**Graduation Project Proposal**

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| **Project Information** | | |
| **Project Title** | **Department/Faculty/University** | **Project Field/Discipline** |
| Agri Lens | Computer Science/ Faculty of Computer and Information Sciences/ Mansoura University | Artificial Intelligence (AI), Agriculture, Robotics |
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| **Motivation** |
| **Please write why you chose this project idea, explaining clearly the problem that the project is addressing** |
| This project was chosen to address specific agricultural challenges faced in Egypt, including:   1. **Late Detection of Plant Diseases**: In Egypt, plant diseases often go undetected until they spread, leading to significant crop losses. This project uses AI-powered disease detection through a smart camera system to ensure early identification and intervention. 2. **Inefficient Resource Usage**: Over-irrigation and excessive use of fertilizers are common, contributing to water wastage and soil degradation. The project's precise irrigation system and environmental sensors optimize resource use, reducing waste and increasing sustainability. 3. **Lack of Accessible Smart Farming Solutions**: Advanced agricultural technologies are often costly or inaccessible for small and medium-scale farmers in Egypt. This modular and cost-effective system provides a practical and affordable entry point to smart farming. 4. **Desertification and Agricultural Land Loss**: Egypt faces increasing desertification, limiting arable land and threatening food security. This project promotes controlled-environment agriculture, enabling farming in non-arable areas by creating self-contained systems that mitigate land loss. 5. **Lack of Automation in Farming**: Egyptian agriculture heavily relies on manual labor, which can be inefficient and error-prone. The integration of automated disease detection, irrigation, and environmental control in this project addresses this gap, enhancing productivity and reducing dependency on human intervention. 6. **Scalability for Large-Scale Farming**: Current solutions often lack scalability for broader applications. This project starts with a small-scale 3×1 box but is designed to be expandable for large-scale farming, making it adaptable to Egypt’s needs for mass agricultural production. |
| **Why do you think your project should be funded? for which the applicants write in a few lines where the help statement should be “Explain in no more than 3 lines the new and innovative aspects in your project that make it worthy of funding.”** |
| **Our project introduces a cost-effective, scalable, and modular smart farming system tailored to address Egypt's agricultural challenges, including early disease detection, optimized resource usage, and farming in desertified areas. By combining AI-powered automation, precise irrigation, and environmental control, it offers an innovative solution to enhance productivity and sustainability in agriculture. This accessible system empowers farmers while promoting eco-friendly practices.** |
| **Block Diagram** |
| **Please insert the project detailed block diagram below, (Please highlight the parts that will be implemented in different colors than the parts that will be purchased)** |
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| **Prototype Description and Specifications** |
| **Please note that ITAC only funds projects that result in a prototype. Include a clear description of how the prototype will operate, explaining a scenario/use case of the operation. Also include the performance metrics you target in the prototype.** |
| **The proposed prototype aims to address several critical agricultural challenges in Egypt through the integration of smart farming technologies. The prototype will consist of a modular, scalable system designed to help detect plant diseases, optimize resource use, and automate farming processes, contributing to improved crop yield and sustainability.**  **Key Components:**   1. **Smart Camera System for Disease Detection:**    * **Technology: AI-powered image recognition.**    * **Function: Detects early signs of plant diseases by analyzing images captured by cameras placed in the agricultural area.**    * **Scenario: The camera takes periodic images of the plants and processes them through a machine learning model to detect any visible signs of diseases or pests. If an issue is detected, an alert is sent to the farmer for immediate intervention.**    * **Performance Metrics: 95% detection accuracy, with a processing time of 5 minutes per image.** 2. **Precision Irrigation System:**    * **Technology: Automated irrigation controlled by environmental sensors (soil moisture, temperature, humidity).**    * **Function: Optimizes water usage by only irrigating when necessary, reducing water wastage.**    * **Scenario: Based on real-time data from the soil moisture sensors, the system activates irrigation only in areas where moisture levels fall below a pre-set threshold.**    * **Performance Metrics: 30% reduction in water usage compared to conventional irrigation systems.**   **3. Environmental Control and Fertilizer Optimization:**   * **Technology: Environmental sensors and automated fertilizer dispensing system.** * **Function: Monitors environmental conditions (e.g., temperature, humidity) and adjusts fertilizer application based on crop requirements.** * **Scenario: The system will gather data on temperature, humidity, and soil nutrients to identify trends and optimize fertilizer usage. The system will not automatically adjust fertilizer levels but will provide data that will later be analyzed for trends and patterns.** * **Data Collected: Temperature, humidity, soil moisture, and nutrient levels.** * **Use for Future Analysis: The data collected will be analyzed later to evaluate the correlation between environmental factors and optimal fertilizer usage, allowing for more accurate future recommendations.**   **4. Controlled-Environment Agriculture Box (3×1 unit):**   * **Technology: Modular self-contained system featuring controlled climate, automated irrigation, and disease detection.** * **Function: Provides a controlled environment for plants, enabling farming in desertified or non-arable areas.** * **Scenario: The prototype will operate in a 3×1 meter area, with sensors collecting data on key environmental factors (e.g., temperature, light intensity, humidity). The system does not adjust these factors automatically but provides data for later analysis.** * **Data Collected: Temperature, humidity, light intensity, soil moisture, and crop growth parameters.** * **Use for Future Analysis: The collected data will be analyzed to identify patterns that optimize crop growth in non-arable conditions, helping to refine controlled-environment strategies for larger-scale applications.**   **5. Automation of Manual Farming Tasks:**   * **Technology: Robotics and AI systems for monitoring and control.** * **Function: Automates key tasks such as disease detection, irrigation, and environmental control, reducing reliance on human labor.** * **Scenario: Automated sensors monitor the crop growth and environmental factors. When necessary, the system adjusts conditions or alerts the operator for manual intervention.** * **Performance Metrics: 50% reduction in manual labor requirements, with 10% improvement in overall productivity.** |
| **Project Plan** |
| **Please define the approach and phases to deliver the intended project outcome.** |
| **Phase 1: Planning and Requirement Gathering**  **Objective: Define the project scope, gather requirements, and plan the design.**   1. **Task 1: Define Project Scope**    * **Identify the purpose and goals of the vertical farming system.**    * **Outline the functional requirements: sensors, actuators, camera system, and automation features.**    * **List non-functional requirements: scalability, power efficiency, and modularity.** 2. **Task 2: Research and Feasibility Study**    * **Research sensor specifications (pH, moisture, NPK, humidity, and temperature).**    * **Research the movement system for the NPK sensor and camera.**    * **Review disease detection techniques using a camera system (e.g., image processing or machine learning).** 3. **Task 3: Create a High-Level Architecture**    * **Draft a block diagram for the system, highlighting major components and their interconnections.**    * **Decide on microcontroller/processor (e.g., Arduino, Raspberry Pi) based on computational needs.** 4. **Deliverables:**    * **Project requirement document.**    * **High-level architecture diagram.**    * **Component list and budget estimation.**   **Phase 2: System Design**  **Objective: Create detailed designs for both hardware and software components.**   1. **Task 1: Hardware Design**    * **Design the sensor placement layout (pH, moisture, humidity, and temperature sensors in fixed positions).**    * **Design the movement system for the NPK sensor and camera (e.g., servo motor or stepper motor with rail systems).** 2. **Task 2: Circuit Design**    * **Use Proteus to create a schematic diagram.**    * **Include power supply circuits, sensor connections, motor driver circuits, and a microcontroller.**    * **Simulate the circuit to ensure functionality.** 3. **Task 3: Software Design**    * **Develop a flowchart for system operation, including:**      + **Data acquisition from sensors.**      + **Movement system control.**      + **Disease detection using the camera.**    * **Outline data logging and processing requirements.**    * **Define communication protocols (e.g., I2C, UART, or SPI).** 4. **Deliverables:**    * **Finalized circuit schematic.**    * **Movement system design and control algorithm.**    * **Software design document.**   **Phase 3: Prototyping and Simulation**  **Objective: Build a working prototype and validate the design.**   1. **Task 1: Prototype the Circuit**    * **Assemble the circuit on a breadboard or test rig based on the Proteus schematic.**    * **Test individual components (e.g., sensors, motors) for expected performance.** 2. **Task 2: Simulate in Proteus**    * **Simulate the entire circuit, including sensor inputs, motor movement, and microcontroller logic.**    * **Debug any issues in the design or logic.** 3. **Task 3: Test Movement System**    * **Build a basic mockup of the rail system for the NPK sensor and camera.**    * **Test precision, speed, and reliability of the movement system.** 4. **Deliverables:**    * **Functional prototype (circuit + movement system).**    * **Simulation results and debugging logs.**   **Phase 4: PCB Design and Fabrication**  **Objective: Design and fabricate a compact and robust PCB for the system.**   1. **Task 1: Design the PCB**    * **Transfer the Proteus schematic to the ARES PCB layout tool.**    * **Optimize component placement and trace routing.**    * **Add mounting holes and headers for sensors and actuators.** 2. **Task 2: Fabricate the PCB**    * **Generate Gerber files and send them to a PCB manufacturer.**    * **Receive and inspect the fabricated PCB for quality.** 3. **Deliverables:**    * **PCB layout design.**    * **Manufactured PCB ready for assembly.**   **Phase 5: System Integration**  **Objective: Assemble all components and integrate hardware with software.**   1. **Task 1: Assemble the System**    * **Mount sensors, actuators, and PCB onto the physical box.**    * **Connect the movement system to the NPK sensor and camera.** 2. **Task 2: Implement and Test Software**    * **Write the microcontroller code to acquire sensor data, control the movement system, and log readings.**    * **Test the system for each functionality:**      + **Sensor data acquisition.**      + **Motor control and positioning.**      + **Disease detection using the camera.** 3. **Task 3: Test the Entire System**    * **Conduct end-to-end tests for all functionalities:**      + **Hourly data collection.**      + **Movement system operation.**      + **Camera-based disease detection.** 4. **Deliverables:**    * **Fully integrated system.**    * **Test results and performance reports.**   **Phase 6: Deployment and Evaluation**  **Objective: Deploy the system and evaluate its performance in a controlled environment.**   1. **Task 1: Deploy in a Test Environment**    * **Place the vertical farming box in a suitable environment for testing (e.g., indoors or a greenhouse).**    * **Monitor real-time performance over a set period (e.g., 1-2 weeks).** 2. **Task 2: Evaluate System Performance**    * **Analyze the accuracy and reliability of sensor data.**    * **Evaluate the movement system's precision and efficiency.**    * **Assess the disease detection system's accuracy (if using image processing).** 3. **Task 3: Gather Feedback**    * **Identify areas for improvement (e.g., sensor calibration, software optimization).**    * **Incorporate feedback for future iterations.** 4. **Deliverables:**    * **Deployment report with performance evaluation.**    * **Recommendations for optimization.**   **Phase 7: Documentation and Handover**  **Objective: Finalize documentation and prepare for scaling or further development.**   1. **Task 1: Create System Documentation**    * **Document hardware connections, software code, and user instructions.**    * **Include troubleshooting guides for common issues.** 2. **Task 2: Prepare for Handover or Scaling**    * **Train users or stakeholders to operate the system.**    * **Explore scalability options (e.g., expanding to more plants or automating additional tasks).** 3. **Deliverables:**    * **Comprehensive system documentation.**    * **Final project report.**    * **System ready for scaling or further development.** |
| **Prototype Prospects** |
| **List the Egyptian ICT companies that may be interested in the developed prototype and the end-users/customers (name the specific class of individuals, governmental agencies, ministries … etc. that will benefit from the prototype)** |
| **List of ICT Companies:**   1. **ITIDA (Information Technology Industry Development Agency)**    * **A government entity supporting innovative ICT projects and fostering startups in Egypt.** 2. **Valeo Egypt**    * **Known for its expertise in AI, IoT, and smart systems development.** 3. **Systel Telecom**    * **Specializes in communications, IoT solutions, and automation, which align with smart agriculture needs.** 4. **Si-Ware Systems**    * **Focuses on sensor technologies, which could be useful for refining and scaling the developed prototype.** 5. **RDI (Research & Development International)**    * **An Egyptian ICT company active in AI, machine learning, and data analytics solutions.** 6. **eFinance**    * **Specializes in digital transformation and could support financial solutions for integrating the prototype into the market.** 7. **Vodafone Egypt**    * **Offers IoT and smart solutions, which could help in scaling and connecting the vertical farming prototype.** 8. **Orange Digital Ventures Egypt**    * **Interested in supporting innovative tech solutions, particularly those with IoT and smart agriculture applications.** 9. **NTRA (National Telecom Regulatory Authority)**    * **Focused on innovative IoT projects that integrate smart devices with national ICT infrastructure.** 10. **CIT Mobiles**     * **Provides technology solutions for IoT systems and could support sensor and data integration.**   **Potential End-Users/ Consumers:**   1. **Agricultural Ministries and Governmental Agencies**    * **Ministry of Agriculture and Land Reclamation (Egypt): Interested in smart farming to improve crop yield and resource management.**    * **Ministry of Water Resources and Irrigation: Could use the prototype to optimize water use in farming.** 2. **Farmers and Agricultural Cooperatives**    * **Smallholder farmers looking to optimize crop production.**    * **Large-scale farm owners focused on precision agriculture.** 3. **Agri-Tech Startups**    * **Startups in precision farming and smart agriculture can integrate the prototype into their solutions.** 4. **Universities and Research Institutes**    * **Faculties of agriculture, engineering, and technology may adopt the prototype for research and educational purposes.** 5. **Export-Oriented Agricultural Companies**    * **Businesses looking to ensure high-quality produce for export markets may adopt the solution for resource optimization.** 6. **Food Security and Sustainability Organizations**    * **NGOs or organizations working on food security and environmental sustainability initiatives.** 7. **Smart City Initiatives**    * **Projects focused on integrating vertical farming solutions within urban areas.** 8. **Greenhouse Operators**    * **Companies operating in controlled farming environments to improve plant monitoring and disease detection.** 9. **Environmental Ministries and Agencies**    * **Entities focused on developing eco-friendly and sustainable farming technologies.** 10. **International Development Agencies**     * **Organizations like USAID or UNDP supporting agricultural innovation in Egypt.** |