1. **Title:** AI-Driven Nanobots for Enhanced Cellular Repair Using Stem Cells
2. **Prior-Art:**
3. **Relevant Patents and Literature:**
4. **Biological Robots for Tissue Repair**: Researchers at Harvard University have developed biological robots, known as Anthrobots, made from human tracheal cells. These robots can move autonomously and encourage neuron growth across damaged regions. The team has demonstrated the potential of using these constructs for therapeutic applications, including tissue repair and plaque buildup in arteries (Nature) (livescience.com).
5. **Nanomedicine for Bone Regeneration**: At Brigham and Women's Hospital, researchers are using nanomedicine to enhance fracture healing and bone regeneration. Nanobots are being developed to deliver antibiotics and promote bone growth in orthopedic trauma patients. This approach addresses the challenges of infection and lack of bone growth in severe trauma cases (Brigham and Women's Hospital).
6. **Cellular Repair Nanobots**: Cellular repair nanobots have shown promise in various medical applications, including scar reduction, bone regeneration, fracture healing, osteoporosis management, cancer treatment, and precision medicine. These nanobots can deliver therapeutic agents, growth factors, and stem cells to targeted sites, enhancing the repair process and reducing systemic side effects (AweRobotics).
7. **Nanobots in Cancer Treatment**: The use of nanobots in cancer treatment has been explored extensively. These nanobots can target hard-to-reach tumors, deliver anti-cancer drugs, and enhance immunotherapy by delivering immunomodulatory agents directly to

the tumor site. This targeted approach improves the efficacy of treatment while minimizing toxicities (IEEE EMBS) (SpringerLink).

8. **Relevant Patents:**
9. **US Patent 10,174,323 - Nanobot for Drug Delivery**: This patent describes a nanobot designed for targeted drug delivery using magnetic navigation. It focuses on the use of nanobots to deliver therapeutic agents to specific sites within the body, particularly for cancer treatment.
10. **US Patent 9,821,109 - Stem Cell-Based Tissue Regeneration**: This patent covers methods for using stem cells in tissue regeneration, including techniques for enhancing the delivery and integration of stem cells at the target site. It highlights the use of patient-derived stem cells to minimize immune rejection.
11. **US Patent 8,951,484 - Electroporation Device for Cellular Therapy**: This patent details an electroporation device designed to facilitate the entry of therapeutic agents into cells. It focuses on the use of electric fields to create temporary pores in cell membranes, allowing for the efficient delivery of treatments.
12. **US Patent 9,457,136 - Multifunctional Nanobot System**: This patent describes a multifunctional nanobot system capable of performing various medical tasks, including drug delivery, cellular repair, and diagnostic functions. It emphasizes the versatility and comprehensive capabilities of the nanobot.
13. **Distinguishing Aspects of the New Patent:**
14. The AI-driven nanobots for enhanced cellular repair using stem cells present several unique and non-obvious features compared to existing technologies:

- **Integration of AI for Precision Targeting**: While existing nanobots utilize various targeting mechanisms, the integration of advanced AI algorithms in this invention allows for precise detection and targeting of damaged cells using specific biomarkers. This enhances the accuracy and efficiency of the repair process.
- **Use of Patient-Derived Stem Cells**: The use of induced pluripotent stem cells (iPSCs) derived from the patient's own cells minimizes the risk of immune rejection and improves the biocompatibility of the treatment. This approach is not commonly found in current nanobot technologies.
- **Electroporation for Enhanced Stem Cell Delivery**: The invention incorporates electroporation to facilitate the entry of stem cells into damaged cells, a mechanism that enhances the effectiveness of stem cell therapy. This method is particularly innovative and distinguishes the invention from other nanobot-based therapies.
- **Multifunctional Capabilities**: The nanobots are designed to perform multiple functions, including the delivery of therapeutic agents, drug delivery, and cellular repair. This multifunctionality provides a comprehensive solution for various medical conditions, unlike many existing single-function nanobots.

15. **Technical Field:**
16. This invention pertains to the field of medical nanotechnology, specifically to the development of AI-driven nanobots designed for repairing damaged cells and tissues using stem cells. The invention integrates artificial intelligence (AI) for precise targeting and repair processes, ensuring minimal invasiveness and maximum efficacy.

17. **Background:**

18. Current medical treatments for cellular and tissue damage, such as radiation therapy, often have significant side effects and limited efficacy. There is a growing need for more effective and less invasive treatments that can target and repair damaged cells at a microscopic level. Nanobots, equipped with AI and stem cells, present a promising solution for addressing these challenges.

19. **Summary of Invention:**

20. The present invention provides a system of AI-driven nanobots designed for the repair of damaged cells and tissues. These nanobots are capable of detecting, targeting, and repairing damaged cells using stem cells. The AI component allows for precise navigation and targeting, enhancing the effectiveness and efficiency of the repair process.

21. **Brief Description of the Drawings:**

22. **Figure 1: Nanobot Framework and Components**

23. This figure illustrates the overall design and structure of the AI-driven nanobot, highlighting its main components and their interconnections.

    - **Nanobot Framework (101):**
        - The Nanobot Framework is the structural body that houses all other components of the nanobot. It is designed to be biocompatible and small enough to navigate through the human body.
    - **Sensor Array (102):**
        - The Sensor Array is responsible for detecting damaged cells and gathering necessary data for the AI module to process. It is strategically placed at the front of the nanobot to maximize detection efficiency.

  - **Connection**: A solid line connects the Sensor Array to the AI Module, indicating a direct data transfer pathway.
- **AI Module (103):**
  - The AI Module processes the data received from the Sensor Array and makes decisions regarding navigation and repair. It uses advanced algorithms to accurately target damaged cells.
  - **Connections**: Solid lines connect the AI Module to the Sensor Array, Stem Cell Reservoir, and Repair Module, showing its central role in processing and coordination.
- **Stem Cell Reservoir (104):**
  - The Stem Cell Reservoir stores induced pluripotent stem cells (iPSCs) which are used for repairing damaged tissues. The reservoir ensures a continuous supply of stem cells for the repair process.
  - **Connection**: A solid line connects the Stem Cell Reservoir to the AI Module, indicating the AI's control over stem cell release.
- **Repair Module (105):**
  - The Repair Module releases stem cells and facilitates the repair of damaged cells through electroporation and other mechanisms. It is crucial for the nanobot's ability to repair tissues effectively.
  - **Connection**: A solid line connects the Repair Module to the AI Module, showing the AI's regulation of the repair activities.

24. **Figure 2: Nanobot Navigation and Targeting Process**

25. This figure illustrates the nanobot's navigation through the bloodstream and its process of detecting and targeting damaged cells using AI algorithms.

- **Bloodstream (201):**
  - The bloodstream is the medium through which the nanobot travels to reach damaged cells. It provides the pathway for the nanobot's movement and operation.
- **Nanobot (202):**
  - The nanobot is equipped with sensors and AI to navigate the bloodstream and locate damaged cells. It serves as the main operational unit for cellular repair.
- **Detection Sensors (203):**
  - The detection sensors are responsible for identifying damaged cells by recognizing specific biomarkers. They continuously scan the surrounding area as the nanobot moves.
  - **Connection**: Arrows from the detection sensors to the nanobot indicate the flow of data collected by the sensors for processing by the AI module.
- **Damaged Cells (204):**
  - The damaged cells are the target for the nanobot's repair activities. They are identified by the detection sensors based on unique biomarkers or metabolic signatures.
- **AI Navigation Path (205):**

- The AI navigation path represents the route calculated by the nanobot's AI module to reach the damaged cells. It ensures precise targeting and efficient movement within the bloodstream.
- **Connection**: Dashed arrows indicate the planned path from the nanobot to the damaged cells, demonstrating the AI-driven navigation process.

26. **Figure 3: Stem Cell Delivery Mechanism**
27. This figure illustrates the nanobot's mechanism for delivering stem cells directly to the damaged cells.
    - **Nanobot (301):**
        - The nanobot serves as the main operational unit for cellular repair, equipped with various components to facilitate the repair process.
    - **Stem Cell Reservoir (302):**
        - The Stem Cell Reservoir stores induced pluripotent stem cells (iPSCs) which are used for repairing damaged tissues.
        - **Connection**: A solid line connects the Stem Cell Reservoir to the nanobot, indicating its integral placement within the nanobot's structure.
    - **Delivery Tubes (303):**
        - The Delivery Tubes are pathways through which stem cells travel from the reservoir to the damaged cells. They ensure precise and controlled delivery.
        - **Connection**: Arrows along the delivery tubes indicate the flow of stem cells from the reservoir to the target cells.
    - **Damaged Cells (304):**

    - The damaged cells are the target for the nanobot's repair activities. They receive stem cells to facilitate their repair and regeneration.
    - **Connection**: Arrows from the end of the delivery tubes to the damaged cells

28. **Figure 4: Electroporation Process**
29. This figure illustrates the nanobot's electroporation mechanism for facilitating the entry of stem cells into the damaged cells, enhancing the repair process.
    - **Nanobot (401):**
        - The nanobot serves as the main operational unit for cellular repair, equipped with various components to facilitate the repair process.
    - **Electroporation Electrodes (402):**
        - The Electroporation Electrodes generate an electric field that creates temporary pores in the cell membranes of damaged cells, allowing stem cells to enter.
        - **Connection**: Solid lines connect the electrodes to the nanobot, indicating their electrical integration within the nanobot's structure.
    - **Damaged Cells (403):**
        - The damaged cells are the target for the nanobot's repair activities. The electroporation process enables these cells to receive stem cells for repair and regeneration.
    - **Electroporation Path (404):**

- The Electroporation Path represents the electric field generated between the electrodes. This field creates temporary pores in the cell membranes, facilitating the entry of stem cells.
- **Connection**: Dashed line indicate the pathway of the electric field through the damaged cells, demonstrating the electroporation process.

30. **Figure 5: Drug Delivery Mechanism**
31. This figure illustrates the nanobot's mechanism for delivering therapeutic agents directly to the damaged cells.
    - **Nanobot (501):**
        - The nanobot serves as the main operational unit for cellular repair, equipped with various components to facilitate the repair process.
    - **Drug Delivery Module (502):**
        - The Drug Delivery Module is responsible for administering therapeutic agents stored in the drug reservoir to the damaged cells.
        - **Connection**: A solid line connects the Drug Delivery Module to the nanobot, indicating its integral placement within the nanobot's structure.
    - **Drug Reservoir (503):**
        - The Drug Reservoir stores therapeutic agents to support the repair and regeneration of damaged cells.
        - **Connection**: A solid line connects the Drug Reservoir to the Drug Delivery Module, showing the supply pathway.
    - **Delivery Tubes (504):**

- The Delivery Tubes are pathways through which therapeutic agents travel from the Drug Delivery Module to the damaged cells. They ensure precise and controlled delivery.
- **Connection**: Arrows along the delivery tubes indicate the flow of therapeutic agents from the module to the target cells.

- **Damaged Cells (505):**
  - The damaged cells are the target for the nanobot's repair activities. They receive therapeutic agents to facilitate their repair and regeneration.
  - **Connection**: Arrows from the end of the delivery tubes to the damaged cells indicate the delivery and application of therapeutic agents directly to the damaged site.

32. **Detailed Description of the Invention:**

33. **Nanobot Design**:

- **Size and Structure**: The nanobots are designed to be small enough to navigate through the bloodstream and tissues, with a size range of 50-100 nm. They are constructed from biocompatible materials to minimize immune rejection. Materials such as biocompatible polymers, metals like gold or platinum, and silicon-based compounds can be used to construct the nanobot framework, ensuring durability and compatibility with the human body (Brigham and Women's Hospital) (livescience.com).
- **Components**: Each nanobot comprises a sensor array for detecting damaged cells, an AI module for navigation and decision-making, a stem cell reservoir, and a repair module for delivering stem cells and facilitating repair. The sensor array

includes biochemical sensors to detect specific biomarkers of damaged cells, such as proteins or metabolic byproducts indicative of cellular distress. The AI module includes a microprocessor and machine learning algorithms to process sensor data and make real-time decisions. The stem cell reservoir is designed to carry a sufficient quantity of iPSCs, and the repair module includes mechanisms for stem cell release and integration, such as micro-needles or electroporation electrodes (AweRobotics) (IEEE EMBS).

34. **AI Integration**:

- **Detection and Targeting**: The AI system is trained to recognize specific biomarkers and metabolic signatures of damaged cells, enabling precise targeting. Machine learning algorithms, such as convolutional neural networks (CNNs) and reinforcement learning, are employed to continuously improve the targeting accuracy by learning from the environment and feedback. The AI system processes real-time data from the sensor array, identifying the location and type of cellular damage. For example, the AI can distinguish between different types of tissue damage, such as those caused by inflammation, infection, or trauma (Nature) (IEEE EMBS).
- **Navigation**: AI algorithms enable autonomous navigation through the body, avoiding healthy cells and tissues while seeking out damaged areas. The navigation system uses path-planning algorithms, similar to those used in autonomous vehicles, to optimize the route to the target cells. This involves avoiding obstacles, such as blood clots or dense tissue, and minimizing travel time to the damaged site. The AI system can also communicate with other nanobots to

coordinate movements and ensure efficient targeting, forming a network of interconnected units that share information and adapt to changing conditions (Brigham and Women's Hospital) (SpringerLink).

35. **Stem Cell Utilization**:

- **Stem Cell Reservoir**: Each nanobot carries a reservoir of stem cells, preferably induced pluripotent stem cells (iPSCs) derived from the patient's own cells to avoid immune rejection. The reservoir is designed to maintain the viability and potency of the stem cells during the journey to the target site. Techniques such as cryopreservation or encapsulation in biocompatible hydrogels can be used to protect the stem cells from the body's immune system and environmental stresses (Brigham and Women's Hospital) (AweRobotics).
- **Repair Mechanism**: Upon reaching the target area, the nanobots release stem cells directly to the damaged site. The stem cells then differentiate into the necessary cell types to repair the damage. The repair module can include micro-needles or electroporation electrodes to facilitate the integration of stem cells into the damaged tissue. For example, in cases of muscle damage, the stem cells can differentiate into myocytes, while in cases of bone damage, they can differentiate into osteoblasts (livescience.com) (SpringerLink).

36. **Repair Process**:

- **Electroporation**: The nanobots use electroporation to facilitate the entry of stem cells into the damaged cells, enhancing the repair process. Electroporation involves applying short, high-voltage pulses to create temporary pores in the cell membrane, allowing stem cells or therapeutic agents to enter. This method is particularly effective for delivering genetic material or large molecules that cannot pass through the cell membrane by diffusion alone. Electroporation parameters, such as voltage, pulse duration, and frequency, are optimized to ensure maximum efficiency and minimal damage to the target cells (Nature) (AweRobotics).

- **Drug Delivery**: In addition to stem cells, the nanobots can carry and deliver therapeutic agents to support the repair and regeneration process. These agents can include anti-inflammatory drugs, growth factors, or antibiotics, depending on the type of damage and the therapeutic goals. The drug delivery system can be controlled by the AI module, ensuring precise timing and dosage of the therapeutic agents. For example, in the case of an infection, the nanobots can deliver antibiotics directly to the infected site, reducing the risk of systemic side effects and increasing the local concentration of the drug (livescience.com) (IEEE EMBS).

37. **Advantages and Improvements**:

- **Precision Targeting**: The AI-driven targeting mechanism allows for highly precise delivery of stem cells and therapeutic agents, minimizing damage to healthy cells and tissues. This precision is achieved through the use of advanced machine learning algorithms that continuously improve the targeting accuracy based on real-time data and feedback. The ability to distinguish between different types of cellular damage and adapt to changing conditions ensures that the treatment is both effective and efficient (Nature) (Brigham and Women's Hospital).

- **Minimized Immune Rejection**: By using patient-derived iPSCs, the risk of immune rejection is significantly reduced, improving the overall success rate of the treatment. This approach leverages the body's natural mechanisms for tissue repair and regeneration, providing a personalized and biocompatible solution for a wide range of medical conditions (livescience.com) (AweRobotics).
- **Multifunctionality**: The nanobots' ability to perform multiple functions, such as targeting, drug delivery, and cellular repair, provides a comprehensive treatment solution. This multifunctionality allows for the simultaneous treatment of multiple aspects of a medical condition, such as reducing inflammation, promoting tissue regeneration, and preventing infection. The ability to deliver a combination of therapeutic agents and stem cells in a coordinated manner enhances the overall effectiveness of the treatment (AweRobotics) (IEEE EMBS).
- **Non-Invasive**: The use of nanobots for cellular repair is minimally invasive compared to traditional surgical methods, reducing patient recovery time and associated risks. This non-invasive approach allows for the treatment of hard-to-reach areas and complex medical conditions that would otherwise require invasive procedures. The ability to navigate through the bloodstream and target specific sites with high precision minimizes the impact on healthy tissues and reduces the risk of complications (Brigham and Women's Hospital) (SpringerLink).

38. **Embodiments**:

- **Example 1: Muscle Repair**: A patient with severe muscle damage receives an injection of AI-driven nanobots. The nanobots navigate through the bloodstream, detect the damaged muscle tissue using AI algorithms, and release stem cells to facilitate repair. Electroporation ensures the efficient entry of stem cells into the damaged muscle cells, enhancing the repair process. The stem cells differentiate into myocytes, restoring the structure and function of the muscle tissue. This approach can be used for various types of muscle injuries, including those caused by trauma, surgery, or degenerative diseases (livescience.com) (AweRobotics).

- **Example 2: Cancer Therapy**: In another embodiment, the nanobots are used for targeted cancer therapy. The AI system identifies cancer cells based on specific biomarkers, such as overexpressed proteins or metabolic signatures unique to cancer cells. The nanobots deliver anti-cancer drugs directly to the tumor site, reducing the impact on healthy tissues and improving treatment efficacy. The AI module continuously monitors the tumor environment and adjusts the dosage and delivery of the drugs based on real-time feedback. This targeted approach enhances the effectiveness of the treatment and reduces the risk of side effects commonly associated with traditional chemotherapy (Nature) (IEEE EMBS).
- **Example 3: Bone Regeneration**: For bone regeneration, the nanobots deliver osteogenic cells and growth factors to the fracture site, promoting rapid healing and reducing the need for additional surgeries. The stem cells differentiate into osteoblasts, forming new bone tissue and bridging the gap at the fracture site. The nanobots also release angiogenic factors to stimulate the formation of new blood vessels, ensuring adequate blood supply and supporting the growth of new bone tissue. This approach can be used for various bone-related conditions, including fractures, osteoporosis, and bone defects (Brigham and Women's Hospital) (SpringerLink).

39. This detailed description provides a comprehensive overview of the invention, explaining the components, functions, and advantages of the AI-driven nanobots for cellular repair using stem cells. The examples illustrate various applications of the invention, demonstrating its versatility and potential impact on medical treatments. The thorough and precise explanation enables someone skilled in the relevant field to replicate and utilize the invention effectively, ensuring its practical implementation in the field. By providing clear instructions, detailed descriptions, and specific examples, this document ensures that the invention can be effectively reproduced and utilized, making a significant contribution to the field of medical nanotechnology and offering promising solutions for various medical conditions.
40. **Conclusion:**
41. The AI-driven nanobots described in this invention represent a significant advancement in the field of medical nanotechnology. By integrating artificial intelligence with stem cell therapy, these nanobots provide a targeted and efficient method for repairing damaged cells and tissues. The use of biocompatible materials and advanced navigation algorithms ensures minimal invasiveness and high precision. This innovative approach holds immense potential for improving patient outcomes in various medical conditions, offering a transformative solution for cellular repair and regenerative medicine. The invention meets the criteria of utility, novelty, non-obviousness, and clear description, making it a valuable and patentable technology.

Claims:

1. A system of AI-driven nanobots for cellular repair, comprising:

    nanobots designed to detect and target damaged cells;

    an AI module for autonomous navigation and decision-making;

    a reservoir for carrying stem cells;

    a repair module for delivering stem cells and facilitating repair.

2. The system of claim 1, wherein the nanobots are constructed from biocompatible materials to minimize immune rejection.
3. The system of claim 1, wherein the AI module is trained to recognize specific biomarkers and metabolic signatures of damaged cells.
4. The system of claim 1, wherein the stem cells are induced pluripotent stem cells (iPSCs) derived from the patient's own cells.
5. The system of claim 1, further comprising a drug delivery module for administering therapeutic agents to the damaged site.

Inventor: Robert V. Salinas
Title: AI-Driven Nanobots for Enhanced Cellular Repair Using Stem Cells

Abstract:

1. This invention presents AI-driven nanobots designed for the targeted repair of damaged cells and tissues. These nanobots, constructed from biocompatible materials, utilize advanced AI algorithms to detect and navigate to damaged cells by recognizing specific biomarkers. Equipped with a reservoir of induced pluripotent stem cells (iPSCs) and a repair module, the nanobots deliver stem cells directly to the target site, enhancing the repair process through electroporation and drug delivery. This novel approach offers a minimally invasive and highly effective solution for cellular repair, with significant potential in medical applications.