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REVIEW ARTICLE

IoT-Enhanced Agni Karma Device: Breakthrough in Agni Karma Parasurgical Procedure

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ABSTRACT
Heating therapy has been a cornerstone of medical treatments across cultures, with Ayurveda's Agni Karma being a well-established method for managing pain, inflammation, and musculoskeletal disorders. Despite its effectiveness, traditional Agni Karma procedures face challenges such as inconsistent temperature control, manual errors, and patient safety concerns. These limitations impact treatment precision and hinder its widespread adoption in modern healthcare. This study presents an IoT-enhanced Agni Karma device designed to address these issues through precise temperature regulation, real-time monitoring, and improved safety mechanisms. The device integrates high- accuracy temperature sensors, a microcontroller-based heating system, and web page for instant feedback, ensuring consistent and controlled heat application. Additionally, cloud-based data storage enhances documentation and tracking, facilitating a more standardized and reliable approach to Agni Karma therapy. By merging Ayurvedic wisdom with modern technology, this innovation enhances the precision, safety, and effectiveness of Agni Karma. The integration of automated monitoring and controlled heating not only reduces human error but also makes the therapy more accessible, standardized, and globally recognized as a reliable treatment method. A working IoT-based Agni Karma device was successfully developed and implemented in clinical settings. The device was effectively used on patients and multiple Agni Karma procedures were safely and accurately performed, demonstrating its clinical efficacy and operational reliability.
KEYWORD: *Agni Karma, IoT in Ayurveda, Para surgical Procedure, Temperature-Controlled Therapy, Real-time Monitoring, Ayurvedic Innovation*

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INTRODUCTION

Heat has long been employed as a therapeutic agent across diverse medical traditions worldwide. From the use of heated stones in ancient Egypt to thermotherapy in Greek medicine and moxibustion in Traditional Chinese Medicine, the healing potential of heat has been universally acknowledged. Among these systems, Ayurveda—the ancient Indian science of life—offers one of the most refined and systematized approaches to heat therapy through the specialized parasurgical procedure known as Agni Karma [1]. Agni Karma is described in the *Sushruta Samhita*, one of the foundational texts of Ayurveda. It involves the controlled application of heat to specific areas of the body for the management of musculoskeletal disorders, chronic pain, and various inflammatory conditions. The procedure is especially effective in treating conditions associated with imbalances in the Vata and Kapha doshas, which often present as joint stiffness, muscular pain, and neurological symptoms. Through the penetrating and warming qualities of Ushna Guna [2], Agni Karma helps restore dosha balance and alleviate these disorders effectively. Agni Karma is particularly effective in managing disorders arising from imbalances in the Vata and Kapha doshas, which commonly manifest as joint stiffness, muscular pain, and neurological disturbances. The procedure mitigates these symptoms by counteracting the cold and dry attributes of Vata, as well as the heavy and moist characteristics of Kapha, through the deep, penetrating, and warming action of heat—referred to in Ayurveda as Ushna Guna [3].

TRADITIONAL TECHNIQUES USED IN AGNI KARMA [4-6, 12]

Ayurvedic classical texts describe various techniques for performing Agni Karma, utilizing different heating materials based on the nature and severity of the disorder:

Pippali Shalaka: Heated metallic rods designed for deep tissue penetration in severe or chronic conditions.

Suvarna and Tamra Shalaka: Gold and copper rods employed for gentler, controlled heat application in moderate cases.

Guda (jaggery), Madhu (honey), and Sneha (medicated oils): These substances are used to deliver mild heating effects, particularly suitable for sensitive areas or delicate conditions. While effective, these traditional techniques demand continuous supervision and a high degree of precision, which are difficult to maintain manually, thus limiting their reliability and reproducibility in clinical settings.

Challenges in Traditional Agni Karma

Despite the therapeutic benefits of Agni Karma, its conventional application presents several limitations:

Lack of Temperature Control: Traditional methods rely on manually heating the Shalaka (metal rod), making it difficult to maintain a stable and safe temperature. This inconsistency can lead to either under-treatment or accidental burns.

Risk of Human Error: Manual handling of heated instruments increases the likelihood of temperature fluctuations, resulting in variable treatment outcomes.

Patient Safety Concerns: In the absence of real-time monitoring, it is challenging to ensure that heat is applied evenly and within a safe range, thereby elevating the risk of thermal injury or insufficient therapeutic effect.

Lack of Standardization: The Agni Karma procedure varies significantly among practitioners, making it difficult to achieve uniformity and reproducibility in treatment results.

Limited Documentation: There is no structured system to record treatment parameters, hindering the ability to monitor patient progress and refine procedural protocols over time.

INNOVATION: IOT-BASED AGNI KARMA DEVICE [12]

To modernize and enhance the Agni Karma procedure while preserving its therapeutic integrity, we successfully developed an IoT-integrated Agni Karma device that addressed the limitations inherent in traditional methods. The fully functional device incorporated the following features:

Precise Temperature Control: An advanced microcontroller-based system regulated the heating element to maintain a constant, safe, and therapeutically effective temperature throughout the procedure.

Real-Time Monitoring: A digital display provided live temperature feedback, allowing practitioners to observe and adjust thermal levels as necessary during treatment.

Uniform Heat Distribution: High-accuracy temperature sensors (PT100) ensured consistent and even heat application, reducing the risks of localized burns or inadequate heating.

Wireless and Portable Design: Unlike conventional systems, the device was designed to be cordless and lightweight, enhancing user convenience and procedural efficiency.

Cloud-Based Data Storage: Treatment parameters and session data were recorded via IoT connectivity, enabling longitudinal analysis, documentation, and enhanced procedural standardization.

Blending Tradition with Modern Technology

By integrating classical Ayurvedic principles with cutting-edge IoT-based precision engineering, the developed device retained the therapeutic value of Agni Karma while elevating its safety, reliability, and accessibility. This innovation successfully bridged the gap between ancient healing wisdom and contemporary clinical requirements, positioning Agni Karma as a more standardized, evidence-based, and globally adaptable treatment modality.

MATERIAL AND METHODS

The IoT-based Agni Karma device was developed by integrating precise temperature control, real-time monitoring, and automated safety mechanisms into the traditional Agni Karma procedure. The system was built using a Xiao C3 microcontroller, which controlled the heating element via a MOSFET driver circuit. The heating element's temperature was continuously measured by a high-accuracy temperature sensor, providing feedback to the microcontroller in real time.

Based on the sensor readings, the microcontroller dynamically adjusted the heating power to maintain the desired therapeutic temperature. The system also incorporated a digital display screen for live temperature readouts and included a safety cut-off mechanism, which immediately stopped heating if the temperature exceeded a predefined threshold.

The device was powered by a 3.7V rechargeable lithium battery with a charging module, allowing for portable and safe clinical use. Additionally, treatment parameters such as temperature logs and heating durations were transmitted to a cloud server via IoT connectivity, enabling systematic documentation and long-term patient tracking.
The methodology followed for the design, development, and implementation of the IoT-based Agni Karma device consisted of the following key steps:

SYSTEM DESIGN AND COMPONENT SELECTION [7, 8]
The following components were selected and configured for the device:
- **Microcontroller (Xiao C3)**
- Enabled precise control and IoT connectivity.
- Precise Temperature Control: Read sensor data in real-time and adjusted heating power output via PWM (Pulse Width Modulation) for stable and accurate heat delivery.
- IoT Connectivity: Utilized built-in Wi-Fi for cloud-based data logging and remote monitoring.
- System Monitoring and Display: Managed a digital display to continuously show temperature, treatment duration, and device status.
- Safety Management: Programmed with an automatic cut-off mechanism if temperature exceeded safety thresholds.

FIGURE 1 – Microcontroller (Xiao C3)
- **Heating Element:** Controlled via MOSFET for variable power delivery


FIGURE 2 – Heating Element
- **Power Source:** 3.7V rechargeable lithium battery with charging module


FIGURE 3 – Lithium Battery
- **Connectivity:** Optional cloud integration for data logging and tracking

- **MOSFET-based driver circuit** to control the heating element using PWM (Pulse Width Modulation) from the Xiao C3.

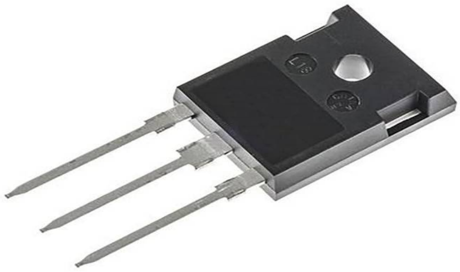

FIGURE 4: MOSFET-based driver circuit

Circuit Design and Hardware Integration

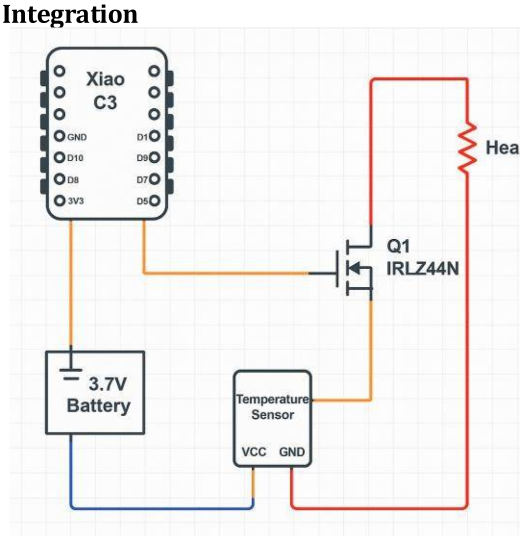

FIGURE 5 – Circuit Design

A **MOSFET-based driver circuit** was designed to control the heating element using PWM signals from the Xiao C3.

- The display module was connected to the microcontroller for real-time thermal readouts.
- The battery and charging module were configured to support safe and mobile usage of the device.

Software Development

The Xiao C3 microcontroller was programmed to:

- Continuously read data from the temperature sensor.
- Adjust the heating element based on feedback control (threshold or PID-based).
- Display real-time temperature and system status on-screen.
- Send session data to a cloud database using standard IoT protocols such as HTTP or MQTT.
- Implement a safety shutdown mechanism in the event of overheating.

IoT Cloud Integration

The device was successfully integrated with a **cloud server**, enabling:

- Storage of key parameters including:
  - Temperature logs
  - Heating durations
  - Session metadata
- Optional remote access for research, monitoring, and multi-device management.

Testing and Calibration

- The device was calibrated to ensure:
  - Accurate temperature measurement
  - Precise heat modulation
  - Effective safety mechanisms
- Multiple trial runs were conducted to validate temperature control, system stability, and response time.

Final Assembly and Validation

- All components were assembled into a compact, insulated, and ergonomic casing.
- The device was tested in simulated and supervised clinical scenarios.
- Its performance was validated against traditional Agni Karma practices, confirming its consistency, safety, and clinical reliability.

RESULTS

Device Functionality and IoT Integration

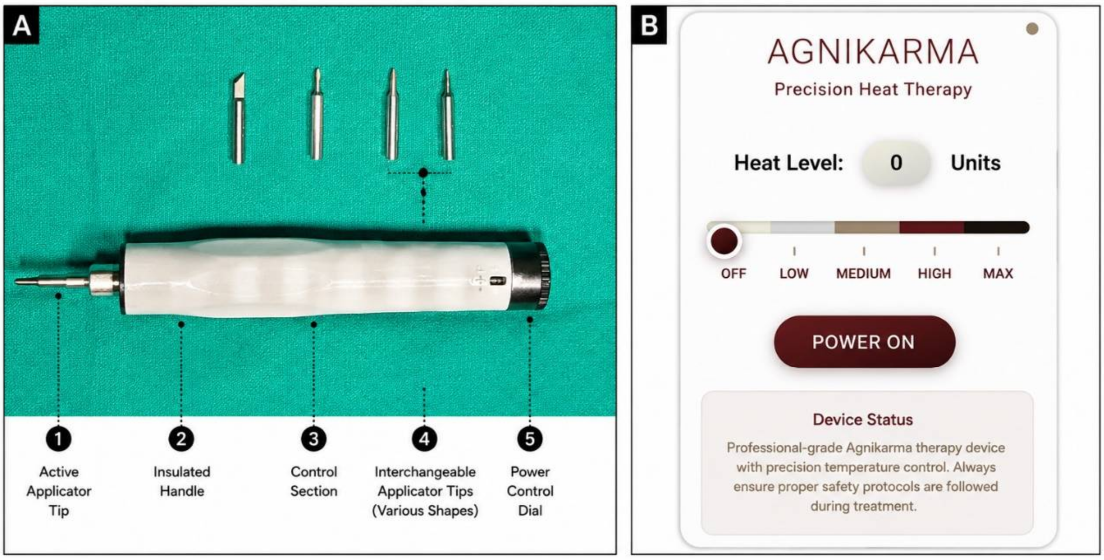

Figure 6. Agnikarma device and user interface.

(A) Handheld Agnikarma device with insulated body and active applicator tip. A set of interchangeable applicator tips of different shapes and sizes is shown, allowing adaptability to various clinical needs.

(B) Digital user interface showing adjustable heat levels from OFF to MAX, real-time heat level display, and power activation control to ensure precise and safe delivery of thermal therapy.

he image illustrates the graphical user interface of a modern Agnikarma device designed for precision heat therapy. The interface prominently displays the device title and operational mode, followed by a real-time digital readout of the heat level in standardized units. A horizontal slider control enables graded adjustment of thermal intensity across five levels: OFF, LOW, MEDIUM, HIGH, and MAX, allowing fine-tuned regulation based on clinical requirements [9].

A centrally positioned activation button facilitates controlled initiation of the procedure, enhancing operational safety. The lower section provides a device status panel, offering guidance on safe usage and emphasizing adherence to clinical safety protocols. The interface design prioritizes usability, clarity, and precise thermal control, supporting standardized and reproducible Agnikarma therapy in both clinical and research settings [10].

CLINICAL IMPLEMENTATION

The Agnikarma device was clinically implemented in patients presenting with musculoskeletal disorders, including Griva Sandhigata Vata (cervical spondylosis)**,** Katigraha (lumbar spondylosis)**, and** Sandhigata Vata (osteoarthritis). The device enabled precise, uniform, and controlled heat application, with the added capability of remote adjustment of thermal intensity, ensuring procedural consistency across cases [11].

The therapeutic intervention demonstrated a favorable safety profile, as no adverse events such as burns or tissue damage were observed during or after treatment. Clinically, patients reported significant symptomatic relief, including reduction in pain intensity, improvement in joint mobility and flexibility, and enhanced overall comfort during the procedure. These findings suggest that the device offers a reliable and standardized approach for Agnikarma therapy in contemporary clinical settings.

Web-Based Control Advantages:

The incorporation of a mobile and web-enabled interface substantially improved the functionality and user experience of the Agnikarma device. This digital platform provided clinicians with the ability to remotely manage and interact with the system in real time, including adjusting temperature settings, initiating or stopping heating cycles, monitoring treatment progression, and visualizing thermal data dynamically. Such capabilities allowed for accurate control over therapeutic parameters, thereby enhancing uniformity and reproducibility across different treatment sessions [19].

Furthermore, the system featured an integrated cloud-based data management framework, which automatically captured and stored all relevant treatment information, including temperature trends, session duration, and time-stamped records. This structured data storage supports systematic clinical evaluation, post-procedure review, and continuous optimization of treatment protocols. Additionally, the digital architecture establishes a scalable foundation for future incorporation of advanced analytical tools and intelligent decision-support systems, promoting data-driven and evidence-based clinical practice.

Ease of Use and Portability:

- The absence of physical controls or displays minimized hardware complexity.
- Cordless operation and remote access through mobile devices enabled use in **varied clinical setups**, including OPD, rural centres, and mobile clinics.

DISCUSSION

The conventional Agni Karma technique, although well-established and clinically effective, is inherently constrained by subjective temperature estimation, operator-dependent variability, and concerns related to safety and standardization. These limitations have historically impeded its integration into evidence-based medical systems and limited its broader global acceptance [12, 13].

The IoT-enabled Agni Karma device developed in the present study addresses these challenges by combining traditional Ayurvedic principles with contemporary engineering and digital technologies. The incorporation of a microcontroller integrated with IoT connectivity enables clinicians to remotely control and monitor the therapeutic process via a secure mobile or web-based interface. This system facilitates real-time temperature modulation, controlled initiation and termination of treatment sessions, and continuous procedural monitoring without reliance on onboard hardware displays.

Importantly, the device ensures precise thermal regulation, with continuous streaming and cloud-based storage of temperature data, thereby enabling accurate documentation, reproducibility, and retrospective clinical analysis. The transition from conventional manual controls to a fully web-based interface simplifies device architecture while improving usability, portability, and cost-efficiency—key factors for wider clinical adoption [15, 16].

Clinical application of the device in patients with musculoskeletal disorders, including Griva Sandhigata Vata (cervical spondylosis) and Katigraha (lumbar spondylosis), demonstrated favorable therapeutic outcomes. Patients reported significant pain relief, improved mobility, and enhanced comfort, with no observed adverse events. The presence of automated safety mechanisms, particularly those preventing overheating, further reinforces the reliability and clinical safety of the system.

By delivering a standardized, controllable, and data-driven approach to heat-based therapy, this innovation fulfills a critical requirement for modernization within Ayurvedic parasurgical practices. Moreover, the integration of digital health technologies positions the system for future advancements, including artificial intelligence-driven analytics and decision-support frameworks, thereby aligning traditional therapies with modern precision medicine paradigms [17, 18].

CONCLUSION

The IoT-enabled Agni Karma device successfully integrates traditional Ayurvedic therapy with modern digital technology, offering enhanced precision, safety, and efficiency. Its web-based remote control, real-time monitoring, and cloud data storage ensure standardized and reproducible treatment outcomes. Clinical use demonstrated effective pain relief and improved patient comfort without adverse effects. Overall, this innovation provides a reliable, scalable, and scientifically robust approach to modernizing Ayurvedic parasurgical practice and supports its wider global acceptance.

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