| Program Profile | | |
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| Program | Program name | An Ensemble Machine Learning Approach for Viral Fever Prediction using WIHMS System |
| | Category | A8. Special Topic 2: Support for Global Resilience |

| Summaryof Program | | |
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| Program Name | | Ensemble Machine Learning Approach for Viral Fever Prediction using a WIHMS System: Advancing SDG 3 |
| Category | | A8. Special Topic 2: Support for Global Resilience |
| Abstract of Program | | Traditional testing and diagnosis procedures for viral fever or infections have restrictions when it comes to managing population health. This research contributes to SDG 3 i.e good health and well-being by enhancing the early diagnosis and management of viral infections, hence improving health outcomes and alleviating pressure on healthcare systems. The WIHMS is prototyped incorporating a variety of sensors, i.e., a heart rate sensor, SpO2 sensor, temperature sensor, accelerometer, and Raspberry Pi 4B. Peripheral oxygen saturation (SpO2), pulse rate, and body temperature are the most fundamental indicators for viral fever symptoms. Also, other viral fever-indicating data, like headache, runny nose, dry cough, and muscle pain, are collected from the patients. The symptoms can be utilized to predict the occurrence of symptoms that are in line with a viral disease. The patient's status based on real time data from sensors is sent to the IoT cloud database to allow remote monitoring by medical staff or users. Through assessing the patient data and early warning features along with the deployment of machine learning models, the viral symptoms have been anticipated. In this work, an empirical evaluation of six machine learning models, including two ensemble models, is conducted. The ensemble methods, such as RFC and GBC, have achieved higher predictive accuracy and balanced performance. Compared to other machine learning models, the Gradient Boosting Classifier (GBC) performed better than K-NN, Logistic Regression (Classifier), SVM, and Decision Tree, attaining a maximum accuracy of 97.5% on the Viral Fever data set. The outcome demonstrates that the proposed ensemble approach offers improved and precise prediction based on the experimental findings, data processing, visualization, and transmission gateway. |
| **Details of Program** | | |
| Planning | | |
| Objectives | Long-term Goals | 1. Nationwide or Global Deployment of WIHMS<br>Goal**:** To deploy the proposed IoMT-based wearable healthcare monitoring system at scale, across hospitals, remote clinics, and |

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| | | refugee camps to support large-scale public health surveillance and early disease detection.<br>2. Integration with National Health Systems and Emergency Networks<br>Goal: To integrate WIHMS with national healthcare systems and emergency medical services for automatic alerting, triage, and epidemiological tracking.<br>3. Development of a Generalized Framework for Infectious Disease Detection<br>Goal: To generalize the machine learning framework to detect other communicable diseases (e.g., tuberculosis, dengue, COVID-XX), not just viral fever.<br>4. Creation of a Real-Time Global Health Dashboard (AI + IoMT + Cloud)<br>Goal: To build a cloud-based dashboard that aggregates real-time data from WIHMS devices across regions, providing health authorities with live analytics and predictive modeling.<br>5. Enhancing Personalization through AI and Generative Models<br>Goal: To incorporate generative AI and personalized analytics into the system to generate natural language health summaries and proactive wellness suggestions for users and clinicians.<br>7. Commercialization and Industrial Collaboration<br>Goal: To partner with medical device companies, health-tech startups, and public health agencies to commercialize the wearable monitoring system and software platform. |
| | Short-term Targets | * Develop a working prototype of the WIHMS device with integrated sensors for vital sign monitoring.<br>* Implement an ensemble machine learning model to predict early signs of viral infection.<br>* Integrate IoMT capabilities for real-time data transmission to a secure cloud platform.<br>* Conduct pilot testing in clinical or controlled community environments.<br>* Evaluate system performance in terms of accuracy and others<br>* Ensure compliance with data privacy and medical device regulations.<br>* Align all activities with SDG 3: Ensure healthy lives and promote well-being for all at all ages. |
| | Rationale | The increasing threat of infectious diseases demands early detection and continuous health monitoring, especially in remote and resource-limited areas. The proposed WIHMS system combines wearable IoMT technology with ensemble machine learning to predict viral infections in real time. This enables |

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| | | timely intervention, reduces disease spread, and supports data-driven public health responses. Aligned with SDG 3, the project promotes accessible, preventive healthcare through scalable, smart technologies. |
| Subject (Leader) | Initiator(s) | TASNIM |
| | Champion(s) | TASNIM |
| | Major team member(s) | FARHAN, BARUA, SALEHEEN |
| Environment | Nature/Society | Nature can limit the proposal through factors like sensor accuracy affected by environmental conditions (e.g., heat, humidity), and variability in physiological responses across individuals. Society poses challenges such as data privacy concerns, technology acceptance, digital literacy, and limited infrastructure in rural or underserved areas, which may affect adoption and deployment at scale. |
| | Industry/Market | The success of WIHMS depends on industry support for hardware manufacturing, data integration, and regulatory approvals. However, high development costs, market competition, may restrict progress. Market readiness and willingness to adopt new health technologies also influence the program’s scalability and commercialization potential. |
| | Citizen/Government | Citizen support is essential for adoption, but concerns over privacy, data security, and wearable comfort may affect acceptance.<br>Government backing through funding, policy support, and integration with public health systems can accelerate implementation, while lack of clear regulations or bureaucratic delays may hinder progress. |
| Resources | Human resources | The program currently has a core team of researchers & engineer, which is sufficient for prototype development and pilot testing. However, additional specialists in regulatory affairs, data security, and large-scale deployment may be needed as the project scales. |
| | Financial resources | The program has adequate initial funding for research, development, and pilot testing. However, additional financial support will be required for large-scale deployment, regulatory approvals, and commercialization efforts. |
| | Technological resources | The program has adequate technological infrastructure for prototype development, including access to IoMT devices, cloud platforms, and machine learning tools. However, scaling and integration with national health systems may require enhanced technical capabilities and partnerships. |
| Mechanism | Strategy (Weight/Sequence) | 1. Subject (Priority: High, Sequence: 1) |

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| | | Focus on developing and validating the ensemble machine learning model for accurate viral infection prediction.<br><br>2. Environment (Priority: Medium, Sequence: 2)<br>Ensure the system operates reliably across diverse environments (hospitals, clinics) and adapts to environmental variables.<br><br>3. Resources (Priority: Medium, Sequence: 3)<br>Secure and optimize technological, financial, and human resources to support development, testing, and scaling phases. |
| | Organization | The university's interdisciplinary structure, combining departments of engineering, healthcare, and data science, aligns well with the program's strategic goals. This facilitates collaboration, resource sharing, and innovation needed for WIHMS development and deployment. |
| | Culture | The university's culture of innovation, collaboration, and community engagement strongly supports the program's execution. However, traditional bureaucratic processes may occasionally slow decision-making and resource allocation. |
| Doing | | |
| Launch date | | February, 2025 |
| Responsible organization | | The program will be executed primarily by World University of Bangladesh, with potential collaboration from healthcare institutions. |
| Program content and process | | The program aims to develop and deploy an IoMT-enabled Wearable Health Monitoring System (WIHMS) integrated with an ensemble machine learning model to predict viral infections early and accurately. This system combines wearable sensors to continuously monitor vital signs with advanced analytics to detect subtle physiological changes associated with viral infections, supporting timely diagnosis and intervention.<br><br>Content:<br>The core components include wearable devices equipped with sensors for monitoring parameters such as temperature, heart rate, and oxygen saturation. Data collected by these devices will be transmitted securely via IoMT infrastructure to a cloud-based platform. The ensemble machine learning model, trained on diverse datasets, will analyze the incoming data in real time to predict potential viral infections. A user-friendly interface will deliver alerts and health summaries to users and clinicians. The system also supports data aggregation for public health monitoring and epidemiological tracking.<br><br>Implementation Process:<br>The project will proceed in phases. First, hardware and software components will be developed and integrated into a functional prototype. Next, controlled pilot testing will be conducted in clinical |

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| | and community settings to validate system accuracy, usability, and reliability. Feedback from users and health professionals will guide iterative improvements.<br><br>Concurrently, efforts will be made to ensure compliance with relevant medical device regulations and data privacy laws. Partnerships with healthcare providers and public health authorities will be established to facilitate system integration and wider deployment.<br><br>Finally, the program will focus on scalability and commercialization strategies, including industrial collaborations. Continuous monitoring and evaluation will ensure the system meets evolving healthcare needs and technological advancements.<br><br>This structured approach ensures a robust, effective, and scalable solution aligned with global health goals, particularly Sustainable Development Goal. |
| Key highlights of the content/process | Content:<br><br>1. Integration of IoMT-enabled wearable sensors for continuous health monitoring.<br>2. Use of an ensemble machine learning model for accurate early viral infection prediction.<br>3. Real-time data transmission to a cloud platform with user-friendly alerts and public health analytics.<br><br>Process:<br><br>1. Development and integration of hardware and software into a functional prototype.<br>2. Pilot testing in clinical and community settings for validation and feedback.<br>3. Ensuring regulatory compliance and establishing partnerships for scaling and commercialization. |
| Differences from traditional approaches | Traditional vs. After Program Implementation<br><br>Traditional:<br><br>* Limited real-time monitoring of viral infections.<br>* Delayed diagnosis and intervention, especially in remote areas.<br>* Fragmented data with minimal integration into public health systems.<br><br>After:<br><br>* Continuous, real-time health monitoring via wearable IoMT devices.<br>* Early, accurate prediction of viral infections enabling timely care.<br>* Integrated data analytics supporting individual health and public health surveillance. |

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| Progress as of today | Significant progress has been made in developing the wearable sensor prototype and initial machine learning models. Data collection and preliminary testing are underway. However, full system integration, large-scale pilot testing, and regulatory compliance processes remain to be completed. |
| Problems in implementation | Challenges Hindering Progress:<br><br>* Delays in hardware procurement and sensor calibration.<br>* Limited access to diverse, high-quality training data for machine learning models.<br>* Regulatory uncertainties and compliance complexities.<br>* Coordination difficulties among interdisciplinary teams and external partners. |
| Approaches to solve the problems | Data limitations were mitigated by collaborating with healthcare institutions for access to diverse datasets. Regulatory guidance was sought from experts to streamline compliance. |
| Completion date, if completed | August, 2025 |
| Seeing | |
| Impacts on students | Students have expressed high satisfaction with hands-on experience in cutting-edge IoMT and machine learning technologies. They appreciate the interdisciplinary collaboration and the program’s real-world impact on healthcare, enhancing both their skills and motivation. |
| Impacts on professors | Professors are satisfied with the program’s progress, noting strong research outputs and effective student engagement. They value the interdisciplinary collaboration and the program’s alignment with advancing healthcare innovation and SDG 3. |
| Impacts on university administration | The university president and administrators are pleased with the program’s progress and impact, recognizing its contribution to innovation, research excellence, and societal benefit. They support continued investment and scaling efforts. |
| Responses from industry/market | Few industry partners have shown positive interest in the program’s innovative approach. However, some express the need for clearer pathways for stronger collaboration frameworks. |
| Responses from citizen/government | Local citizens appreciate the program’s focus on accessible healthcare and early disease detection. Government officials are supportive due to its alignment with public health goals, though both call for continued transparency and wider outreach. |
| Measurable output (revenues) | The program is expected to ensure cost savings through early viral infection detection by reducing hospital admissions and treatment expenses. |
| Measurable input (expenses) | The program has used an initial investment of 40,000 BDT covering hardware development, software engineering, and pilot testing. |
| Cost-benefit analysis for effectiveness | Total Expenses: 40,000 BDT (development, testing, compliance)<br>Generated Revenue/Cost Savings: It is yet to evaluate |

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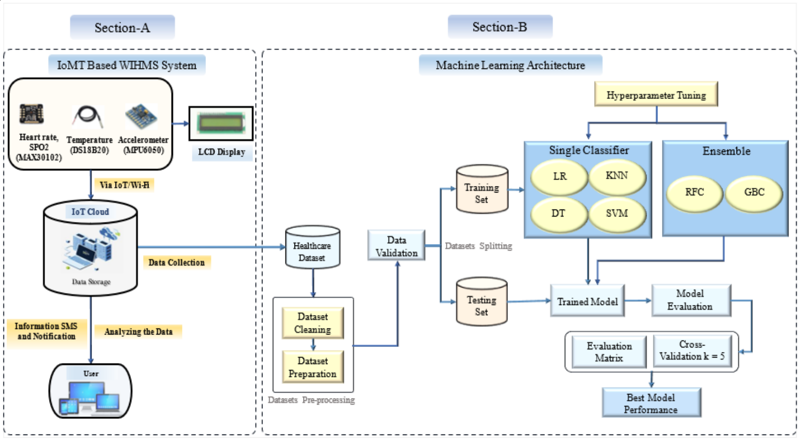
<tr><td></td><td>Effectiveness: The program is expected to show a return on investment in the first year, indicating strong financial and social value.</td></tr>
<tr><td colspan="2">Future Planning</td></tr>
<tr><td>Where does the project go from here?</td><td>The WIHMS program has laid a strong foundation for transforming healthcare through innovative IoMT and machine learning technologies. By enabling early detection of viral infections, it contributes significantly to public health and aligns with global sustainability goals. Continued collaboration, refinement, and scaling will ensure lasting impact and improved well-being for communities worldwide.</td></tr>
<tr><td colspan="2">Addendum</td></tr>
<tr><td>Exhibits, pictures, diagrams, etc.</td><td>


Figure: Model Architecture
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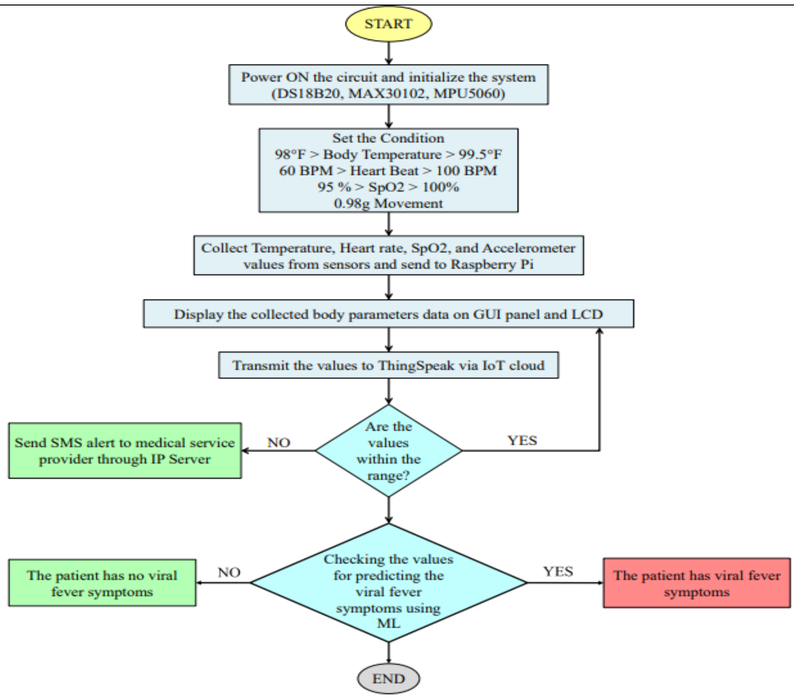
<tr><td></td><td>
<br>Figure: Flow diagram</td></tr>
<tr><td>Reports, mimeos, monographs, books, etc.</td><td>(Describe the specific documents that validate the program, and list them here.)</td></tr>
<tr><td>Others which may help explain the program (including website links)</td><td>(Include any materials that may help validate the program; links to the program's website will be especially useful.)</td></tr>
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