by this. Consequently, we provide the IOT idea of "Disease detection utilising IOT from urine." It is designed to help people utilise and keep restrooms tidy and hygienic. The endeavour is built on IoT ideas and makes use of several sensors, including RFID readers, databases, smell sensors, dirt sensors, and acoustic sensors. We are attempting to offer the public with clean restrooms and raise awareness with these items.

Clinicians can quickly identify anomalies and determine whether additional medical testing are necessary using urine strip readouts. However, errors are possible with urinalysis using a dipstick; for instance, Between neighbouring pads, reagent leakage may are brought about by leftover pee after the test strip it has been saturated in urine, resulting in a mismatch of colours and incorrect readouts. Additionally, Unless the urine sample is well mixed, some urine components have a tendency to settle to the container's bottom, raising the risk being of unintentionally missed36.

Few more sophisticated urine diagnostics than Raman spectroscopy-based urinalysis, urine culture, urine particle flow cytometer, urine cytology, microscopy mass spectrometry, and dipsticks are also available. This urine test, however, is not suitable for monitoring a person's health at the point of service. A variety of disease indicators, include those of various malignancies, such as urologic or colorectal malignancies, may be found in the urine and faeces of the toilet thanks to technology installed in it. People desire to maintain good health and are genetically predisposed to specific illnesses, a condition like IBS, prostate cancer, or renal failure, may find the gadget particularly intriguing.

Nothing truly compares to digital technology when it comes to jargon that is incomprehensible and constantly evolving. There is no shortage of jargon in the digital sector, from routers to smart hubs, dongles to podcasts. IoT, on the other hand, could only be worth knowing.

By seeing items and observing behaviours in diverse contexts, Wi-Fi or a WPAN (wireless personal area network) connection goods may eventually find their way into every house in the globe. Studies on improving the restroom experience are uncommon, though. This paper discusses the evolution of use of a smart bidet that monitors your health in

complete detail, with fresh and extra material, according to our prior the conference proceedings for publication.
By enabling prompt treatment, early illness detection can help individuals live longer. With this in mind, we created an electronic bidet that is practical for daily use and can identify potential early-stage illnesses. The "medical bidet" is a brand-new type of bidet that incorporates IoT sensing technology and numerous kinds with sensors (i.e., pressure, oxygen, and thermometer sensors). We present using a medical bidet usage in prudent medical care in this article. It gathers and analyses individual biometric data in the often used bathroom in a nonrecognition and nonrestraint manner. It outlines the building of many sensor that maybe installed in the clever toilet seat with bidet for health monitoring. It displays the sensor data acquired under waterproof International Protection. The Internet of Things is a group of linked devices by communications from machines to machines, and it has the potential to improve healthcare systems' effectiveness and efficiency by assisting in the prevention and management of chronic illnesses affecting the ageing population. With the use of this technology, a variety of sectors may automate processes, gather huge data, and exchange data. Additionally, electronic bidets are replacing traditional bidets because they offer more convenience and employ a variety of sensors and a remote controller. However, this bidet is unable to accept biometric data or large data; in fact, the many kinds of biometrics data collected based on the sensors only ever presented once before disappearing. The obtained biometric data may be used in the healthcare industry by fusing IoT technology with currently installed traditional electronic bidets. IoT offers the chance to create intelligent wearable applications for the health fields, as well as expand the current wireless technology

Urine — Excellent for ongoing health monitoring According to definitions, urine is a "waste protein of product metabolism combined with the salts and colours that is released by the kidney." Nephrons in the kidney create urine. Because pee is produced directly from blood by kidney glomerular filtration, it includes more a greater amount of biological data than sweat many organs. One of the earliest medical tests, urine analysis, or urinalysis, has a 6,000-year history to the Babylonian and Sumerian civilizations.

Three types of urinalysis tests can be distinguished: microscopic, chemical, and physical. Color, volume, specific gravity, appearance, and smell are examples of physical characteristics that can be examined. chemical characteristics that retestable pH, sugar, hormones, proteins, and peptides (collectively referred to as proteomics), ascorbic acid, nitrites, urobilinogen, ketones, bilirubin, creatinine, drugs, and blood content are some examples. Microscopical analysis entails checking for microbes, yeasts, epithelial cells, and the microbiome bacteria, among other things. Test strips of urine, often called dipsticks, are the most straightforward analysis technique. These paper-based, multiparameter tests are inexpensive and contain many chemical pads that quickly come in touch with urine, change color. The pH, specific gravity, leucocytes, proteins, nitrites,

urobilinogen, bilirubin, glucose, ketones, and haemoglobin are only a few parameters to consider. can all be examined, despite the method's simplicity.

Toilet-based health monitoring platforms

Urine tests should be performed within two hours otherwise of collection, cooling is required to prevent microbiological or bacterial development the urine sample contains, which could lead to unreliable test findings. Additionally, restrooms are now practically ubiquitous (in homes, public spaces, and places of employment), making it easier to continuously check health and identify infections early on. As many as 90% of Adults with CKD are unaware of their condition., according to the Centre Disease Control and Prevention (CDC). This statistic emphasises the critical need for the creation of easily accessible platforms for ongoing health monitoring to update patients and caregivers regarding health problems in the prior to complications, the early stages occur74. According to statistics, urinary system malignancies among the top 10 most prevalent cancer kinds (prostate cancer) will account for 2020 will see 1,400,000 new cases and 375,000 fatalities worldwide. while bladder and kidney cancer will account for 573,000 fresh instances and 212,500 death body, respectively). Additionally, the cost of CKDs in the USA in 2018 was estimated to be $81.8 billion when accounting for diagnosis, medication management, kidney transplantation, and dialysis76. Due to its ability to identify a variety of health issues, including UTD, smart toilets can play a crucial part in monitoring and early diagnosis of UTDs, offering a previously unheard-of chance to reduce mortality, disability, and financial burden.

The combination of cutting-edge technology and traditional toilets is referred to as a "smart toilet." One class of smart toilets includes those with lids that open and close automatically, water-saving flushing mechanisms, and autonomous cleaning systems that use a variety of sensors (such as smell sensor, a radio-frequency identification sensor, a sonic sensor, and an infrared sensor), but no planned medical-monitoring system. features. The phrase "smart toilet" in this context refers to a different kind of smart toilet that can track health indicators.

The earliest smart toilet patents with the capacity to calculate basic data were submitted in the 1990s (including body temperature and urine fat81–83). The development into a clinic-home interface using these early smart toilets was hampered by their High price (for instance, US$6,100 per unit for the 2008 edition), lack of valuable clinical data, need for human involvement to record outcomes, and incompatibility with user's electronic health record are all disadvantages (EHR). Since then, efforts have been undertaken to create practical and affordable clever restrooms. In this context, a primitive smart toilet model capable of gathering Data and differentiating b/w defecation, urination as well as user gender was created for the settling of emergencies. This setup effectively determined the reason for 60% of visits was urine and 40 percent were due to urination in a case study. In

a another study, a toilet was equipped with a metal oxide gas sensors (called a "E-Nose") to monitor variations in urine odour. According to principal component analysis, the fitting of multidimensional data revealed that in all three experiments, more than 95% of the total variance was explained, indicating that the e-nose has excellent potential for discrimination and separation between urine smell indicative of diabetes, health, and Alcohol content85. Other toilet had a camera added that could detect the presence of diabetes by capturing photos of the pee. The camera's aim was to create a red and green, and blue color model that could be used for image analysis. This toilet's urine colour detection accuracy was 95%86. In another experiment, body weight, bioelectrical impedance of the body,body fat, and electrocardiography were measured using a hand-held electrode tool and a toilet seat with sensors.

CHAPTER 2

THE METHODOLOGY-

A completely automated smart toilet has been created that uses a ten-parameter urinalysis strip to test the pH, erythrocytes, glucose, bilirubin, nitrite, protein, urobilinogen, specific gravity, and ketones in pee. Three cameras are employed along with a test strip for image assessment of the faeces and video examination of the urine stream with computer assistance using a machine-learning algorithm. To initiate data collection automatically upon the onset of urine, a passive IR motion sensor was added. A fingerprint module is included in the setup to wirelessly capture personal information in a cloud-based health portal and identify the user The used strip is immediately disposed away into the toilet bowl after the urine sample has been analysed, and a new strip is then installed, avoiding the need for any steps during the exam. Results of the volume measurement from both Uroflowmetry using machine learning and traditional methods were comparable with 0.92 linear correlation, which assesses how strongly two variables are related linearly. As a result, the machine-learning system managed to properly quantify pee volume, just like uroflowmetry as practised in the past approach. When urine and analysis are complete, discarded strip is promptly thrown replaced into the toilet bowl, removing any human interference from the test. Volume measurements from conventional uroflowmetry and Uroflowmetry using machine learning was comparable, and there was a linear association values of 0.92 indicating a good linear relationship between two variables.

As a result, just like the conventional standard uroflowmetry approach. The volume could be measured with accuracy thanks to the machine-leaning algorithm. of pee.

An innovative Using prototype testing, a 3D-printed sample collector device for long-term toilet-based urine analysis was developed. platform91. A base was created to test prototype Collecting devices for urine samples that provide automated sample handling, collection, measurement, and flushing capabilities. The set-up included a 3D-printed sample holder for stereolithography with an ideal form also the drain angle installed on the wall of the toilet bowl, which accumulates and routes urine to a urine analysis module based on a toilet. It also included a water pump and a stepper motor. The gathered tests were analysed employing readily accessible dipsticks and plate readers for measuring protein content in order to verify the platform's analytical capabilities, and the findings demonstrated agreement. After performing the measurements 100 times, it was consistently possible to identify proteins with concentrations as low as 0.1g/l, with an average standard deviation of 0.018g/l.

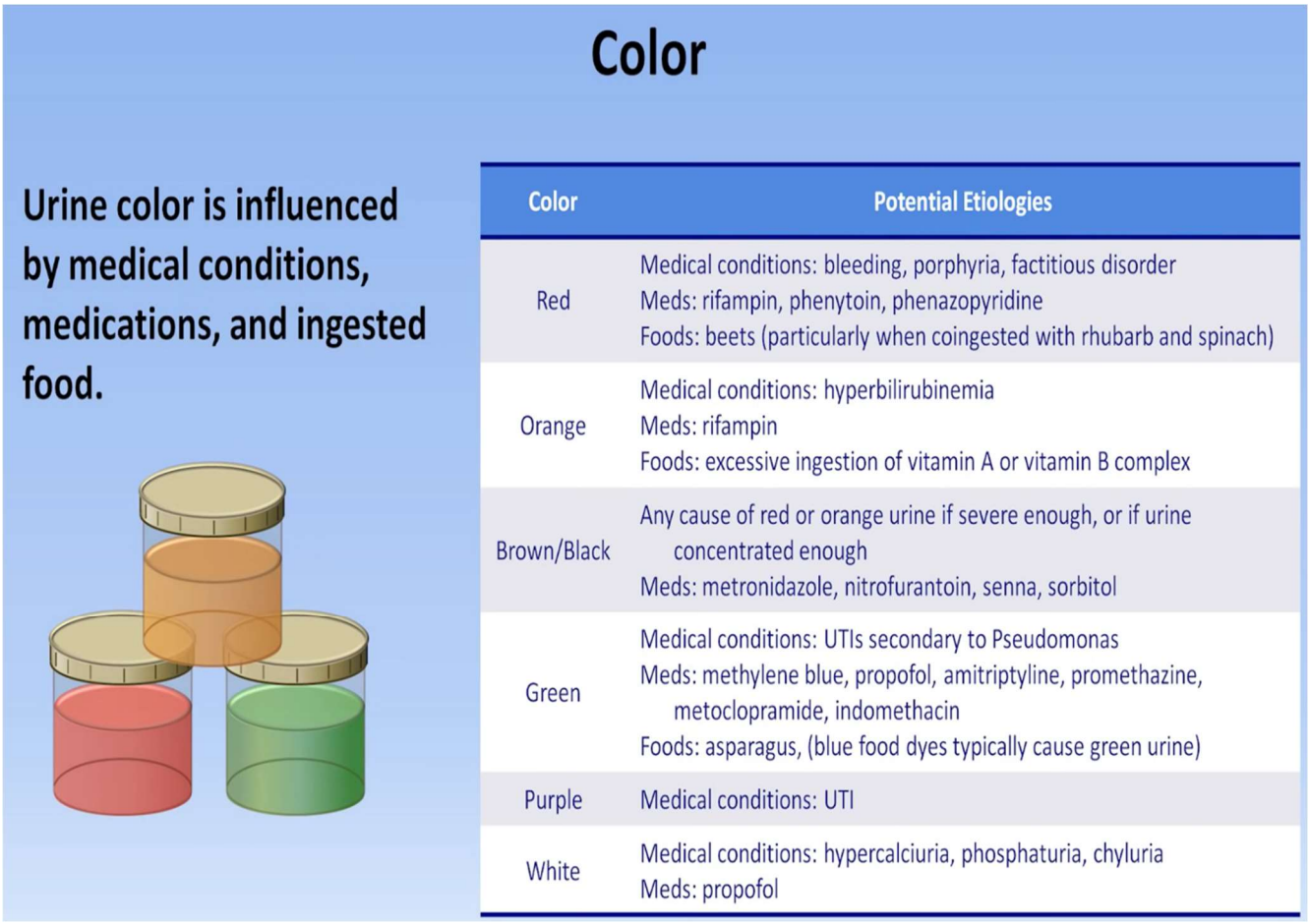

FIGURE 1.1 : colour

Urine color can provide valuable information about a person's overall health, but it is not a definitive diagnostic tool. Urine colour can be affected by a variety of factors, including hydration levels, diet, and medications.

Urine that is dark yellow or amber in colour may indicate dehydration or the presence of certain medications or supplements. Conversely, urine that is clear or pale yellow may indicate adequate hydration levels.

In some cases, urine color can indicate the presence of certain medical conditions. For example, red or pink urine may indicate the presence of blood in the urine, which may be caused by a urinary tract infection, kidney stones, or other medical conditions. Green or blue urine may indicate the presence of certain drugs or medical conditions, such as porphyria or copper poisoning.

It is important to note that urine color must be interpreted in conjunction with other factors, such as symptoms, medical history, and the results of other diagnostic tests, to make an accurate diagnosis. If a person is concerned about the color of their urine, they should contact their healthcare provider for further evaluation and testing.

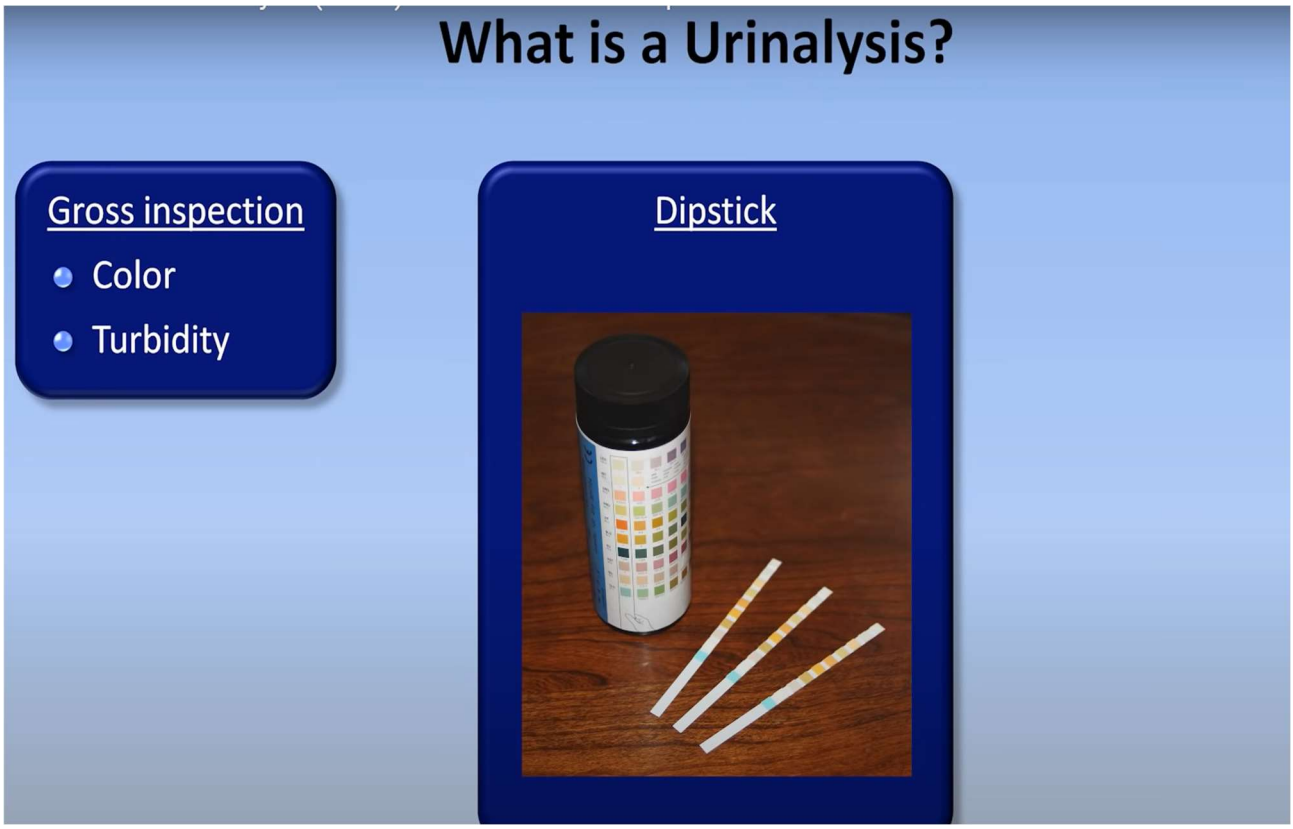

FIGURE 1.2: Dipstick

Dipstick test

The dipstick test is a simple and widely used urinalysis method. It involves dipping a small plastic bag or "dip stick" into a urine sample, then comparing the color change on the stri p to a picture to determine if certain drugs are present in the urine.
Dipstick usually has several pads or squares that respond to different components of the output. Some chemicals that can be tested with a dipstick include.

pH: measures the acidity or alkalinity of urine.

Protein: Detection of protein in the urine that may indicate kidney damage or other conditions.

Glucose: This measures the amount of sugar in your urine, which can be an indicator of di abetes or other metabolic disorders.

Ketones: This ketone urine test can show that the body is burning fat instead of using glu cose for energy, this could be a sign of diabetes or other diseases.

Bilirubin: Measure the amount of bilirubin in your urine, which can be a sign of liver disea se or other conditions.
urobilinogen: measures the amount of urobilinogen in the urine, which can be an indicat or of liver disease or other conditions.

Nitrite: This is a test that detects the presence of bacteria in the urine, which can indicate a urinary tract infection.
White blood cells: This measures the presence of white blood cells in the urine and can in dicate a urinary tract infection or infection.

When the swab is dipped in urine, the color of the urine changes depending on the amou nt of various substances in the urine. The color is then compared to the lip map to deter mine the concentration of each product.
Although urine tests are a quick and easy method of urinalysis, they have limitations. The y may not be as accurate as more urine tests and may depend on the person's diet, medic ations, etc. They may give negative or negative results depending on the
Therefore, if the smear shows abnormal results, other tests are needed to confirm the di agnosis.

While dipstick tests are a quick and easy way to perform urinalysis, they do have limitations. They may not be as accurate as more comprehensive urinalysis tests, and they can give false positives or false negatives depending on the individual's diet, medications, and other factors. Therefore, if a dipstick test suggests an abnormal result, further testing may be required to confirm the diagnosis.

The dipstick test has many benefits, including:

QUICK AND EASY: The dipstick test is a quick and easy urine test that.
takes a few minutes to complete.
This makes it an easy choice for doctors to use in the clinic.

Non-Invasive: The dipstick test is a non -
invasive urine collection method that is less comfortable for the patient than other sample collection methods.

Cost-effective: The dipstick test is a relatively inexpensive way to perform urinalysis, making it a cost-effective option for healthcare providers and patients.

Early diagnosis: Dipstick tests can help detect early signs of certain health conditions, such as kidney disease, urinary tract infections, and diabetes. Early detection can lead to earlier treatment and better outcomes for patients.

Monitoring: Dipstick tests can be used to monitor the progress of certain health conditions, such as diabetes and kidney disease. This can help healthcare providers adjust treatment plans as needed to optimize patient care.

Point-of-care testing: Dipstick tests can be performed at the point-of-care, which means healthcare providers can get results quickly and make decisions about patient care in real time.

While the dipstick test has many advantages, it is important to note that it is not a comprehensive diagnostic tool. False positives and false negatives can occur, and further testing may be needed to confirm the diagnosis. However, the dipstick test can be a useful tool for healthcare providers to use in conjunction with other diagnostic tests to help identify and monitor certain health conditions.

Microscopic exam

In this test, a large volume of machine-swirled urine is tested in the machine, sometimes as part of a urine test.

You may need additional tests if any of the following levels are higher than normal:

white blood cells or white blood cells may indicate an infection.

Bacteria, yeasts or bacteria may indicate illness.

Castes are proteins in tubular structures that can be caused by kidney disease.

Crystals formed from the chemical composition of urine may be a sign of kidney stones.

Stool and urinalysis are done in the bathroom.

The smart toilet recognizes the onset of "urine" and "stool" and begins collecting data and analysing various images of stool, urine and biomarkers.

It does this using three cameras, a ten-point urinalysis test, and a sound sensor.

Fingerprint scanner identifies the user to store collected data for cloud-based healthcare.

What do my test results mean?

Test results may vary depending on your age, gender, health history, and other things. Your test results may be different depending on the lab used. They may not mean you have a problem. Ask your healthcare provider what your test results mean for you.

Here is a sample of what certain results may mean:

A high number of red blood cells may mean that you have kidney disease, urinary tract infection, a drug reaction, or cancer.

A high number of white blood cells may mean that you have an infection or inflammation in your urinary tract.

A high number of cells called eosinophils may mean that you have problems in your urinary tract.

A high number of certain kidney cells may mean that you have kidney damage.

Substances created in the kidney, called casts, can suggest different diseases.

Abnormal crystals formed from amino acids and certain medicines can be a sign of a variety of health problems.

URMC / Encyclopedia / Microscopic urinalysis

Look it up in an encyclopedia

Look it up in an encyclopedia

Microscopic urinalysis

Is there another name for this test?

Microscopic urinalysis, microscopic examination of urine

What is this test?

This test looks at your urine sample under a microscope. They can see cells in your urinary tract, blood cells, crystals, bacteria, parasites, and cells from tumors.

These tests are often used to confirm the results of other tests or to add information to a diagnosis.

Do you need this test?

You may need these tests to make a diagnosis:

1. Kidney disease
2. Urinary tract infection
3. cancer
4. Drug reaction
5. Prostate infection
6. Liver disease
7. Viral infection
8. Mold infection
9. Parasitic infection

What do my test results mean?

Test results may vary depending on your age, gender, health history, and other factors. Your test results may vary depending on the laboratory used. It doesn't mean you have a problem. Ask your healthcare provider what your test results mean for you.

Here's an example of what some of the results might mean:

A high red blood cell count can indicate kidney disease, urinary tract infection, drug addiction, or cancer.

A high white blood cell count can indicate an infection or inflammation in your urinary tract.

Many cells called eosinophils can indicate a problem with your urinary tract.

An increase in certain kidney cells indicates kidney damage.

Kidney stones can indicate various diseases.

Abnormal crystals formed from amino acids and certain medications can be a sign of a variety of health problems.

How is this test done?

This test is done on a urine sample. Your healthcare provider may ask for a sample at a specific time, such as in the morning. Or you can collect a random sample. For this test, you may need to collect all of your urine over a period of time, such as 24 hours. For this example, you empty your bladder in the morning. Pay attention to the timing. Then collect your urine every time you go to the bathroom for the next 24 hours. You will collect it in a container provided by your healthcare provider or laboratory.

Does this test have any risks?

This test does not show any specific risk.

What could affect my test results?

Certain medications can change the appearance of urine under the microscope:

1. Sulfamethoxazole

2. ampicillin

3. Paint used in photographic experiments.

4. Many medications contain salicylate

Sample collector for urinalysis using 3D printing.

A 3D-printed pattern is fixed on the wall of the urine outlet to collect the urine and transport it to the urine meter.

A fragmented view of the plan. The ability of the platform to perform urinalysis was tested by measuring the amount of protein in the prepared samples, and the results were found to be useful and accurate for urinalysis.

CHAPTER 3

Smart Toilet

Smart toilets are the latest technological advancement in the world of home automation and Internet of Things (IoT). With the integration of IoT technology into everyday objects, we can now transform a simple toilet into a smart, innovative device that offers various features and benefits. In this article, we will discuss the concept of smart toilet, its benefits and various IoT technologies that can be integrated to create a smart toilet.

What is a smart toilet?

A smart toilet is a toilet that incorporates advanced technology to enhance its functionality, efficiency and convenience. With the integration of IoT technology, smart toilets can offer features such as automatic flushing, self-cleaning and water temperature control. In addition, some smart toilets may include sensors that can detect the user's health parameters such as body temperature, blood pressure, and glucose levels. These features make smart toilets a valuable addition to any home, as they can significantly improve the overall bathroom experience while providing useful health-related information.

A smart toilet is a high-tech toilet equipped with various advanced features and technologies to enhance user experience and improve overall hygiene. Smart toilets typically have built-in sensors, touchless controls and advanced water-saving features. They can also be equipped with additional features such as heated seats, air dryers and bidets.

One of the main benefits of a smart toilet is that it can help improve cleanliness and hygiene in the bathroom. For example, many smart toilets are equipped with self-cleaning features such as automatic flushes and disinfectant sprays. These features can help reduce the spread of germs and bacteria in the bathroom and make it a cleaner environment.

Additionally, smart toilets can also help save water and reduce the environmental impact of bathroom use. Many smart toilets have advanced water-saving features like dual-flush systems and low-flow toilets. These features can help conserve water and reduce the amount of water wasted during bathroom use.

Another advantage of smart toilets is that they can be connected to the Internet of Things (IoT), allowing them to be controlled and monitored remotely. This means users can adjust the temperature of the seat, control the water pressure and temperature, and

even monitor their health through the toilet's sensors. For example, some smart toilets can analyze the user's urine and provide insight into their health, such as detecting the presence of certain diseases or conditions.

Smart toilets are also increasingly being used in healthcare facilities, where they can provide valuable data for healthcare professionals. For example, a smart toilet can detect changes in a patient's urine that may indicate a health problem, such as kidney disease or dehydration. This data can be transmitted to medical professionals in real time, allowing for early intervention and treatment.

Overall, smart toilets offer a number of benefits and features that can improve the user experience, improve hygiene and even provide valuable data for healthcare professionals. As technology continues to move forward, we can expect to see even more advanced features and capabilities in smart toilets in the future.

Smart toilets have many advantages over traditional toilets, including:

Enhanced hygiene: Smart toilets are equipped with various features such as automatic flushing, self-cleaning and deodorizing, which reduce the need for manual cleaning and improve overall hygiene.

Improved comfort: Smart toilets are equipped with features like heated seats, air drying and bidet functions that provide more comfort and convenience than traditional toilets.

Health monitoring: Some smart toilets are equipped with sensors that can monitor urine and stool samples for signs of infection or disease, allowing for early detection and treatment.

Accessibility: Smart toilets are equipped with features such as automatic lid opening and closing and seat height adjustment, making them more accessible to people with disabilities or mobility issues.

Energy-efficient: Many smart toilets are designed to be energy-efficient, using less water for flushing and featuring automated power-saving modes.

Cost-effective: While smart toilets may cost more upfront, they can be cost-effective in the long run due to features like water-saving methods and reduced need for cleaning supplies.

Entertainment: Some smart toilets are equipped with features like built-in speakers or Bluetooth connectivity, allowing users to enjoy music or other audio entertainment while using the bathroom.

Aesthetics: Smart toilets often have a sleek, modern design that can enhance the overall look and feel of a bathroom.

Overall, smart toilets offer several benefits compared to traditional toilets, including enhanced hygiene, improved comfort, health monitoring, accessibility, energy efficiency and cost-effectiveness. While they may not be right for everyone, they are a viable option for those who value convenience, technology and cleanliness in their daily lives.

IOT Technologies used in Smart Toilet

IoT technologies have revolutionized the way we interact with everyday objects, and smart toilets are no exception. Smart toilets are designed to be more efficient, convenient, and user-friendly, thanks to the integration of various IoT technologies. In this article, we will explore some of the IoT technologies used in smart toilets and how they are transforming the bathroom experience.

Here are some ways in which IoT is used in smart toilets:

Sensors: Smart toilets come with various sensors that collect data about the user's behaviour, such as their weight, body composition, and the volume and flow rate of their urine. These sensors can be used to monitor the user's health over time. For example, some smart toilets come with sensors that can detect the user's body temperature, which can be used to detect signs of a fever or infection. Other sensors can detect the user's weight and body composition, which can be used to monitor their overall health and fitness levels.

Smart toilets use various types of sensors to collect data and perform different functions. Some of the sensors commonly used in smart toilets include:

Pressure Sensors: These sensors are used to detect when someone sits on the toilet seat. They can also be used to measure the weight of the user, which can provide useful health data over time.

FIGURE 1.3 Pressure sensor

Proximity Sensors: These sensors detect the presence of a person near the toilet. They can be used to automatically open or close the lid and seat, as well as to turn on the lights or activate other functions when the user is near.

FIGURE 1.4 Proximity Sensors

Temperature Sensors: These sensors measure the temperature of the water in the bidet or other components of the smart toilet. They can be used to ensure that the water is at a comfortable temperature for the user, and to adjust the temperature as needed.

Humidity Sensors: These sensors measure the level of humidity in the bathroom. They can be used to adjust the temperature and humidity levels to create a comfortable environment for the user.

FIGURE 1.5 Temperature Sensors and humidity Sensor

Flow Sensors: These sensors measure the flow of water and other fluids in the smart toilet. They can be used to track water usage and detect leaks or other problems.

FIGURE 1.6 Flow Sensors

pH Sensors: These sensors measure the acidity or alkalinity of the urine or other fluids in the smart toilet. They can be used to monitor changes in pH over time, which can provide valuable health data.

FIGURE 1.7 Ph sensor

Overall, the sensors used in smart toilets are designed to provide a range of data about the user's health, habits, and preferences. By collecting and analyzing this data, smart toilets can provide valuable insights that can help users maintain good health and hygiene, conserve water, and reduce their environmental footprint.

Cleaning Systems: Smart toilets often come with built-in cleaning systems that keep the toilet bowl and seat clean and hygienic. These cleaning systems use various IoT technologies, such as sensors and actuators, to detect when the user has finished using the toilet and initiate the cleaning process. For example, some smart toilets come with built-in bidet systems that use water and air to clean the user after they have finished using the toilet. These bidet systems can be customized to the user's preferences, such as water temperature, water pressure, and spray pattern.

A cleaning system is an important feature in smart toilets as it helps in maintaining cleanliness and preventing the spread of diseases. Smart toilets use several cleaning systems, including:

Automatic Flushing: This system automatically flushes the toilet after use, reducing the need for manual flushing and ensuring that the toilet is always clean and ready for the next user.

Self-cleaning: Some smart toilets are equipped with self-cleaning features that use water jets and cleaning agents to clean the bowl and surrounding areas after each use. This helps reduce the need for manual cleaning and ensures that toilets are always clean and hygienic.

Ultraviolet (UV) sterilization: Some smart toilets use UV light to sterilize the toilet bowl and surrounding areas after each use, killing bacteria and other germs that may be present. This can be especially useful in public toilets where many people may use the toilet throughout the day.

Automatic lid opening and closing: This feature eliminates the need for users to touch the toilet seat, reducing the risk of cross-contamination and improving overall hygiene.

Integrated cleaning systems: Some smart toilets are equipped with integrated cleaning systems that use a combination of water, air and cleaning agents to clean the toilet bowl and surrounding areas after each use.

Overall, the use of cleaning systems in smart toilets can help maintain hygiene and prevent the spread of diseases. However, it is important to ensure that these systems are effective and safe to use, and that they are regularly maintained to prevent the build-up of bacteria and other germs. Additionally, privacy and security concerns must be carefully addressed to protect user data and maintain trust in the technology.

Energy Efficiency: Smart toilets are designed to be energy-efficient, using less water and electricity than traditional toilets. This is achieved through the integration of various IoT technologies, such as sensors and actuators, which optimize the toilet's water and energy usage. For example, some smart toilets come with sensors that detect when the user has finished using the toilet and initiate the flushing process. This ensures that the toilet is not flushed unnecessarily, which helps conserve water.

Augmented Reality: Augmented reality (AR) is another IoT technology that is being used in smart toilets to enhance the user's experience. AR technology can be used to provide interactive and immersive experiences for the user, such as personalized health coaching or entertainment programs. For example, some smart toilets come with AR displays that

provide the user with real-time feedback on their posture, breathing, and other health-related metrics. This feedback can help the user improve their overall health and well-being.In summary, IoT technology has significantly enhanced the functionality and convenience of smart toilets.

From sensors and IoT devices to machine learning and artificial intelligence, cleaning systems, energy efficiency, and augmented reality, IoT technologies are being used in smart toilets to improve the user experience, promote better health, and conserve.

Benefits of Smart Toilets

Smart toilets offer numerous benefits that make them a valuable addition to any home. Some of the benefits of smart toilets include:

Improved Hygiene: With the integration of self-cleaning mechanisms, smart toilets can keep themselves clean and free from bacteria, viruses, and germs, providing a more hygienic environment.

Energy Efficiency: Smart toilets are designed to conserve water, which can help reduce water bills and promote sustainable living.

Improved Health: With the ability to detect health metrics, smart toilets can provide valuable information that can help people monitor their health and prevent health problems.

Convenience: Smart toilets offer various features that make them convenient to use. For instance, automated flushing eliminates the need to touch any buttons or handles, while water temperature control ensures a comfortable experience.

Smart toilets have several uses and benefits, including:

Health Monitoring: Smart toilets are equipped with various sensors and internet of things (IoT) devices that collect data about the user's behavior and health. These sensors can detect parameters such as the user's weight, temperature, and body composition, which can be used to monitor their health over time. This data can also be used to detect signs of health issues such as urinary tract infections or dehydration.

Personalized Feedback: Smart toilets can provide personalized feedback to the user based on their behavior and health data. For example, if the user is not drinking enough water, the toilet can remind them to drink more water or suggest ways to increase their water intake. This feedback can help the user maintain a healthy lifestyle.

Energy Efficiency: Smart toilets are designed to be energy-efficient, using less water and electricity than traditional toilets. This can help reduce the user's carbon footprint and save money on their utility bills.

Hygiene: Smart toilets often come with built-in cleaning systems that keep the toilet bowl and seat clean and hygienic. This can help reduce the spread of germs and bacteria and promote better overall hygiene.

Convenience: Smart toilets are designed to be user-friendly and convenient to use. They often come with touchscreen displays that allow the user to access information about their health and lifestyle, and they can also be controlled using voice commands or smartphone apps. This convenience makes them an attractive option for busy individuals who want to stay on top of their health and lifestyle.

Overall, smart toilets offer a range of benefits to users, from health monitoring to energy efficiency and convenience. They are a valuable addition to any home or commercial facility and can help improve the user's overall quality of life.

What is Urinalysis

A urinalysis is a diagnostic test that analyzes a person's urine sample to detect and identify various substances such as protein, glucose, and red blood cells that can indicate various health conditions. It is a non-invasive and relatively simple test that can provide valuable information about a person's overall health.

Urinalysis may be done for a variety of reasons, including screening for kidney disease, monitoring the effectiveness of certain medications, and detecting signs of infection and other conditions that affect the urinary tract. It is often included as part of a routine exam and can be recommended by a healthcare provider if certain health problems are suspected.

For this test, a urine sample is taken from the patient and analyzed in the laboratory. Urine samples are tested for the presence of various substances such as protein, glucose and ketones. Urine is also checked for color, smell, and appearance, and examined under a microscope for bacteria or abnormal cells.

Urinalysis results provide valuable information about a person's overall health and specific medical conditions. For example, the presence of protein in the urine may indicate kidney damage or disease, and the presence of glucose may indicate diabetes. It may indicate a medical condition.

Briefly, urinalysis is a diagnostic test that involves analyzing a person's urine sample to identify and identify various substances that can provide valuable information about overall health and specific medical conditions. This is a relatively simple and non-invasive test that can be recommended as part of a routine physical examination or when a health care provider suspects a specific health problem.

what assessments are protected in urinalysis?

your healthcare issuer can embody numerous precise tests in a urinalysis. relying on your symptoms, modern health conditions, and/or situation, your issuer will pick out which urine checks to reserve below a urinalysis.

in fashionable, a healthcare issuer or laboratory technician can check a urinalysis urine sample for the following massive components:

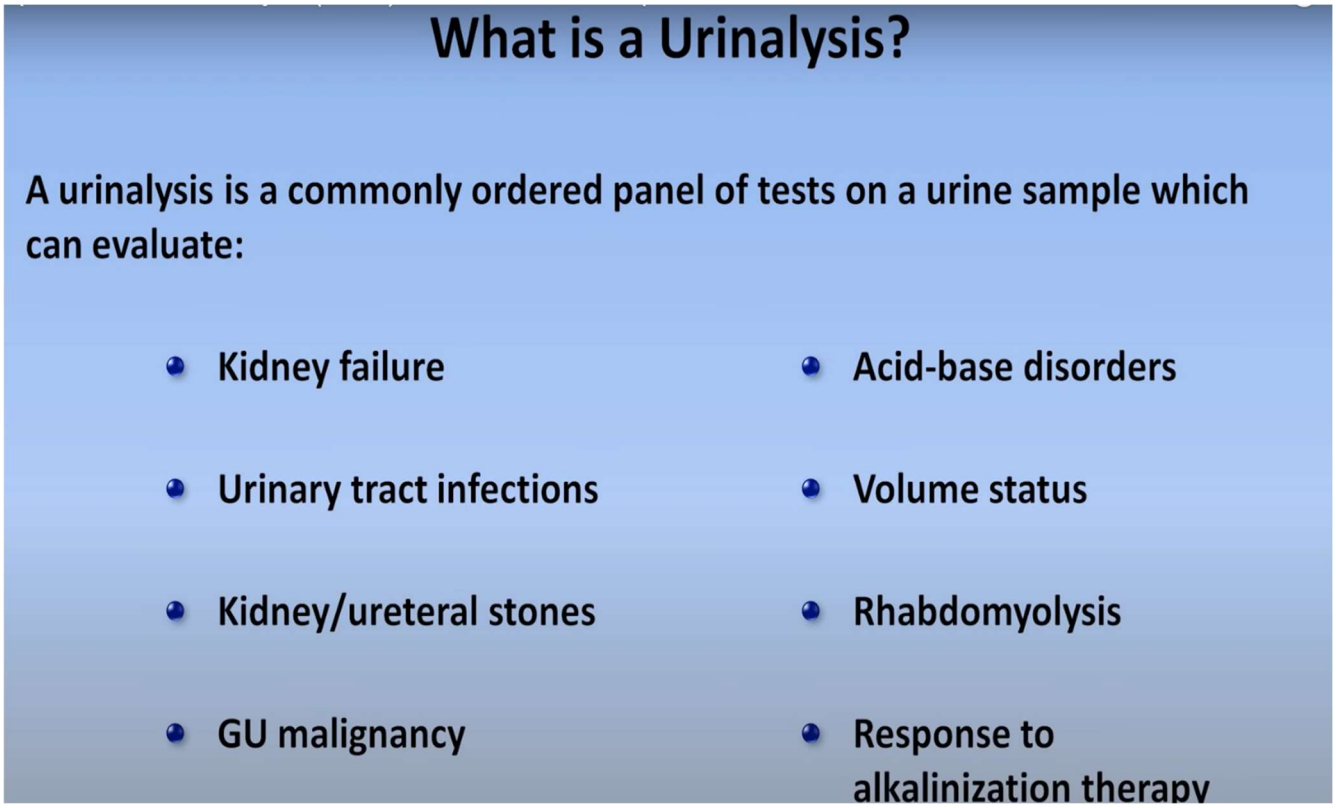

FIGURE 1.8: What is Urinalysis

Urinalysis is a diagnostic test used to analyze urine samples to diagnose and evaluate various medical conditions. A non-invasive and simple test that provides important information about the patient's health. Urinalysis involves a series of physical, chemical, and microscopic tests to determine the composition of urine and detect possible abnormalities.

Before a urinalysis test, you should make sure you are drinking enough fluids, such as water, to go to the bathroom and test the urine.

How should I prepare for urination?

Depending on the reason for the urinalysis, your doctor may ask you to collect the urine when you urinate in the morning (not available on the first morning). In such a case, your doctor will inform you.

Some medications can change the color of urine.Your doctor may recommend that you avoid certain medications that can affect urine test results. Do not take this medicine unless your doctor tells you to.

If you are pregnant (during your period), it is important to inform your doctor before collecting urine. Menstruation and vaginal bleeding can interfere with some urinalysis tests.

What can I take while urinating?

In most cases, you'll get the test done at your doctor's office or in a lab using a "clean collection" designed to help keep your urine from becoming contaminated with bacteria and cancer. You or your doctor may also use a catheter to collect urine.

For proper collection, your doctor will provide you with a container, sterile wipes, and specific instructions for collecting the urine sample. After taking your urine sample, your doctor will tell you what to do. It is important to wash your hands with soap and water before taking the sample.

Urine chemical findings

To examine chemical aspects of a urine sample, healthcare providers or lab technicians often use special test strips called dipsticks to test for certain chemical substances in the urine sample. The strips have pads of chemicals that change color when they come in contact with specific substances.

The degree of color change on the dipstick can give an estimate of the amount of substance present. For example, a slight color change in the test pad for protein may indicate a small amount of protein present in the urine sample, whereas a deep color change may indicate a large amount.

Common types of tests that use a dipstick that providers may include in a urinalysis include:

Protein urine test: A protein urine test measures the presence of proteins, such as albumin, in your urine. Higher-than-normal urine protein levels may indicate several different health conditions, such as heart failure, kidney issues and dehydration.

Urine pH level test: A urine pH test measures the acid-base (pH) level in your urine. A high urine pH may indicate conditions including kidney issues and a urinary tract infection (UTI). A low urine pH may indicate conditions including diabetes-related ketoacidosis and diarrhea.

Ketones urine test: Ketones build up when your body has to break down fats and fatty acids to use as fuel for energy. This is most likely to happen if your body does not get enough sugar or carbohydrates as fuel. Healthcare providers most often use ketone urine tests to check for diabetes-related ketoacidosis.

Glucose urine test: A glucose urine test measures the amount of sugar (glucose) in your urine. Under regular circumstances, there shouldn't be glucose in your urine, so the presence of glucose could be a sign of diabetes or gestational diabetes.

Bilirubin urine test: Bilirubin is a yellowish pigment found in bile, a fluid produced by your liver. If you have bilirubin in your urine, it may indicate liver or bile duct issues.

Nitrite urine test: A positive nitrite test result can indicate a urinary tract infection (UTI). However, not all bacteria are capable of converting nitrate (a substance that's normally in your urine) to nitrite, so you can still have a UTI despite a negative nitrite test.

Leukocyte esterase urine test: Leukocyte esterase is an enzyme that's present in most white blood cells. When this test is positive, it may indicate that there's inflammation in your urinary tract or kidneys. The most common cause for white blood cells in urine is a bacterial urinary tract infection (UTI).

Urine specific gravity test: A specific gravity test shows the concentration of all chemical particles in your urine. Abnormal results may indicate several different health conditions.

Urine Electrolyte Test: This test is used to measure the levels of electrolytes such as sodium, potassium, and chloride in urine. This test can help in the diagnosis of various medical conditions such as dehydration and kidney disease.

Urine Osmolality Test: This test is used to measure the concentration of urine. This test can help in the diagnosis of various medical conditions such as diabetes insipidus and kidney disease.

Proteinuria Test: This test is used to detect the presence of protein in urine. The presence of protein in urine can indicate various medical conditions such as kidney disease and diabetes.

Urinalysis is an important diagnostic tool that helps in the early detection and treatment of various medical conditions. Routine urinalysis is a simple and cost-effective test that can be performed in a clinical laboratory. Specialized urinalysis is a more detailed test that is used to diagnose specific medical conditions.

Smart toilets have the potential to detect a wide range of diseases and health conditions through the analysis of urine and stool samples. Some of the diseases that can be detected using smart toilets are:

Urinary tract infections (UTIs): Smart toilets can detect UTIs by analyzing the levels of leukocytes and nitrites in the urine. These are indicators of a bacterial infection in the urinary tract.

Kidney disease: Smart toilets can detect kidney disease by analyzing the levels of protein in the urine. High levels of protein in the urine are a sign of kidney damage.

Smart toilets can detect kidney disease by analysing urine samples. Some kidney diseases that can be prevented by using smart toilets are:

Chronic Kidney Disease (CKD): Smart toilets can detect CKD by analyzing protein levels in urine. High levels of protein in the urine, also known as proteinuria, are an early sign of kidney damage and can lead to CKD if left untreated.

acute kidney injury (AKI): smart toilets can detect AKI by analyzing urine creatinine levels. High levels of creatine in the urine are a sign of kidney damage and can lead to AKI if left untreated.

Nephrotic Syndrome: Smart toilets can detect nephrotic syndrome by analyzing protein levels in urine. Nephrotic syndrome is a kidney disease characterized by high levels of protein in the urine.

Glomerulonephritis: Smart toilets can detect glomerulonephritis by analyzing the levels of red and white blood cells in urine. Glomerulonephritis is a type of kidney disease that causes swelling of the glomeruli, which are tiny filters in the kidney.

Polycystic Kidney Disease (PKD): Smart toilets can detect PKD by analyzing protein levels in urine and monitoring kidney size. PKD is a genetic disorder that causes fluid-filled cysts in the kidneys, causing kidney damage over time.

Smart toilets can monitor the progression of kidney disease by analyzing changes in urine volume and composition over time. By detecting kidney disease early, smart toilets can help people seek medical attention and prevent kidney damage.

Diabetes: Smart toilets can detect diabetes by analyzing the levels of glucose in the urine. High levels of glucose in the urine can be an early sign of diabetes.

Dehydration: Smart toilets can detect dehydration by analyzing the color and density of the urine. Dark, concentrated urine is a sign of dehydration.

Liver disease: Smart toilets can detect liver disease by analyzing the levels of bilirubin and urobilinogen in the urine. High levels of these substances in the urine are a sign of liver damage.

Colon cancer: Smart toilets can detect colon cancer by analyzing the stool samples for the presence of blood and abnormal cells.

Inflammatory bowel disease (IBD): Smart toilets can detect IBD by analyzing the levels of certain biomarkers in the stool samples.

Prostate cancer: Smart toilets can detect prostate cancer by analyzing the levels of prostate-specific antigen (PSA) in the urine.

Liver disease is a serious and potentially life-threatening condition that can have many different causes, including viral infections, alcohol abuse, and certain genetic conditions.

Early detection and treatment are critical for improving outcomes and preventing serious complications.

While there are many different types of liver disease, some of the most common include hepatitis B and C, alcoholic liver disease, and nonalcoholic fatty liver disease. Each of these conditions can have different symptoms and require different treatment approaches.

Smart toilets have the potential to be a valuable tool for detecting liver disease early on, particularly in individuals who may be at higher risk due to their lifestyle or medical history. Here are some ways that smart toilets could help in the detection of liver disease:

Monitoring liver function: One of the primary ways that liver disease is diagnosed is through blood tests that measure levels of certain enzymes and proteins in the blood that are produced by the liver. Smart toilets could potentially be equipped with sensors that can detect these substances in urine, providing a non-invasive way to monitor liver function over time and detect changes that could indicate the presence of liver disease.

Detecting elevated bilirubin levels: Bilirubin is a yellow pigment that is produced when red blood cells break down. When the liver is functioning properly, it helps to remove bilirubin from the body.

However, when the liver is damaged, bilirubin levels can become elevated, leading to a condition called jaundice. Smart toilets could potentially be equipped with sensors that can detect elevated levels of bilirubin in urine, providing an early warning sign of liver disease.

Identifying hepatitis infections: Hepatitis B and C are viral infections that can cause serious liver damage if left untreated. While there are blood tests that can detect the presence of these viruses, they may not always be accessible or convenient for individuals who may be at risk. Smart toilets could potentially be equipped with sensors that can detect specific markers of these infections in urine, providing an easy and non-invasive way to identify individuals who may need further testing and treatment.

Overall, smart toilets have the potential to be a valuable tool for detecting liver disease early on and improving outcomes for individuals who may be at risk. While more research is needed to fully understand the capabilities and limitations of these technologies, they represent an exciting new frontier in the field of healthcare and could have a significant impact on the way that liver disease is diagnosed and treated in the future.

Sexually transmitted infections (STIs): Smart toilets can detect STIs by analyzing the levels of certain biomarkers in the urine or by testing the urine for the presence of bacteria or viruses.

Smart toilets can also detect potentially sexually transmitted infections (STIs) by analyzing urine samples. Some of the STIs that can be detected using a smart toilet are:

Chlamydia: Smart toilets can detect chlamydia by analyzing the levels of Chlamydia trachomatis bacteria in urine. Chlamydia is a common STI that can cause pelvic inflammatory disease and lead to infertility if left untreated.

Gonorrhoea: Smart toilets can detect gonorrhea by analyzing the level of Neisseria gonorrhoeae bacteria in urine. Gonorrhea is a common STI that can cause pelvic inflammatory disease and lead to infertility if left untreated.

Trichomoniasis: The smart toilet can detect trichomoniasis by analyzing the level of Trichomonas vaginalis protozoa in urine. Trichomoniasis is a common STI that can cause vaginal itching, discharge, and discomfort during sex.

Human papillomavirus (HPV): The smart toilet can detect HPV by analyzing the level of HPV DNA in urine. HPV is a common STI that can cause genital warts and cervical cancer if left untreated.

Human immunodeficiency virus (HIV): Smart toilets can detect HIV by analyzing the level of HIV antibodies in urine. HIV is a viral STI that can lead to acquired immunodeficiency syndrome (AIDS) if left untreated.

By detecting STIs early, smart toilets can help individuals receive timely medical intervention and prevent the spread of infection to others. However, it is important to note that a smart toilet is not a substitute for routine STI testing and diagnosis by a healthcare professional.

It is important to note that while smart toilets have the potential to detect these diseases, they should not be used as a substitute for medical diagnosis and treatment. Smart toilets are a tool for early detection and monitoring of health conditions, but they cannot replace the expertise of a medical professional.

CHAPTER 4

Challenges and perspectives for the future

The continued growth and the success of platforms for ongoing health monitoring that are based in bathrooms depend on overcomes present difficulties, incorporating contemporary scientific advances, and adhering to emerging trends. The potential of bathroom-based health monitoring systems has the most potential for advancement through the use of cutting-edge technology including Internet of Things, cloud-based data storage, and machine learning algorithms, in addition to microfluidic' chips. increased acceptance by users is essential any innovative gadget to succeed in the IoTs, ml, and cloud-based storage'. This acceptance can be attained by considering Taking into account user expectations, current privacy worries, and using environmentally friendly materials. Most of the smart toilets that have been created so far have concentrated on efficient sample gathering and precise data; capture and study, but it's also crucial to store data for the long term and perform correct categorization, analysis, and result interpretation.

Smart toilets now under development can measure and read data independently, but the objective is that exchange collected data' in real time both the user and the caregivers (such as hospital servers) via a personal computer or smartphone). As a result, an appropriate data transport technique should be suggested. Bluetooth low energy is a strong option for short limit of range wireless communication. since it is safe, has a decent range (150m), has minimal latency, and uses little power. IoT technologies such as Sigfox, LoRa, and narrowband technologies can all be utilised for long-range wireless communications. The wireless connection known as Sigfox has a modest data rate, a long range (10 km in cities and 40 km in the countryside), and minimal power. The NB-IoT standard, which has a high network capacity, data transmission rate, and band of operation, is already used in healthcare applications. This standard's general adoption is hampered by the fact that it requires a licence and has a convoluted implementation structure.

While smart toilets have many advantages and benefits, there are challenges that must be addressed for their adoption and success. Some of the challenges and future prospects of smart toilets are listed below.

Cost: One of the biggest challenges facing the deployment of smart toilets is the high cost. Smart toilets are much more expensive than traditional toilets, which can be an obstacle for many consumers to accept. However, as technology continues to advance and manufacturing costs decrease, we can expect to see more affordable smart toilets in the future.

Cost is a key factor in the adoption and use of smart toilets. Smart toilets are more expensive than traditional toilets, which can be a barrier to adoption for many consumers.

The high cost of smart toilets is due to the advanced technology and features they offer, such as touchless controls, sensors and data monitoring capabilities.

Smart toilets typically cost anywhere from hundreds to thousands of dollars, depending on the brand, model, and features. For example, a simple smart toilet with touchless controls and heated seats can cost around $500, while more advanced models with data monitoring and self-cleaning capabilities can cost upwards of $2,000.

Smart toilets are expensive and may be out of reach for many consumers, especially those on a budget or with limited financial resources. However, it is important to note that as the technology continues to improve and manufacturing costs decrease, the cost of smart toilets may decrease in the future.

In addition, it is worth considering the long-term cost savings of smart toilets. While the initial cost may be higher, smart toilets help save water and reduce the environmental impact of bathroom use. Many smart toilets have advanced water-saving features, such as dual-flush systems and low-flow toilets, which can help you conserve water and lower your water bill over time.

As a result, cost is an important factor to consider when it comes to smart toilets. Although they may be more expensive than traditional toilets, the advanced features and technology they offer significant benefits in terms of hygiene, water savings and the overall user experience. As technology continues to advance and manufacturing costs drop, we can expect to see more affordable smart toilet options in the future.

User acceptance: Another challenge is user acceptance and training. Many people are not familiar with the technology and features of smart toilets and may hesitate to introduce them. Therefore, there is a need for educational and awareness campaigns to promote the advantages and benefits of smart toilets and help consumers understand how to use them correctly.

User acceptance is a key factor in the adoption and success of smart toilets. Smart toilets are new and unfamiliar technologies for many, which can lead to scepticism and resistance to adoption. Therefore, considering user acceptance is essential for the development and popularity of smart toilet systems.

One of the main reasons why some people are hesitant to use smart toilets is the fear of technology malfunctions. For example, users may worry that the sensors and controls of

their smart toilets may malfunction, leading to embarrassing situations. User-friendly experience should be ensured.

Another concern that can affect user acceptance is the invasion of privacy. Smart toilets collect and transmit sensitive data such as health information, which can be offensive to some users. Manufacturers should design smart toilets with strong information and security features to protect user information and prevent unauthorized access.

User education and awareness is also important for the adoption of smart toilets. Many people are not familiar with the technology and features of the smart toilet and may hesitate to use it. Therefore, manufacturers should provide clear and concise instructions on how to use smart toilets and provide support and training for users to use them comfortably and effectively.

Finally, cultural, and social factors can also affect user acceptance of smart toilets. In some cultures, there are taboos and stigmas associated with discussing bodily functions and toilet habits, which can make it difficult to promote the adoption of smart toilets. These factors should be considered when promoting a toilet system.

Consequently, user acceptance is a key factor in the success of smart toilets. Manufacturers must ensure that smart toilets are reliable, easy to use, and designed with strong security and data privacy features. User education and awareness campaigns can also help with adoption.

Data privacy and security: Smart toilets collect and transmit sensitive data such as health information, raising data privacy and security concerns. To protect user information and prevent unauthorized access, it is important to design smart toilets with strong information and security features.

Maintenance and repair: Smart toilets are complex devices that require regular maintenance and repair. Therefore, it is critical that consumers have access to reliable support and maintenance services to ensure the longevity and reliability of smart toilets.

Compatibility and Interoperability: With the wide variety of smart toilet makes and models available, compatibility and interoperability standards exist to ensure that different smart toilet systems can communicate with each other and integrate seamlessly with each other.

As for the future outlook, we can expect to see continued innovation and advancement in smart toilet technology. For example, it may integrate artificial intelligence (AI) and machine learning (ML) algorithms to provide more personalized and accurate health monitoring and analytics. In addition, we may see its development.

growing demand: Growing demand for water saving technology is driving the global smart toilet market. One of the main goals of leading smart toilet manufacturers is to conserve water and water resources. Population growth has increased the need for water sustainability, increasing the need for water conservation. Smart toilets effectively contribute to water conservation. Growing demand for water-saving technology is expected to drive the growth of the global smart toilet market.

Market threats : The threat of substitute products challenges the smart toilet market. Traditional toilets are much favoured in countries like China, India and other developing countries. Lack of awareness of smart toilets, cost constraints, and low penetration in developing countries are expected to hinder future smart toilet market growth. Additionally, hygiene culture varies from country to country. Demand for smart toilets is limited to high-income groups and high-end commercial buildings.

Market opportunities

Smart toilets offer significant benefits with a range of efficiency sensors built into their systems, such as automatic flushing and the ability to detect the amount of water needed to complete a single pass discharge. This feature reduces water usage compared to traditional toilets and automatically shuts off when there is a potential overflow, leak and smart device alerts, saving utility costs.

These products can optimize water and electrical energy consumption, making them a healthy and practical option for buyers. Smart toilets can automatically open and close, heat, and even clean and smell. It can be seen that the installation of smart bathroom products has become a style statement.

These factors, along with rapid economic growth and improvement in lifestyles worldwide, are expected to act as significant headwinds for the global smart toilet market.

Future possibilities in IOT based toilet

The future of IoT-based toilets looks promising, as the technology continues to advance and more features and capabilities are being developed. Some possible future aspects of IoT-based toilets include:

Increased integration with healthcare systems: As IoT-based toilets become more advanced, they can be integrated with healthcare systems, enabling medical professionals to monitor patients remotely. This will enable early detection of health problems and personalized treatment plans.

Enhanced Personalization: IoT-based toilets have the potential to provide more personalized experiences for users, as the technology allows customization of features such as water temperature, pressure and lighting. Additionally, users can receive personalized health recommendations based on their personal health data.

Improved sustainability: As the world focuses more on sustainability, IoT-based toilets have the potential to play a role in reducing water wastage and energy consumption. Features like automatic flushing and water-saving settings can help conserve resources.

Integration with Smart Homes: IoT-based toilets can be integrated with other smart home devices, allowing for a more seamless and integrated experience for users. For example, users can control their toilet through voice commands or a mobile app, and the toilet can adjust its settings based on data from other devices in the home.

Enhanced security: IoT-based toilets will need to incorporate advanced security features to protect user privacy and prevent unauthorized access. This may include features such as biometric authentication, encrypted data transmission and secure data storage.

One-Stop Turnkey Sanitation Solutions:

These automated solutions are coin/smart card operated where the doors open through a coin drop or a card swipe, with a clear occupancy indicator and differently-abled friendly modular design, they are easy to maintained and IoT enabled.

Among the many resources, India is facing a massive scarcity of water resources. Water has been a huge problem in many parts of the world for a very long time, and people have been facing this crisis for quite some time. We often overlook the amount of water wastage, particularly in toilets, but a significant reduction in water wastage has been observed with the launch of smart toilets. These toilets use only the required amount of water for every flush and floor sanitation, which, when compared to a regular toilet, is usually an issue. Smart toilets are thus a brilliant addition and a one-stop turnkey solution for serving the Indian mass.

Online Control & Monitoring:

The smart toilets come with inbuilt IoT Systems that transmit data like the usage, cleaning indications, sensor status to a remote computer. Our Smart EzyNest sanitation solution offers such a system of monitoring through the web interface so that supervisors/municipal authorities can ensure proper operations of such advanced toilets.

Other features of a smart toilet include a switch on and off system to prevent unwanted usage of the toilets.

The smart toilets have also been accompanied by a free downloadable mobile application that lets people locate nearby toilets and report any problems. Through the app, people can also make suggestions or complaints.

Strong Stainless Steel Floor Design:

The floor of smart toilets features a unique two-layer design, with the superior grade stainless steel layer providing easy clean-up. The bottom layer of the floor is for ventilation purposes and also has a slant for draining wastewater.

Periodic automated spray power cleaning of walls and floors at pre-fixed intervals is another unique feature of smart toilets, that solves the problem of manually cleaning them periodically.

This rational floor design is thus, not only visually pleasing for a user but also is a solution to the problem of stained flooring which is quite common to the traditional mass toilets.

Smart Toilets are Environment Friendly:

With smart toilets, toxins put into the environment are substantially reduced due to their quick clean-up capacity. Since smart toilets come equipped with automatic jet sprays/ sensor hand faucets, they significantly reduce the wastage of excess water and toilet paper. Each time a toilet is used, enormous amounts of toxic waste, toilet paper, and plastic are dumped into the environment, which is why smart toilets prevent patrons from having to use toilet paper to clean up, and if they do, the amount they use will be considerably less than usual.

As a result, by installing these smart toilets, India can observe a significant reduction in the wastage of such resources, and in this way, a smart toilet helps maintain and preserve the balance of nature.

Aesthetic & Robust Structure:

The exteriors are aesthetic and they come with a coating of ACP/PUF Panels that prevent the panels from dust and rust. On entering the inside, the toilet gets illuminated automatically. Furthermore, there is also scope for installing of solar panels (since the toilets are fully automated), aromatic dispensers, space for audio/video system advertising, and napkin vending systems.

Integration with existing infrastructure: Smart toilets should be integrated with existing infrastructure such as water supply, sewerage and waste management systems. This will help ensure efficient use of resources and reduce environmental impact.

By taking these steps, the infrastructure to build smart toilets can be improved, and more people can take advantage of this technology.

Some smart toilets have built-in smart virtual assistants that allow users to create an ideal environment using their voice. These toilets can also be connected to mobile apps that will enable users the freedom to set their personal preferences, such as preferred temperature, cleaning pressure and status for everyone in the household. The increasing consumer demand for convenience hygiene products is expected to be a driving factor in the growth of the market in the coming years. Additionally, industry participants are offering innovative hygiene technologies, including UV lighting, automatic flushing, Bluetooth connectivity and auto-opening seat covers to provide customers with a superior bathroom experience.

CONCLUSION

This research proposes a smart bidet system for health monitoring that makes use of a variety of touch sensors, including heat, pressure, and oxygen. These sensors functionality was evaluated in an IPX6 environment. The error rates for the pressure, oxygen, and heat sensors were, respectively, 4.1%, 0.6%, and 1.1%, suggesting outstanding accuracy. The Bluetooth connection protocol was then used to communicate the data gathered to a smartphone app by these sensors. Our sophisticated bidet system can track a variety of physiological parameters to identify health issues. IoT-based solutions are now making a big difference in the globe. It is now abundantly evident that there will be an increase in the number of IoT devices, which are designed to make everyday tasks easier by supporting people with a wide range of tasks.

One current IoT innovation that will soon be used is the smart bathroom. In this study, we used a health-detection bidet using artificial intelligence software, wireless connection, touch and noncontact sensors, and to measure and analyse bio-signals in an unrestricted, unrecognised environment and calculate various health indicators. Additional research will be required to turn In order to assess the clinical effectiveness of the system, this smart bidet system was converted into a Clinical Decision Support System (CDSS) for patients with health difficulties.

The time has come for the smart toilet and it has a potentially huge market – in the developed world, everyone who can use the toilet multiple times a day. Grego adds that he "can certainly imagine a world" in which a toilet that does more than flush excrement is "available to every household". Countless companies are working to bring it to market – a race to the bottom, if you will.

Smart toilet innovators believe that it can be the ultimate health monitoring tool. Grego believes her product — which analyzes and tracks stool samples and sends the data to an app — will provide "information related to cancer and many chronic diseases." For ordinary consumers, it will provide peace of mind, she says, by establishing a "healthy baseline": "Having technology that tracks what's normal for a person can provide an early warning that a checkup is needed." For people with certain conditions, such as inflammatory bowel disease, the device can provide helpful monitoring for doctors. "It's very difficult to know when to escalate or de-escalate treatment," he says. "Stool-based biomarkers can provide that information."

Pictorial image of project

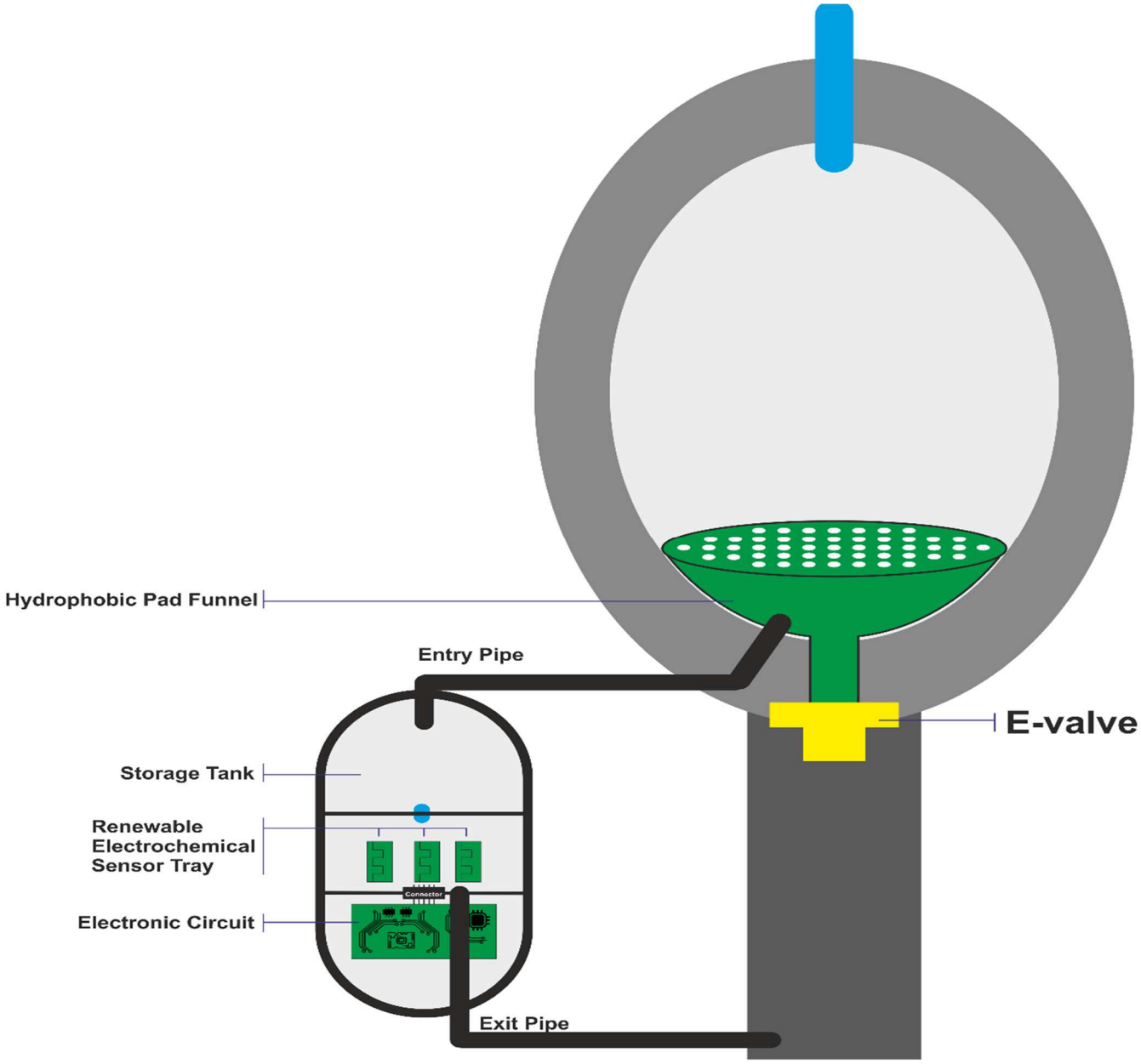

FIGURE 1.9 Pictorial image of project

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