Project proposal for CloudPhysician

Introduction

The proposed project aims to address the challenges posed by the current nurse-to-patient ratio in ICUs, where compromised patient care and delayed detection of critical changes in patients' vitals are prevalent. The project proposes the development of machine learning that can accurately extract vital signs information from patient monitor images obtained through CCTV footage or dedicated cameras. By leveraging computer vision techniques, the model will analyze the video footage in near real-time, extracting key vital signs indicators such as SPO2, heart rate/pulse rate, ECG, and blood pressure. This automated approach eliminates the need for constant manual monitoring by healthcare professionals, allowing them to focus on critical interventions and ultimately improving patient care.

Domain: Computer vision, Machine learning, Deep learning and healthcare

Problem Statement

The current nurse-to-patient ratio in ICUs, which typically stands at around 1:6 as per healthcare guidelines, often results in compromised patient care due to limited human resources. Consequently, the inability to closely monitor patients' vital signs can lead to delayed detection of critical changes in their condition, potentially resulting in adverse outcomes. Furthermore, the cost and complexity associated with integrating Wi-Fi connectivity into existing multiparameter monitors pose a significant hurdle in implementing a more efficient monitoring system.

Proposed Solution

The proposed solution entails developing a machine learning or deep learning model capable of accurately extracting vital signs information from patient monitor images obtained through CCTV footage or dedicated cameras. The model will be designed to process the video footage and analyze the patient monitor in near real-time, first segmenting the monitor from the footage and then classify it into the type of monitor and then extracting vital signs data at a frequency of five seconds or less using specialized pipelines for that particular monitor. The primary vitals to be extracted include SPO2, heart rate/pulse rate, ECG, and blood pressure (diastolic and systolic). This approach eliminates the need for physical presence and direct manual monitoring by healthcare professionals, freeing up their time for critical interventions.

Objectives

The objectives of the proposed solution are:

1. Develop and train a machine learning or deep learning model capable of accurately extracting vital signs data from patient monitor images.
2. Utilize computer vision techniques to identify and isolate regions of interest within the monitor image, focusing on key vital signs indicators such as SPO2, heart rate/pulse rate, ECG, and blood pressure.
3. Implement a near real-time processing pipeline to extract vital signs information from patient monitor images at regular intervals, enabling continuous monitoring.
4. Validate and evaluate the performance of the proposed model by comparing the extracted vital signs data with manual measurements, ensuring accuracy and reliability.

Benefits

Following are the benefits of this project:

1. **Near real-time Information Extraction:** Vital can be extracted from patient monitors every 5 seconds, providing continuous and up-to-date data.
2. **Digital Data Storage:** The extracted information is digitized and can be stored in digital formats, allowing for easy access, retrieval, and analysis.
3. **Anomaly Detection and Early Alerts (Future extension):** ML models can be applied to the stored data, enabling the detection of anomalies and potential health risks. Healthcare staff can be alerted in advance, reducing the chances of adverse events.
4. **Reduction in Human Error:** Automating the vital monitoring process reduces the reliance on human observation, minimizing the possibility of human errors and ensuring more accurate data collection.
5. **Improved Nurse-to-Patient Ratio:** By automating vital signs monitoring, healthcare professionals' time can be better utilized for critical interventions, effectively increasing the nurse-to-patient ratio and enhancing overall patient care.

By leveraging technology and ML models, this proposed solution empowers healthcare providers with near real-time, accurate, and automated vital signs monitoring, leading to enhanced patient safety and improved healthcare outcomes.

Schedule

Estimated time of completion

The estimated time of completion of this project is approximated to be 4 weeks (28 days).

Timeline

1. Week - 1:
    a. Gathering relevant and correct information for the project
    b. Preparing a plan to move forward
    c. Work delegation

    d. Creating the first pipeline that will take the image of the ICU and will detect and locate the presence of the monitor, and the pre-processing and the post-processing steps.
        i. Benchmarking all the possible ways to find the model with least time and most accuracy.
2. Week - 2:
    a. Developing and training the classifier to classify different monitors.
        i. Benchmarking all the available models like, efficient-net, yolo-classifier, etc to find the model that takes least time and good accuracy.

3. Week - 3:
    a. Developing four models for the four types of monitors present (one model for one type of monitor).
        i. To extract the information from the monitor using predefined areas, to reduce time to find using deep-learning models.
    b. Create and train OCR to get the best information retrieval from the patient monitor. (using divide and conquer to solve the problem)
4. Week - 4:
    a. Create a model to convert the graph in image to a digital graph.
    b. Deploying all the code on DSAI club github repository and few final checks.
        i. Create readme.

Budget

Personnel

This project will only require three contributors; The contributors will:

1. Abhishek Singh Kushwaha - Coordinator, DSAI Club
2. Bhavik Shangari - Core Member, DSAI club
3. Kriti Gupta - Core Member, DSAI Club

Materials or Equipments

This is a completely software-based project, It will not require any budget for materials or equipment.

Software

The project requires a lot of model training and benchmarking and it is very computationally expensive. This project demands the usage of cloud-based computing resources; i.e., Gradient Paperspace.

Conclusion

In conclusion, the proposed project offers a promising solution to the challenges faced in ICUs due to limited nurse-to-patient ratios. By leveraging machine learning and computer vision techniques, the project aims to automate the extraction of vital signs data from patient monitor images, providing continuous and up-to-date information in near real-time. The benefits of this approach include improved patient safety, reduced human error, and enhanced nurse-to-patient ratios, ultimately leading to better healthcare outcomes.

The project's timeline spans approximately four weeks, during which the team will gather relevant information, develop and train machine learning models, implement near real-time processing pipelines, and validate the performance of the proposed solution. The project does not require any additional budget for materials or equipment, as it is a software-based initiative. Cloud-based computing resources will be utilized to handle the computational requiresments.

By successfully completing this project, healthcare providers will have access to accurate and automated vital signs monitoring, enabling early detection of anomalies and potential health risks. The digital storage of extracted data will facilitate easy access, retrieval, and analysis, allowing for improved decision-making and proactive healthcare interventions. The proposed solution has the potential to significantly enhance patient safety and overall healthcare outcomes in ICUs, making it a valuable addition to modern healthcare practices.