

<sup>1</sup> T. Senthil Kumar  
<sup>2</sup> Rakesh Kumar  
 Giri  
<sup>3</sup> Kalaiarasi N  
<sup>4</sup> D. Yuvaraj  
<sup>5</sup> T. Mahalingam

## Functional Gastrointestinal Disorders (FGID): Information Technology Adoption Based on Power Transmission



**Abstract:** - One of the most investigated topics in information systems (IS) has been the adoption of new technologies. While several models have been developed in the past ten years to address the acceptance or rejection of information systems, there is still a dearth of studies that provide a thorough analysis and classification of the literature in this field. Many functional gastrointestinal illnesses have been linked to potential treatments with electrical stimulation (FGID). An implanted electrical stimulation system with a transcutaneous power supply is presented in this research. The issue of providing an implanted electrical stimulator with prolonged power is resolved by this technology. Following implantation, the external controller can reprogram the stimulation parameters, which are subsequently communicated to the implanted stimulator. This would make it possible to do parametric research to find out how well different stimulation parameters work to encourage gastric contractions. Feedback on changes in the gastrointestinal tract can be received in real time via an internal stimulator pressure detector. The investigation provides academics and practitioners with insights and future directions on technology adoption by looking into related research works to gather data on IT adoption patterns. This paper outlines potential future research directions for scholars interested in pursuing studies on technology adoption. It also provides a summary of the major discoveries from earlier investigations, including statistical conclusions about variables that were added in IT adoption research.

**Keywords:** Information systems (IS), gastrointestinal illnesses, Electrical stimulation, Power Transmission.

### I. INTRODUCTION

Gastrointestinal symptoms like pain, discomfort, bloating, or altered bowel habits that cannot be explained by biochemical or structural defects found in normal medical settings are the hallmarks of functional gastrointestinal disorders (FGIDs). Irritable bowel syndrome (IBS), functioning dyspepsia, and functional constipation are common FGIDs. FGIDs are common; estimates of their prevalence in the community range from 10% to 20%, as is frequently reported [1]. There are substantial financial, societal, and personal costs related to FGIDs. These include increased rates of work absence and medical care use, and greater rates of psychological illnesses such as sadness and anxiety. Current models of FGID pathophysiology show that there is a bi-directional connection between FGIDs and worse psychological health. The potential function of psychological treatments is highlighted by this reciprocal connection.

Globally, these illnesses are thought to affect 10%–45% of people. Functional dyspepsia (FD), gastroesophageal reflux disease (GERD) [2], functional dysphagia, gastroparesis, functioning diarrhea, diarrhea, and faecal incontinence are common subtypes of functional group identity disorders (FGIDs). Nonetheless, the most common FGID subtypes are IBS and FD. It is believed FGIDs are a category of complicated and multifactorial disorders lacking specific pathogenesis. Furthermore, there is strong evidence of treatment efficacy when patients in various nations respond similarly to a new medication or other therapy (a) evidence of the disorders' global prevalence can support their credibility as diagnostic individuals, and (b) Comparing the incidence and features of these disorders in populations that differ in critical dimensions like nutrition, exposure to infectious agents history of war trauma, and culturally defined gender roles may help us understand their aetiologia (d)

<sup>1</sup> \*Corresponding author: Department of Computing Technologies, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu 603203, India. Email: senthilt2@srmist.edu.in

<sup>2</sup> Assistant Professor, Department of Computer Science & Engineering, Sunrise University, Rajasthan. Email: rakesh274@gmail.com,

ORCID: 0009-0003-8082-835X

<sup>3</sup> Professor, R.M.K College of Engineering and Technology, Thiruvallur, Tamilnadu. Email: kalaiarasiece@rmkcet.ac.in

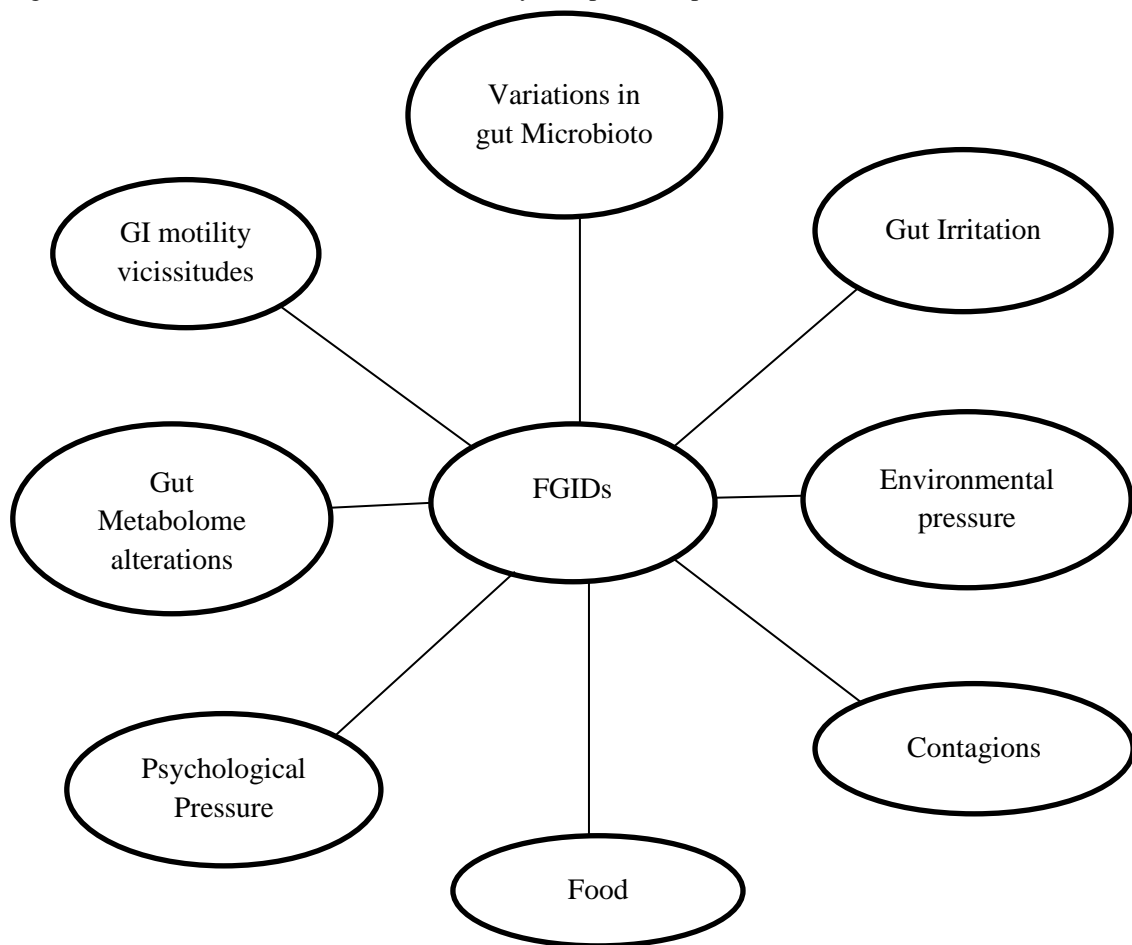
<sup>4</sup> Department of Computer Science, Cihan University-Duhok, Duhok, Iraq. Email: d.yuvaraj@duhokcihan.edu.krd

<sup>5</sup> Associate Professor, Department of Information Technology, R.M.K Engineering College, RSM Nagar, Kavaraipettai, Chennai- 601 206.

Email: tmm.it@rmkec.ac.in, ORCID: 0000-0002-3676-2088

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Evaluations of various health care delivery systems can help policymakers make decisions about how best to manage these disorders at a reasonable cost and may also point out potential hazards.



**Figure 1.1. Functional Gastrointestinal Disorders: their Aetiology. FGIDs: GI: Gastrointestinal Illnesses with a Functional Component**

Some of the FGID aetiologies are shown in Figure 1.1. Based on the symptoms described by the patient, these illnesses are diagnosed. The identified subgroups of FGIDs with clear symptom profiles are illustrated by several criteria. In clinical practice, there is a significant amount of overlap between the symptom profiles [4]. Cross-cultural, multi-national research is becoming viable due to the increasing interest in studying IBS and other functional gastrointestinal diseases as well as the advancement of telecommunication technology. For instance, the widespread availability of low-cost phone and video conferencing equipment, along with the expansion of Internet access worldwide, has made it possible to communicate in real-time and effectively undertake cross-cultural lessons.

It is estimated by the World Health Organisation that air pollution exposes about 90% of the world's population because of urbanization. Notably, 1012–1014 particles per person are expected to be consumed daily by an average Western diet. Additionally, through promoting generalized inflammation, aerosols can have an impact on the GI tract. Hence, the GI tract is likely a critical organ system in which air pollution might produce symbiosis and intestinal illnesses along with modifications in the gut flora variety. Numerous researches have been done on the effects of air pollution on human health, specifically cardiovascular and respiratory diseases. More research is needed to fully understand the role that air pollution plays in the pathophysiology of GI disorders like FGIDs. This narrative review included research showing that FGIDs and air pollution are related. This study examined the potential effects of air pollution on two prevalent forms of functional group identification disorders (FGIDs) by examining gut microbiota, GI motility, and intestinal inflammation.

The succeeding portions of the essay are structured as follows. Section 2 includes the research on the literature review work. The features of the suggested system, including its suggested architecture, implementation model,

graph-based approach components, and data analysis, are covered in Section 3. In Section 4, the system's efficacy is evaluated and the implementation environment is explained. Section 5 presents the conclusion.

## II. LITERATURE REVIEW

The autonomic nervous system connects the psychological and pathological components of operational gastrointestinal diseases, according to the suggested bio-psychosocial concept of these conditions. There is growing recognition of a role for aberrant autonomic nervous system activity, which may extend beyond the digestive system [5]. Pediatric FGID has been linked to autonomic dysfunction, according to preliminary research. Though other associations have not been thoroughly examined, FGIDs have been linked to orthostatic intolerance (OI), primarily postural tachycardia syndrome (POTS) and syncope. Three basic forms of orthostatic diseases have been described in individuals undertaking tilt table testing (TTT): postural tachycardia syndrome (POTS), reflex syncope, and orthostatic hypotension.

In 715 cases (14.37%) of our sample, multiple FGIDs were evident, while 473 cases (10.21%) only had one type of FGID. The Venn diagram illustrates the overlap between the functional gastrointestinal disorders (FGIDs) classified under Rome criteria into four categories: functional bowel disorders (Category C) [6], functional anorectal disorders (Category F), and functional esophageal disorders (B). The following values indicate the incidence (%) in each category: groups A, B, and C separately 0.31%, groups A, B, C, and F 0.23%, and groups A and C separately 2.36%. There was nothing notable about the pattern.

Because ascertainment standards, people, and contextual factors vary greatly, there are wide variations in the frequency of FGIDs [7]. Numerous functional abnormalities of the digestive system in the general population share a significant amount of comorbidity. Given their jobs, hard working conditions, and exposure to a variety of substances, notably jet fuel, Air Force members should pay particular attention to this element. Additionally, these workers face stress from battle, flying at high altitudes, air illness, and extended time away from family. Their profession necessitates an all-time high degree of physical and mental competence. We conducted this study among CAF members because there aren't many comprehensive studies of FGIDs in the armed forces.

Only when a critical threshold of several genetic and environmental variables is met does a clinical picture become apparent [8]. Clinical phenotype fluctuates. For instance, patients with the infection frequently exhibit symptoms for multiple of these disorders at different points in their lives, and an individual's clinical characteristics are not consistent across time. In a similar vein, ancestral records indicate that relatives and various generations of FGID patients frequently fit the criteria for another illness while exhibiting no digestive symptoms. We will outline the current state of our understanding of the genetic causes of IBS, evaluate these discoveries critically, and talk about fresh perspectives and potential paths forward in this instant.

As the most comprehensive national study on FGIDs in children in the Western hemisphere, this is also the largest study of the Functional International Digestive Epidemiological Research Survey team. In Ten Colombian Cities, twelve schools participated in this cross-sectional survey. With an approximate population of roughly 50 million [9], Colombia is the next most populous nation in South America. Around the Andean and Caribbean coasts is where the majority of people live. Public schools are attended by 60% of secondary school students and 85% of pupils in primary care schooling in Colombia. Both public and private educational institutions were chosen as research locations to maximize the external validity of the data and to improve racial, ethnic, and economic variety.

FGIDs are among the top 10 disorders affecting Indonesian adolescents, with prevalence as high as 40.85%, according to data from the Ministry of Health of the nation-state of Indonesia in 2020 [10]. A compromised connection between the cerebral cortex and the gut is more prone to cause FGIDs, which manifest in situations lacking an organic basis. Put differently, problems in the process of digestion are mutual. Digestive disorders are more common in people with predominant anxiety diseases, whereas anxiety disorders are more common in those with FGIDs. According to the most recent research, medication therapy is still typically used to treat FGIDs; however, this therapy frequently causes additional adverse effects that the patient afterward experiences.

## III. METHODS AND MATERIALS

### 3.1 Treatment options for gastrointestinal problems using Emerging Psychological Treatments

#### 3.1.1 Conscientiousness

In a variety of adult patient populations, mindfulness-based approaches have shown advantages for reducing stress and enhancing general well-being. To foster greater awareness and connection to the present moment or activity—without passing judgment or attempting to alter the circumstances—mindfulness-based treatment, or MBT, combines relaxation and meditation techniques [11]. Research on MBT's effectiveness in treating adult IBS patients is lacking; however, no research has been conducted on pediatric patients. These abilities may be used to lessen reactivity to GI symptoms, encouraging a composed coping response to what is usually emotionally and physically upsetting, even though further research in GI-specific groups is required. GI symptoms were found to be adversely correlated with well-being traits that are encouraged in mindfulness training when these traits were evaluated in GI-specific groups.

### *3.1.2 Treatment based on Dedication and Tolerance*

Acceptance and Commitment Therapy (ACT) is defined as a therapeutic approach that assists individuals in embracing constructive principles and accepting challenging circumstances as a natural part of life's experiences. When compared to IBD treatment as usual, an eight-week ACT program trial involving adult IBD patients showed a clinically significant decrease in stress and depression levels in the therapy group. Additionally, individuals in the ACT groups stated that their quality of life had improved more. Although early evidence from kids with persistent discomfort suggests good impacts on reports of pain and impairment, further data on pediatric GI patients are required.

### *3.1.3 Launching and Sustaining the Endeavour*

By seeking out and employing psychologists to work in the clinic or by locating community resources, doctors can help patients get the right psychological therapies. This lowers obstacles to starting therapy and might also lessen patient resistance or emotions of being abandoned by their doctor [12]. The list of helpful resources below might help you locate therapists in the US who have experience treating gastrointestinal diseases.

Furthermore, a lot of university and/or hospital-based clinics employ psychiatrists who are either qualified to treat patients or who have connections to community psychologists who specialize in health or gastrointestinal issues.

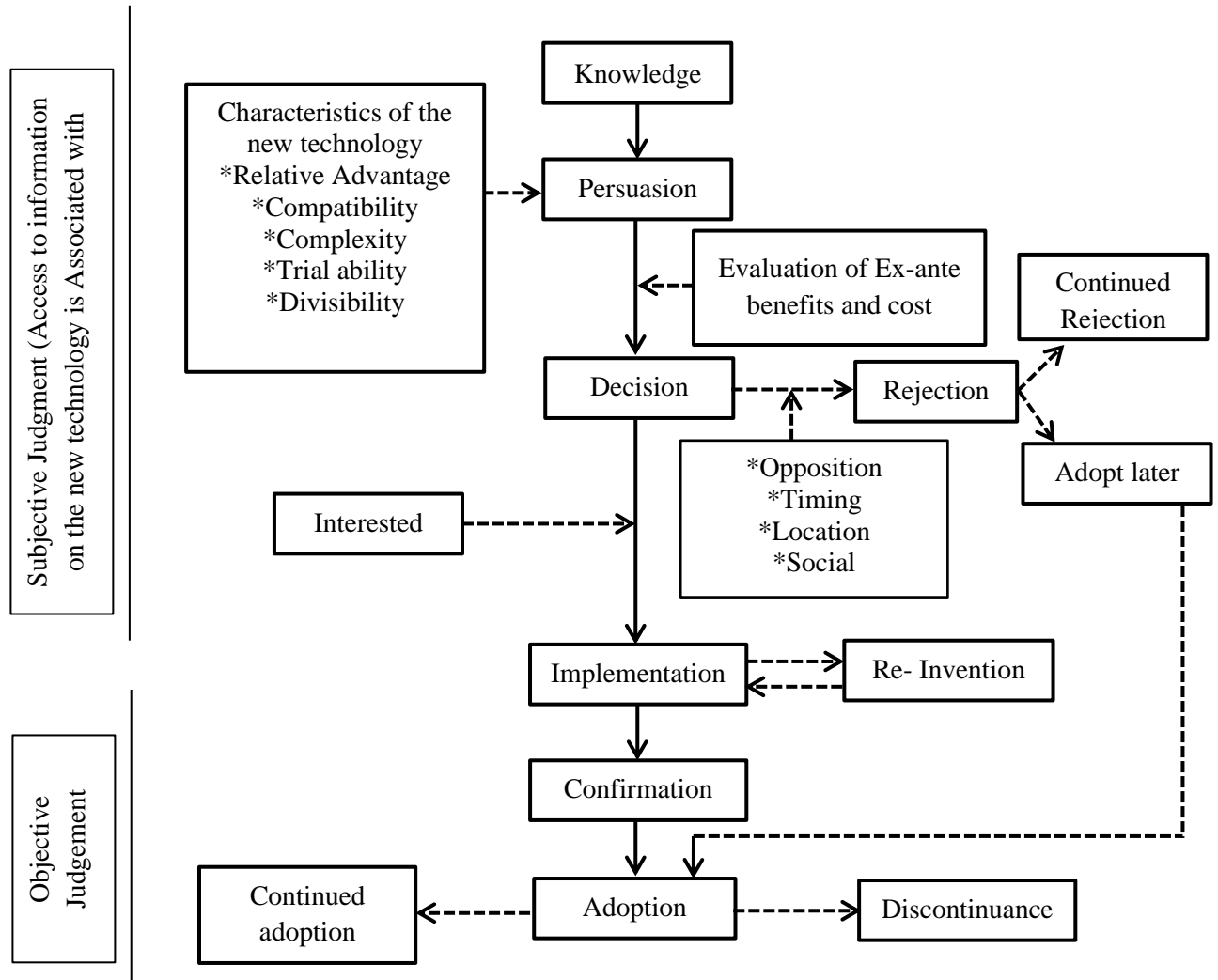
It is probably insufficient to only advise parents to seek mental health services on their own, since therapists who are not trained or experienced in treating gastrointestinal disorders will probably concentrate more on general stress and worry than on symptoms unique to the GI system.

Finding appropriate doctors and collaborating closely with them is crucial, thus the patient shouldn't be responsible for making these arrangements.

## *3.2 The Decision-Adoption Process*

According to research on economic decision-making, the adoption of innovations or technologies is influenced by four key factors: the ability of businesses in a given industry to maintain a competitive edge, the knowledge of alternative innovations that arise as a result of market conditions, the drive or incentive to investigate options, and the accessibility of resources to carry out the decision.

The choice to accept a new technology requires five steps including information (consciousness); argumentation, potentially by acquiring sufficient information on the features, advantages, and drawbacks of a new technology; choice; execution; and verification. Understanding the key elements that could influence technology adoption as well as the adoption decision-making process is necessary to comprehend the role those new technologies play [13].



**Figure 3.1. Model of the Decision-Making Process for Technology Adoption**

The process that a person, a farmer, a business, or a group goes through while deciding whether to accept technology is shown in Figure 3.1. Getting knowledge (awareness) about the latest innovations through media advertisements, extensions, or social media sites is the first step in the adoption process. A thorough examination of the technology's regarded qualities as well as the possible advantages and disadvantages of purchasing it come next. The most important step is deciding whether to accept or reject the novel technology after considering its features and assessing its advantages, disadvantages, and trade-offs.

Rejection may be caused by several things, such as opposition, the timing or location of the technology's introduction, or social media, where acceptance is typically influenced by the views of technical leaders. A technology may be rejected initially and then decided to be adopted later. If the prospective adopter shows interest in the novel technology at first, he or she will use it, maybe with the assistance of specialists to allay concerns about its possible side effects. To make sure the technology lives up to expectations, it could be evaluated further at this point. Decisions about adoption that are taken before the process of adoption is put into action may be influenced by personal opinion. When it comes to adopting novel technologies, the person who implements them looks for real proof that takes into account the features of the technology to bolster their judgment. Adopting technology objectively comes from a satisfied user.

Depending on the results, the technique may be used continuously. As an alternative, the innovation might be dropped if a better model is available for replacement, if it no longer lives up to demands, or if it is thought to be relatively inferior.

3.3 Adoption and Spread of Innovations in Technology

Many research investigations on technology adoption in the literature utilize various approaches and may produce contradictory findings when examining adoption at various levels, such as home, enterprise, industry, or nation. The literature's research on technology adoption frequently shows that the implementation pathway follows an S-shaped (the sigmoid) curve, indicating that new technology is initially adopted slowly by a small number of users. As word of the technology gets out there, more people adopt it; but, as more potential end users accept it, the overall amount of adopter's decreases.

Even with the apparent advantages of a new technology, certain actors will not adopt it for a variety of reasons. These include the technology's attributes, such as its relative advantages, difficulty, reliability, or splitting; consumer resistance, as with farming biotechnology; farm size; costs about advantages; revenue; decision-makers socioeconomic backgrounds; and location since some technologies have different effects in different areas.

3.4 A Thoughtful Diagnosis with Simplicity

The development of pathophysiological knowledge has led to and will continue to lead to the diagnosis of FGID. For the time being, the majority of these illnesses lack a biological marker; hence the diagnosis is mostly dependent on symptoms. Following a recent assessment of clinical criteria, the Rome IV criteria were developed for the diagnosis of FGID.

While meeting the requirements is necessary to confirm the diagnosis of FD or IBS, ruling out any organic condition as a possible cause of the symptoms is as important. The primary determinants of the extent of this assessment will be the patient's age, the existence or absence of warning signs, the evolution period, and the clinical hypothesis.

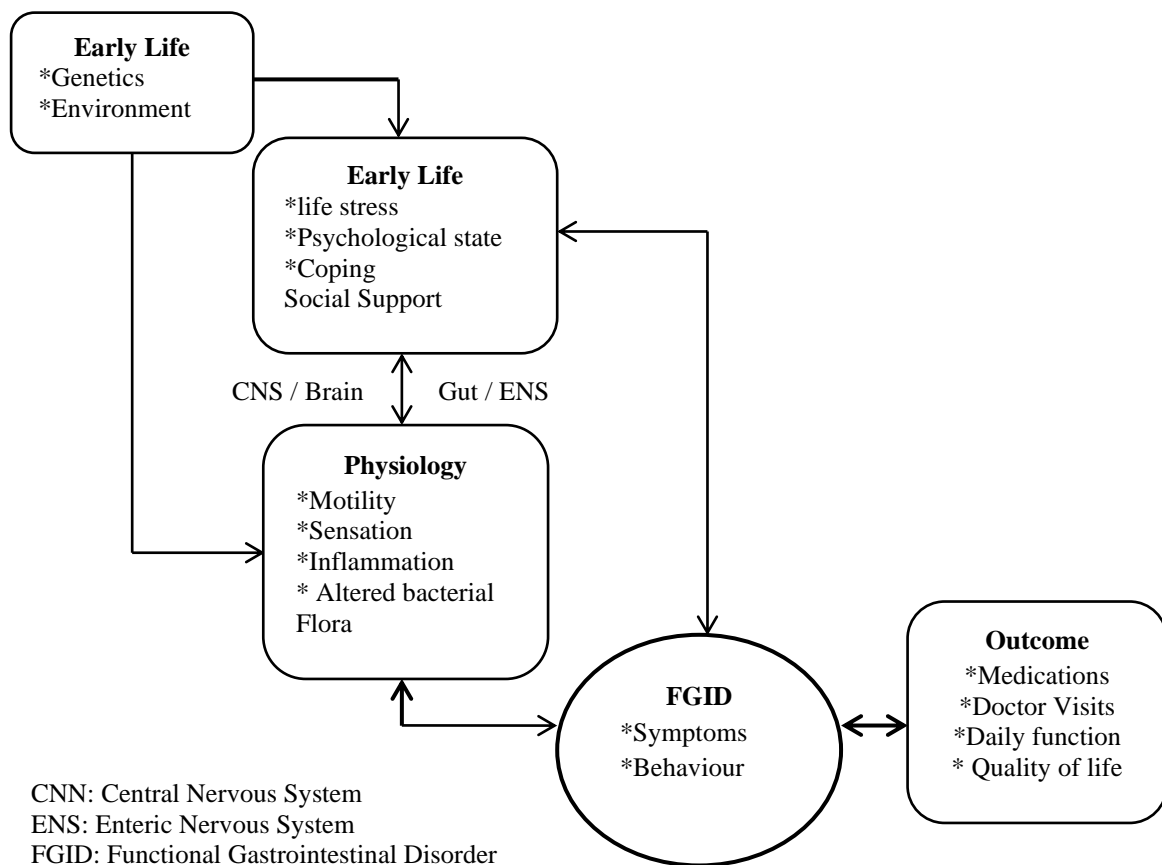


Figure 3.2. An Illustration of Functional Gastrointestinal Problems

Postprandial feeling satisfied, early satisfaction, epigastric discomfort, and epigastric burning—symptoms of FD that remain undiagnosed following a standard clinical evaluation—are among its defining characteristics. Three diagnosis categories' worth of patients is included in the general term "FD":

- Postprandial discomfort syndrome, a condition marked by dyspeptic signs brought on by meals.
- The term "epigastric pain syndrome" describes burning or discomfort in the stomach that does not just happen after a meal; it can also happen during fasting.
- Similar symptoms to postprandial distress syndrome and epigastric pain condition, which includes burning or pain in the stomach after eating.

Diseases can have a single cause, like any other issue in life, but most of the time there are multiple contributing factors. Anatomical lesions, for instance, are simple to comprehend and have a clear treatment: replacing the damaged organ. The pathophysiology of FGID is incredibly complex, involving interactions between the microbiota, neurons, and digestive system. Numerous mechanisms are implicated, such as dysbiosis, psychological diseases, increased abdominal sensitivity, disturbed internal and external intestinal reflexes, and intestinal dysmotility (Figure 3.2) [14].

### 3.5 Psychosocial Aspect

While psychosocial aspects do not define these illnesses, they are crucial in influencing the patient's experience, behavior, and eventually the success of the clinical trial (more on this later). Three broad conclusions can be drawn from work on the social characteristics of people with FGIDs:

- Gastrointestinal symptoms are aggravated by psychological strain. In healthy individuals, psychological strain or an individual's emotional reactions to stress can affect gastrointestinal function and cause discomfort; however, this effect is more pronounced in people with FGIDs.
- The experience of disease and illness-related behaviors, such as seeking medical attention, are altered by psychological problems. Since the data are derived from patients treated at referral centers, mental health issues in patients with FGIDs are not different from those in the general community, even if they are more prevalent in these patients than in healthy people and patients with medical diseases.
- Psychosocial factors, then, influence how people experience disease and behave, including seeking medical attention. This helps to explain research on psychosocial trauma, which is linked to worse clinical outcomes, is more prevalent in referral centers than primary care settings, and may lower pain thresholds and symptoms by submitting reports.

## IV. IMPLEMENTATION AND EXPERIMENTAL RESULTS

### 4.1 Electromagnetic Stimulator Test

The internal stimulator was incorporated within a 60 mm by 35 mm by 28 mm box. The gadget's life was estimated to be more than four months on a single charge when utilizing Li-ion batteries with an operating voltage and power rating of 4.6 V and 1.4 Ah, considering 5 daily stimulating sessions and 600  $\Omega$  comparable resistance of the tissue. The charging temperature was set to 5 V and the charge current was regulated at 300 mA to safeguard the battery and prolong its useful life.

In a lab test, the effectiveness of the GI electrical stimulation device was evaluated. The output signal of each channel was coupled to a resistive load with a range of 300  $\Omega$  to 2 k $\Omega$  to replicate the diversity of tissue during typical stimulation. Tests of stimulation were conducted with various variable combinations. The transmission range in the air was at least three meters.

### 4.2 Examination of Transcutaneous Voltage

In the transcutaneous electrical power system, a series of planar spiral coils were employed.

AWG 50 enameled copper wire was twisted around a disk-shaped magnet made of high-permeability MnZn ferrite to enhance magnetic flux and minimize skin effect and closeness effect losses in the coils, hence optimizing the receiving strength. At a frequency of 230 kHz, the electrical properties were measured using an LCR meter. During operation, there would undoubtedly be variations in the distance and synchronization of the communication coils. Variable coil alignment and distance can alter the induction link's operational state and connection factor  $k$ . As seen in Figure 4.1 [15] a test bench was built in order to examine the transcutaneous electrical system's efficiency.

- The coils were positioned parallel to one another on the same axis. There was an axial distance at which the efficiency peaked at 72%. The efficiency was 53% and the current was 26.5 V when the axial length was 15 mm.
- A fixed axial distance of 25 mm and a variable radial distance ranging from 0 to 35 mm were observed. The transmission's effectiveness and final voltage marginally dropped as the radial distance rose from 0 to 20 mm. When the radius was 20 mm, the output power was more than 680 mW and the effectiveness was still almost 40%.
- Rotating the receiving coil 5 degrees at a time allowed for the measurement of findings. Sending efficiency could reach 60% and output power could reach greater than 2 W when the radius angel was around 25 degrees.

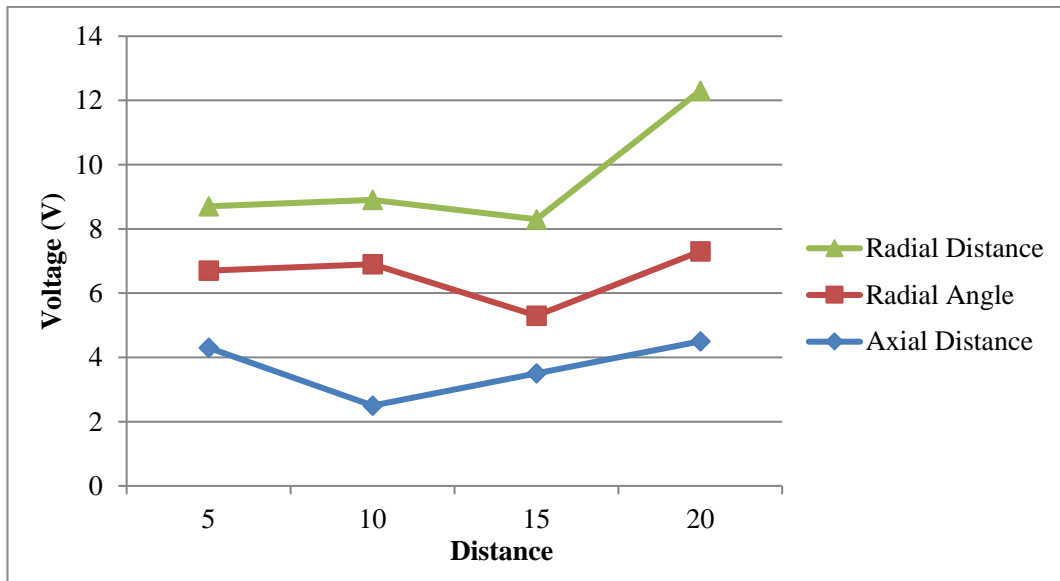


Figure 4.1. Equipment Test for Transcutaneous Power Supply

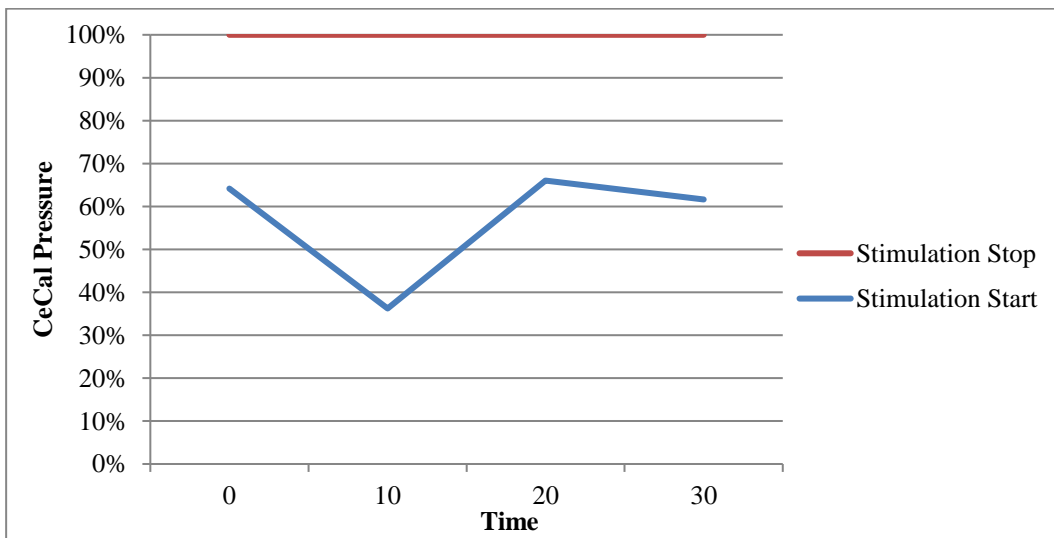


Figure 4.2. An STC's cecal Pressure under Various Stimulation Conditions

The detailed pressure change of the cecum of an STC pig under various stimulation settings is shown in Figure 4.2. Comparison of the waveform produced by different pressure levels allowed for the verification of the parameters' effects on the electrical stimulation. The electrical stimulation pulses did not appear to harm the tissue during the procedure.

Nevertheless, the cecum remained in a tetanic contraction as illustrated in Figure 4.2 and harm would transpire when stimulation settings reached a 6 ms pulse width, 160 Hz rate, and 30 V peak-to-peak voltages when the



electrical current was at a high level. The receiving coil was implanted beneath the skin and attached to the internal stimulator after taking the transcutaneous energy delivery system's gearbox range into account. The transcutaneous power supply system was tested using an electrical stimulator equipped with an operational charging alarm. Given a maximum charging power of 700 mW, the receiving flow was set to 300 mA, this indicated that the receiving power was 4 W, and the receiving coils were attached optimally to the receiving coil. In the end, the recharging process lasted roughly 6 hours until the alarm signal showed that the gadget had been fully charged.

#### V. CONCLUSION

To overcome the constraint of limited battery power and achieve permanent implantation, the goal of this research was to evaluate the viability and technique of inducing repeatable cramps of the cecum using the suggested GI stimulation system and wireless transcutaneous power transfer technology.

The implementation of transcutaneous power enabled the long-term implantation of devices for stomach electrical stimulation. This paper looked into various coil orientations to maximize the power supply of the apparatus. The battery in the creature's test required six hours to fully charge wirelessly through the living tissue. The thickness of the patient's skin, fat tissue, and bone would roughly correspond to the distance between the converter windings, which is typically between 1 and 2 cm. By raising the transmitting current, the receiving power may be ensured. To make sure that doing so wouldn't endanger patient safety, further research has to be done on the impact that extended exposure to a strong magnetic field might have on human cells. Before these technologies are fully incorporated into clinical practice, it is vital to assess the long-term effects of this approach on the tissue around the stimulating electrodes, lodging, and absorbing. It is necessary to investigate potential side effects, such as discomfort, before utilizing this technique on humans.

In conclusion, a transcutaneous power transmission technology-based GI electrical stimulation system has been proposed; this system uses an external portable controller to create and propagate peristaltic contractions artificially. Pressure detection in real-time tracked the GI tract's response. By ensuring that the power supply is sufficient for long-term implantation, transcutaneous energy transmission technology will enhance patient satisfaction and lower the hazards involved in repeat procedures to replace the power source.

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