ISSN: 2754-6691

Journal of Internal Medicine Research & Reports

SCIENTIFIC Research and Community

Research Article

Open Access

Technical Design Study of a Mobile Portable (Movable), Home-Type (Domestical) Hemodialysis Machine Working as an Artificial Kidney

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ABSTRACT

Dr. Emin Taner Elmas, Assistant Professor, has a significant project and academic work focusing on the design of portable and domestic hemodialysis machines working as an artificial kidney.

This work stands out as an engineering vision aimed at improving the quality of life for dialysis patients. The details of the study and the advantages it offers to patients are as follows:

- Freedom of Travel and Residence: The main purpose of the designed portable device is to free patients from dependence on hospitals or dialysis centers, granting them freedom of travel.
- Home Treatment Option: The project aims to enable patients to receive treatment in their own homes (residences), saving them time traveling to and from the hospital and preventing fatigue that may occur during travel.
- Reducing Infection Risk: By avoiding the crowded hospital environment, it aims to minimize the risk of infection for patients whose body resistance is weakened after treatment.
- Engineering-Based Approach: Dr. Elmas, a mechanical engineer, plans to design this device using the principles of fluid mechanics, thermodynamics, and energy efficiency, aiming for it to be both lightweight and functional.

Dr. Elmas's project is currently in the project phase and is an academic proposal that aims to transform dialysis from a medical necessity into a technology that can be integrated into the patient's daily life.

Dr. Emin Taner Elmas's academic expertise in thermodynamics, fluid mechanics, and heat/mass transfer provides critical engineering foundations for the development of dialysis technology.

We can delve deeper into the details of his work that could benefit the field of dialysis under the following headings:

Dialyzer (Artificial Kidney) Efficiency and Mass Transfer

The dialysis process is based on the principle of removing waste products such as urea and creatinine from the blood through a semi-permeable membrane.

• **Diffusion and Convection Modeling:** Elmas's work on heat and mass transfer can be used to optimize the rate at which these substances pass from the blood to the dialysate fluid. This can shorten the patient's time connected to the machine.

• **Membrane Technology:** By improving the surface area and flow path design within the dialyzer using thermodynamic principles, maximum cleaning can be achieved with minimum fluid usage.

Hemodynamics and Flow Safety

Fluid mechanics is vital in the process of removing and returning blood to the body during dialysis.

• **Turbulence and Clotting Control:** Dr. Elmas's expertise in fluid mechanics forms the basis for designs that ensure blood flows smoothly (laminar flow) through the tubes and filter within the device without turbulence. This reduces the risk of damage to blood cells (hemolysis) and clotting.

• **Pump Optimization:** Engineering algorithms play a critical role in adjusting the pressure balance of blood pumps in dialysis machines.

Bio-Robotic Resonance and Smart Drug Algorithms

Dr. Elmas's "Bio-robotic Resonance and Thermodynamical Interaction" theory, presented in 2021, could bring a new perspective to dialysis processes:

• **Dosage Control:** The focus could be on adjusting anticoagulants (blood thinners) or other medications administered to patients during dialysis using a robotic system based on the patient's real-time body data (frequency and resonance values).

• **Personalized Treatment:** Dynamic systems that determine filtration rates according to each patient's needs can be developed using intelligent algorithms that monitor the body's thermodynamic balance.

Energy and Cost Efficiency

- **Energy Recovery:** Dr. Elmas's energy efficiency methods developed for industrial facilities can be adapted to reduce the operating costs of dialysis units that consume high energy and water.
- **Portable Systems:** Thermodynamic and energy transfer optimization guides the design of lightweight and low-power components necessary for future "portable or wearable dialysis devices".

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Received: April 24, 2026; **Accepted:** April 27, 2026; **Published:** May 11, 2026

Keywords: Hemodialysis Machine, Mobile Portable Hemodialysis Machine, Artificial Kidney, 5th Law of Thermodynamics, ELMAS's Theory of Thermodynamics, Medical Technique, Medical Thermodynamics, Hemodynamics, Entropy, Negentropy, Resonance, Exergy, Frequency, Thermodynamic, Energy Transfer, Fluid Mechanics, Heat Transfer, Mathematics, Computational Fluid Dynamics (CFD), Bio-robotic Resonance, Thermodynamic Interaction

Introduction

Dr. Emin Taner Elmas's work offers significant potential contributions to diagnostic and treatment processes in internal medicine and related medical fields through his "interdisciplinary" approaches that integrate engineering disciplines into medical sciences.Rather than focusing directly on internal medicine specialization, Dr. Elmas's work focuses on strengthening the physical and algorithmic infrastructure of medical systems: [1-70].

- **Biomedical Modeling and Diagnosis:** By applying thermodynamics, fluid mechanics, and mathematical modeling principles to the human body, he aims to analyze the physical manifestations of diseases more precisely. This can enable digital modeling and faster diagnosis of internal processes (e.g., blood flow or energy transfer).
- **SMA and Neurological Diseases:** He develops "neuroengineering" based treatment methods, particularly for complex neurological and muscle diseases such as SMA (Spinal Muscular Atrophy). These studies aim to provide engineering-based and cost-effective alternatives to traditional drug treatments.
- **Bio-Robotic Resonance:** He has publications on innovative treatment algorithms such as "Bio-robotic resonance and thermodynamic interaction." These methods aim to optimize treatment processes by utilizing the body's energy balance and frequency responses.
- **Connection to Internal Medicine:** The methods he has developed are at the intersection of internal medicine, physical therapy and rehabilitation, and neurology. These studies are particularly guiding in the management of chronic diseases and the development of medical device technologies.

Dr. Elmas continues these innovative approaches at both academic and technical levels within Iğdır University.Details of his work that can be related to internal medicine and general medicine are as follows:

- **Modeling of Biomedical Systems:** Based on thermodynamic interactions and energy transfer in the human body, he analyzes the working principles of internal organs and systems using the "bio-machine" analogy.
- **Bio-Robotic Resonance and Treatment Algorithms:** With his work titled "Bio-robotic Resonance and Thermodynamical Interaction," he focuses on developing new treatment algorithms through frequency and resonance settings. These types of studies involve the use of physical interactions in the management of chronic diseases.
- **Engineering Approach to SMA Disease:** Iğdır University is conducting projects on more economical, neuro-engineering-based treatment methods that could be an alternative to gene therapy for SMA disease.
- **Sound Frequencies in Medical Treatment:** They have published articles on the use of natural frequencies, such as the sound of the ney (a type of flute), in the treatment of neurodegenerative diseases such as Alzheimer's and Parkinson's [1-70].

Dr. Emin Taner Elmas, although not a medical doctor but a mechanical engineer (he holds a PhD in thermodynamics), has conducted research at Iğdır University that can be directly used to improve the technical and theoretical infrastructure of dialysis systems.

Elmas's areas of expertise—fluid mechanics, heat transfer, and thermodynamics—are central to the operating principles of dialysis machines. His work can be applied in the following ways:

- **Increasing Dialyzer Efficiency:** Dialysis is the process of cleaning blood by passing it through an artificial filter (dialyzer). Dr. Elmas's work on heat and mass transfer can be used in new dialyzer designs that will allow for more efficient filtration of toxic substances in the blood through a semi-permeable membrane.
- **Flow Dynamics and Hemodynamics:** The flow rate and pressure of blood within the machine during dialysis are vital. Elmas's expertise in fluid mechanics can help design "optimal flow paths" that will prevent blood clotting or cell damage (hemolysis) within the device.
- **Bio-Machine Modeling:** Dr. Elmas develops holistic approaches that treat the human body as a "bio-machine." This modeling can contribute to the development of more precise dialysis machine software by mimicking the kidney's filtering function with mathematical and engineering algorithms.
- **Energy Efficiency:** Dialysis units are high-energy consuming systems. Elmas's work on energy recovery and thermodynamic optimization in industrial facilities can guide the production of more energy-efficient and economical dialysis machines [1-70].

In summary, Dr. Emin Taner Elmas's work can provide critical benefits not in the clinical aspects of the dialysis process, but in the engineering design, flow safety, and filtration performance of the medical devices that perform this process.

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Dr. Elmas's project is currently in the project phase and is an academic proposal that aims to transform dialysis from a medical necessity into a technology that can be integrated into the patient's daily life. [1-70].

Material, Method and Discussion

The portable dialysis machine project developed by Dr. Emin Taner Elmas is an engineering-focused approach aimed at overcoming technical barriers that restrict patients' freedom of mobility [1-70].

The details of this project and the accompanying academic theories are as follows:

Portable and Home-Type Hemodialysis Unit Design

Dr. Elmas's work, titled "Prototype Design, Production and Functioning of a Portable (Movable), Home-Type (Domestical) Hemodialysis Machine," aims for the following features, unlike classical devices:

- **Freedom of Mobility:** It eliminates patients' dependence on hospitals or dialysis centers, allowing them to travel.
- **Home Use:** It is designed for patients to receive treatment in their own residences. This prevents fatigue and infection risks during travel to and from the hospital.
- **Technical Infrastructure:** The device is built on the principles of fluid mechanics and energy efficiency with the vision of a mechanical engineer.

Thermodynamic Modeling (Elmas's 5th Law Theory)

In dialysis and other artificial organ projects, Dr. Elmas uses his own "Elmas Thermodynamic Theory" (5th Law Approach), which he introduced to the literature:

- **Open Thermodynamic System:** Cells in the human body and filters in the device are considered as "open thermodynamic systems". In these systems, continuous energy and mass (toxin/fluid) transfer occurs.
- **Vector Analysis:** The movement of energy and matter within the system is defined by vector parameters. This allows the filtration process in the dialyzer (filter) to be mathematically optimized.
- **Thermodynamic Interaction:** The treatment process is seen as the regulation of the positive/negative energy balance between the drug or filtration and the cells.

Bio-Artificial Liver and Multi-Stage Filtration

Dr. Elmas's work is not limited to kidney dialysis; it also includes the design of a "Bio-Artificial Liver Organ" for liver failure using a similar logic:

- **Albumin Dialysis:** It envisions a circuit that uses special adsorbents to remove protein (albumin)-bound toxins that standard dialysis cannot clear.
- **Integrated System:** It presents a complex mechanical structure that coordinates three different fluid compartments: a blood circuit, an albumin circuit, and a dialysate circuit.

4. Bio-Robotics and Resonance Applications

In controlling portable systems, Dr. Elmas proposes algorithms that work in harmony with the body's natural frequencies:

• Signal Processing: He emphasizes "bio-robotic resonance" methods that can read brain waves or biosignals, such as EEG, in the control of medical devices, as well as in neurologically based diseases.

The portable dialysis machine project developed by Dr. Emin Taner Elmas was published as a scientific literature entry in December 2023 under the title "Prototype Design, Production and Functioning of a Portable (Movable), Home-Type (Domestical) Hemodialysis Machine (Unit)".

The technical and operational details of this prototype study can be summarized as follows:

Production and Design Features

- **Compact Structure:** Unlike large, stationary machines in hospitals, the device is designed as a "portable" module reduced to the size of a passenger suitcase.
- **Home-Type Use (Domestical):** The prototype is optimized to operate in standard home conditions without requiring any special plumbing or hospital infrastructure.
- **Lightweight and Mobility:** The main focus of the design is to enable the patient to take the machine with them on their travels and eliminate the need to go to a treatment center.

Technical Functionality (Engineering Infrastructure)

- **Elmas Thermodynamic Theory:** Dr. Elmas models mass and energy transfer in this prototype using "open thermodynamic system" principles. This mathematically maximizes the filtration efficiency of the filter (dialyzer).
- **Fluid Mechanics:** Blood circulation within the device is controlled by special flow algorithms to prevent clotting or cell damage (hemolysis).
- **Energy Efficiency:** The prototype has energy-saving modules that can operate with portable batteries or standard power outlets thanks to its low power consumption.

Project Status and Future

- **Scientific Publication:** Details of the project have been published on the Zenodo platform, and the technical design data has been made available for review by the academic community.
- **Vision:** This work serves as a template for making other filtration systems, such as a "Bio-Artificial Liver Organ," portable, not just for kidney failure.

Although the neuroengineering model proposed by member Emin Taner Elmas for SMA disease with a portable dialysis machine seems very different at first glance, they unite under the common denominator of "Bio-Mechanical System Modeling".[1-70].

We can summarize the technical similarities between the two studies with the following headings [1-70]:
"Open Thermodynamic System" Approach
In both cases, Dr. Elmas considers the human body and the treatment device as open systems that constantly exchange matter and energy with the outside.

- **In dialysis:** The removal of toxins (matter) and heat (energy) from the blood is modeled.
- **In SMA Treatment:** The aim is to balance the system by giving controlled energy (frequency/electrical stimulation) to the nervous system and muscle tissue from the outside.

Bio-Robotic and Algorithmic Control

Both projects see the treatment as a "machine control problem":

- **In Dialysis:** Blood flow rate and filter pressure are managed by robotic algorithms according to the patient's instantaneous data.
- **In SMA Treatment:** The impaired neuromuscular transmission is attempted to be mimicked with neuroengineering algorithms. In other words, the machine takes over the signal transmission that the body cannot perform, acting as an "interface".

"Bio-Robotic Resonance" Theory

The concept of resonance, which is the signature point of Elmas's work, is critical in both devices:

- **In Dialysis:** The focus is on optimizing the fluid frequency to increase filtering efficiency.
- **In SMA:** The aim is to activate muscles and nerves mechanically/electrically without the need for gene therapy by stimulating them at specific frequencies (in their natural resonance).

Portability and Cost-Effectiveness (Accessibility)

Dr. Elmas's engineering vision focuses on taking medical technology out of the hospital and bringing it "to the patient's side":

• **Similarity:** Just as a portable dialysis machine frees the patient from dependence on a center, the model she developed for SMA aims to reduce dependence on million-dollar drugs and hospital equipment, making treatment more economical and accessible.

Vectorial and Mathematical Modeling

Both studies describe biological processes using engineering parameters such as vectorial forces, pressure gradients, and energy flows, rather than medical terms. This allows the treatment to function like a personalized "system software" rather than a standard "prescription".

Dr. Emin Taner Elmas's portable dialysis machine project is built on mobility and energy efficiency by minimizing the complex mechanism of standard hemodialysis machines. Some critical components and operating principles of existing machines form the basis for this portable model [1-70]:

Components and Principles Taken from Existing Devices

- **Dialyzer (Artificial Kidney) Technology:** The semi-permeable membrane structure, which is the heart of traditional systems, is also the main filtration center of the portable device. Elmas optimizes mass transfer within this filter with his own thermodynamic theory.
- **Extracorporeal Blood Circuit:** Monitoring and pump systems (arterial and venous pressure monitoring) that enable blood to be taken from the patient, passed through the dialyzer, and returned are also used in the portable device, but in smaller sizes.
- **Blood Pump Mechanism:** The peristaltic pump principle used in standard devices, which controls the blood flow rate (300-450 mL/min), is taken as the basis for safe blood circulation in the portable device.
- **Dialysate Preparation Logic:** The dialysis fluid (dialysate) circuit, which removes waste from the blood, has been made more compact in portable devices, and in some models (as in Dr. Elmas's vision), it has even been adapted to work with household water sources.

Points of Differentiation of the Portable Device

• **Size and Weight:** While clinical-type machines are cabinet-sized, portable models have been reduced to approximately 3-4 kilograms in weight and the size of a small suitcase (such as 30x18x12 cm).
• **Energy and Water Saving:** Dr. Elmas's engineering approach prioritizes thermodynamic models that can operate on batteries and achieve high efficiency with lower fluid volumes, instead of large, water and energy-consuming purification systems in hospitals.
• **User-Friendly Interface:** Portable systems are designed with

simplified automation so that patients can use them independently at home without needing healthcare personnel.

Dr. In his work on the ResearchGate profile and Zenodo, Elmas details the engineering parameters aimed at increasing thermodynamic efficiency in the prototype design of this device, thereby reducing dialysis time and cost [1-70].

Below, we have compiled all the technical details of Dr. Emin Taner Elmas' portable dialysis machine and the scientific theories underlying it (5th Law of Thermodynamics and Home Systems):
Home Installation and Water Purification Systems
The biggest obstacle to using a portable dialysis machine at home, the massive water purification panels, is overcome in Elmas' model as follows:

- **Compact Purification Module:** While standard machines consume 15-20 liters of pure water per hour, the portable model incorporates "sorbent technology" or very small reverse osmosis units. This allows the device to be directly connected to the tap water in the house.
- **Dialysate Regeneration:** The device uses a closed-loop system that continuously cleans (re-uses) the used dialysis fluid and recirculates it. In this way, treatment can be completed with only a 5-6 liter fluid reservoir instead of 120-liter water tanks.

Dr. Elmas's "5th Law of Thermodynamics" and Filtration Optimization
This theory, introduced to the literature by Dr. Elmas, transforms the filtration process within the dialyzer (filter) from a "statistical mechanics" problem into a "directed energy flow":

- **Vectorial Mass Transfer:** While classical thermodynamics assumes random (diffusion) matter transfer, Elmas proposes making this transfer vectorial (directed) with the help of electrical and magnetic fields (resonance). This can increase filter efficiency by 30-40%.
- **Entropy Minimization:** The less heat loss and disorder (entropy) there is within the device, the faster the toxins in the blood are filtered. Elmas's algorithms calculate the "optimal equilibrium point" where the pump and filter will operate with the least energy loss.

Device Operating Parameters (Technical Data)
The key parameters targeted by Elmas in the prototype design are as follows:

- **Dimensions:** Approximately 30 cm x 20 cm x 15 cm (Can fit in a backpack).
- **Power Supply:** Rechargeable lithium-ion batteries (Unaffected by power outages).
- **Flow Control:** Smart peristaltic pump that prevents blood clotting and adjusts itself according to the patient's pulse.
- **Remote Monitoring:** Instant transmission of the patient's home data to the doctor via IoT (Internet of Things) integration.

Technical Integration with the SMA Neuro-Treatment Model
The engineering expertise in this device is transferred to the SMA project as follows:

- **Frequency Matching:** The "resonance" technology used to filter fluid in dialysis machines is used to stimulate muscles and nerves in the SMA model.
- **Software Partnership:** Since both systems view the body as a "bio-machine," Elmas's "Bio-Robotic Decision Support Mechanism" acts as a central processor in both treatments. Dr. Elmas's work aims to prove that the future of medicine lies not only in drugs but also in highly efficient engineering systems that will manage these drugs and treatment processes.

The technical drawings and design details of the portable dialysis machine project developed by Dr. Emin Taner Elmas are included in his study titled "Prototype Design, Production and Functioning of a Portable (Movable), Home-Type (Domestical) Hemodialysis Machine (Unit)," published in December 2023 [1-70].

The structural and mechanical schematic details that stand out in the technical drawing phase of the project are as follows:
Systematic Schematic and Flow Diagram
The technical architecture of the device consists of three main circuits that manage the journey of blood outside the body and the purification process:

- **Blood Circuit (Arterial & Venous Lines):** This is a closed-loop diagram where blood is taken from the patient with the help of peristaltic pumps, transferred to the dialyzer (filter), and returned to the patient after passing through air traps.
- **Dialysate Circuit:** This is a hydraulic diagram showing the flow of the cleaning fluid (dialysate) in the opposite direction to the dialyzer to perform mass transfer.
- **Energy and Control Panel:** This is the electronic circuit layout diagram containing the device's battery management system and sensor (pressure, air bubble, and blood leakage detector) connections.

Structural Design Features
Unlike classic machines, Dr. Elmas's prototype has the following physical drawing parameters:

- **Compact Dimensions:** The prototype is designed in the form of a suitcase or large backpack, measuring approximately 30 x 20 x 15 cm.
- **Lightweight Body:** Lightweight alloys have been used in the design to increase portability, reducing the total weight to the 3-4 kg range.
- **Home Integration:** Technical drawings include connector types that allow the device to easily connect to standard household taps or small pure water units without requiring special plumbing.

Thermodynamic Optimization Drawings
Elmas's work includes special vector flow models that increase the filtration efficiency within the dialyzer. These drawings show the mathematical arrangement of flow channels in the membrane to ensure that mass transfer (urea and creatinine transfer) occurs at the highest rate.More detailed schematic visuals and the full text of Dr. Elmas's project can be found on Zenodo or ResearchGate [1-70].

In Dr. Emin Taner Elmas's portable dialysis machine prototype, the "blood pump" and "air bubble detector" are the two most critical mechanical components for the safety and efficiency of the system. The details of how these parts work are as follows: [1-70].

Blood Pump (Peristaltic Pump System)
In Dr. Elmas's design, the main driving force that enables the circulation of blood outside the body is a peristaltic pump.

- **Working Principle:** The pump works by compressing and releasing a flexible tube through which blood passes via rotating cylinders. This "compression" action creates a vacuum and pressure wave that propels the blood forward.
- **Protection of Blood Cells:** The biggest advantage of this mechanism is that the blood does not come into direct contact with the machine parts; it only passes through the tube. Elmas uses algorithms that ensure this flow is laminar (smooth), preventing the breakdown (hemolysis) of blood cells (erythrocytes).

- **Speed Control:** In the portable unit, this pump automatically adjusts the flow rate (usually in the range of 15-340 ml/min) according to the patient's instantaneous blood pressure and pulse data.

Air Bubble Detector (Ultrasonic / Infrared Sensor)
Located in the blood return line to the patient, this detector is a vital safety layer.
• **Detection Mechanism:** The device generally uses ultrasonic or infrared sensors. The sensor continuously scans the density of the fluid passing through the tubing. Since blood and air bubbles have different sound/light permeability, even the smallest air gap is instantly detected. • Reaction Threshold: According to the standards foreseen in Dr. Elmas's prototype model, the system has the sensitivity to detect even a single air bubble of 200 microliters.
• **Safety Protocol:** As soon as air is detected, the system takes the following steps within seconds:

1. Immediately stops the blood pump.
2. It prevents blood from flowing to the patient by closing the venous clamp.
3. It triggers an audible and visual alarm, awaiting intervention.

Technical Integration
These two components are managed by software compatible with Dr. Elmas's "Bio-Robotic Resonance" theory. Data from the sensor optimizes the pump's speed and pressure balance with millisecond precision, allowing the device to function like a "smart" artificial organ.

Dr. Emin Taner Elmas proposes "domestic production" focused strategies to reduce the cost of portable dialysis machines and decrease dependence on foreign sources. The main goal of these strategies is to minimize the total cost of the system by replacing expensive imported components with local engineering solutions: [1-70].

- **Replacement of Imported Components:** While the prices of hemodialysis machines sold in Türkiye range between (10,000) and (20,000) dollars, it is predicted that the production cost of a domestic device can be reduced to approximately (2,000) dollars. Elmas advocates for closing this gap with domestic resources.
- **R&D and Process Innovation:** The domestic production strategy aims not only to localize parts but also to reduce dependence on foreign sources through R&D-based process innovations (e.g., more efficient water-based dust filters or the use of domestic raw materials).
- **Operating Cost Advantage with Smart Design:** Portable device design reduces the cost per treatment thanks to less maintenance support and lower dialysis fluid (dialysate) requirements. This provides an indirect cost advantage by reducing the need for hospital infrastructure.
- **Efficiency through Engineering Algorithms:** Using its own developed thermodynamic and fluid mechanics algorithms, Elmas prioritizes the use of original and domestic software infrastructure instead of complex foreign software that increases the hardware cost of the device.
- **SME Support and Industry Collaboration:** Supporting R&D-focused domestic firms and SMEs in the medical device sector is one of the main pillars of the domestic production strategy.

According to Dr. Elmas's vision, domestic production aims to transform the device from a product simply "assembled in Türkiye" into a technology with all its technical algorithms and critical hardware components, and intellectual property rights, locally owned. [1-70].

Conclusion
In Dr. Emin Taner Elmas' portable dialysis machine project, uninterrupted power and remote monitoring systems are central to the design, as the device is intended for "out-of-hospital" use. Here are the technical details of these two features: [1-70].

Battery Durability and Energy Management
The portable device is designed with high-density Lithium-Ion (Li-ion) battery technology to operate independently of the electrical grid:

- **Operating Time:** The device has the capacity to operate at full performance for 4 to 6 hours (during a standard dialysis session) on a single charge.
- **Backup Power Mode:** In the event of a power outage, the device switches to "critical mode". In this mode, high-energy consuming functions such as heating are optimized, providing additional time for the safe return of blood to the patient (reinfusion).
- **Charging Flexibility:** The batteries operate within a voltage range (12V/24V) that allows them to be charged not only from wall sockets but also from car cigarette lighter sockets or portable solar panels. This technically enables the patient's freedom of movement.

Remote Doctor Monitoring and IoT (Internet of Things)
Dr. Elmas's "smart device" vision in the project includes a digital network that ensures the patient remains safe even when alone at home:

- **Real-time Data Transfer:** Sensors on the device (blood pressure, flow rate, dialyzer efficiency, and air bubble status) send data to a cloud system via Wi-Fi or 4G/5G modules.
- **Doctor Panel:** The specialist doctor or dialysis center to which the patient is connected can monitor the progress of the session live via a special software.
- **Smart Alert System:** If the device's sensors detect a value outside the normal limits (e.g., excessively high venous pressure), the IoT system both alerts the patient audibly and simultaneously sends an emergency signal to the health center.
- **Telemedicine Integration:** The doctor can remotely intervene in the device's operating parameters (pump speed, etc.) or give a command to safely terminate the session if necessary. Technical Advantage. [1-70].

Dr. Elmas creates "smart energy maps" that minimize battery consumption using thermodynamic algorithms he developed himself in these systems. This allows the device to remain mobile for much longer than heavier models on the market. [1-70].

The production process of the portable dialysis machine designed by Dr. Emin Taner Elmas has a multi-stage engineering roadmap aiming for a transition from an academic prototype stage to industrial mass production. The production stages of the project include the following details:
Prototype Production (Current Status)
Dr. Elmas designed the first working example (Alpha Prototype) of the device by publishing his work under the title "Prototype Design, Production and Functioning...". In this stage:

- **3D Modeling:** The outer casing and internal component placement of the device were optimized using Computer-Aided Design (CAD) programs.
- **Material Selection:** Lightweight but biocompatible polymers and alloys were used for portability.

Component Supply and Assembly
Parts available on the production line and those requiring custom

manufacturing are separated:

- Standard Parts: Peristaltic pumps, LCD screens, and basic sensors can be sourced from existing industrial stocks.
- Custom Manufacturing (Elmas Modules): Special dialyzer heads and smart control boards designed by Dr. Elmas for thermodynamic efficiency constitute the unique manufacturing part of the project.

Software Integration

The control software, which is the "brain" of the device, is loaded onto the hardware during the production phase. This software:

- **Bio-Robotic Algorithms:** Processes data from sensors (pressure, air, flow rate) according to Elmas's resonance theory.
- **IoT Layer:** Communication protocols necessary for remote monitoring are embedded in the system.

Testing and Calibration (Critical Stage)

The following tests must be passed for each unit produced to be used in the medical field:

- **Hydraulic Leakage Tests:** It is verified that the blood and dialysate circuits do not leak under high pressure.
- **Failure Simulation:** It is measured whether the air bubble detector and battery management system respond correctly in different scenarios (power outage, etc.).

Mass Production and Certification (Future Goal)

The following steps are planned for the widespread adoption of the device:

- **ISO 13485:** Compliance with the medical device manufacturing quality management system.
- **CE Certificate and Clinical Approval:** Certificates obtained after clinical trials proving that the device can be used safely on humans.
- **Cost-Effective Production:** Dr. Elmas emphasizes that thanks to the simplicity of the design, this device can be produced much more cheaply than existing hospital-type machines. Dr. Elmas's project has high potential for commercialization through meetings with investors or university-industry collaboration [1-70].

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Asst.Prof. Dr. Emin Taner ELMAS is a Mechanical Engineer having degrees of B.Sc., M.Sc., Ph.D., and was born in Sivas in 1974. He completed his doctorate at Ege University, Graduate School of Natural and Applied Sciences, Mechanical Engineering Department, Thermodynamics Science Branch, and his master's degree at Dokuz Eylül University, Mechanical Engineering Department, Energy Science Branch. He also completed his undergraduate education at Hacettepe University, ZEF, Mechanical Engineering Department and graduated from the faculty with honors in 1995 and became a mechanical engineer. He was awarded a non-refundable scholarship by the Turkish Chamber of Mechanical Engineers in his 4th year because he was the most succesful student during his first 3 classes study at the faculty. He graduated from İzmir Atatürk High School in 1991.

Asst. Prof. Dr. ELMAS has completed his military service as a NATO Officer in Bosnia and Herzegovina. He was a "Reserved Officer" as a "2nd Lieutenant" as an "English-Turkish Interpreter". He was also a "Guard Commander" and served in Sarajevo, Camp Butmir within the SFOR task force of NATO. He has been awarded with 2 (two) NATO Medals and Turkish Armed Forces Service Certificate of Pride (Bosnia & Herzegovina).

In addition to his academic duties at universities, he has worked as an engineer and manager in various industrial institutions, organizations and companies; He has served as Construction Site Manager, Project Manager, Management Representative, Quality Manager, Production Manager, Energy Manager, CSO-CTO, CBDO, Factory Manager, Deputy General Manager and General Manager.

Asst. Prof. Dr. Elmas is Department Head and is an Assistant Professor of Automotive Technology at the Department of Motor Vehicles and Transportation Technologies at Vocational School of Higher Education for Technical Sciences at IGDIR UNIVERSITY, Turkey. He is also an Assistant Professor of Bioengineering & BioSciences at the same university. He has nearly 30 years of total experience in academia and in industry.

He has served as a scientific referee and panelist for ASME, TUBITAK and many scientific institutions, organizations and universities, including NASA.

He has published numerous international and national academic scientific articles, books, and book chapters, and serves as an editor for international academic journals. He also serves on the scientific committees of many international conferences, publishing conference and congress proceedings and giving presentations.

"Mechanical Engineering, Energy Transfer, Thermodynamics, Fluid Mechanics, Heat Transfer, Higher Mathematics, Evaporation, Heat Pipes, Space Sciences, Automotive, Bioengineering, Medical Engineering Applications, Neuroengineering, Medical Technique" are his academic and scientific fields of study; "Heating-Ventilation Air Conditioning Applications, Pressure Vessels, Heat Exchangers, Energy Efficiency, Steam Boilers, Power Plants, Cogeneration, Water Purification, Water Treatment, Industrial Equipment and Machinery, Welding Manufacturing, Sheet Metal Forming, Machining" are his industrial experience fields.

As of 2026, he has been awarded the Nobel Scientist Award by the international platform organization Scientific Laurels.

Asst. Prof. Dr. Emin Taner ELMAS is also a musician, saz (baglama) virtuoso player and ney (Nay, Turkish Reed Flute) performer. He plays also cümbüş instrument and performs darbuka, drum rhythm instruments. He has a YouTube Music Channel (Emin Taner ELMAS) which includes some of his sound recordings of him playing the saz-baglama and blowing the ney. He composed the poem written by the great poet Âşık Veysel ŞATIROĞLU under the name of "Raşit Bey" in memory of his father Judge (Hâkim) Raşit ELMAS as "Raşit Bey Türküsü", wrote it down, notated and published it as an academic article and broadcasted this song on his own music channel. He wrote the poems entitled "Canım Babam" and "Geldim Babam" which he wrote also in memory of his father and published in an academic literature journal, and composed instrumental musics for these poems. He also composed an instrumental song called "Annem Annem Türküsü" and gave it to his mother, Lawyer Tuna ELMAS, as a gift on Mother's Day, 11.05.2025. He also has a poem titled "Ney and Neyzen." He also wrote and presented a poem titled "Esra Kardeşim" to his sister, Esra ELMAS, an archaeologist and English teacher. He has published books including "Saz-Bağlama Tuning System Method" ("Saz- Bağlama Akort Sistemi Metodu") and "Ney and Neyzen; Ney's Pitches, Frets, Sound Stages, Octaves, Structure, Performance, Ney Maintenance and Basic Music Theory" (Ney ve Neyzen; Ney'de Perdeler, Ses Devreleri, Oktavlar, Yapısı, İcrası, Ney Bakımı ile Temel Musiki Nazariyatı) and My Collection of Literary and Musical Art Works – I Story / Anecdote / Essay / Poetry / Verse / Prose / Humorous; witty - satirical; poetic stories / Lyrics / Composition (Edebiyat ve Musiki Sanat Eserleri Külliyatım – I Hikâye / Anekdot / Deneme / Şiir / Manzume / Nesir /Mizahi; nükteli – hicivli; şiirsel hikâyeler / Güfte / Beste). He continues his artistic studies by writing various articles, books, poetry, lyrics and also realizing musical composition and repertoire works.

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