Paper-based Approach for Pancreatic Cancer: MMP7 Detection using CdTe Quantum Dots and Molecularly Imprinted Polymers.

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Introduction

Preliminary investigation using lab-on-paper Molecular Imprinted Polymers (MIPs) paired with Quantum Dots (QDs) to detect Matrix Metalloproteinase-7 (MMP7) using image processing to quantify fluorescence and area with a CMOS sensor reflex camera.

MMP7 is critical in pancreatic tumor formation, which has the lowest survival rate among malignant malignancies. High levels of the MMP7 in blood have been associated to a poor prognosis and limited survival in patients.[1]

CdTe Quantum Dots (CdTe@MPA QDs) are luminescent nanoparticles with narrow emission spectra, enabling for exceptional sensitive detection of biomarkers.Combination of MIPs with CdTe MPA-capped provide selectivitive for biomiarker .[2]

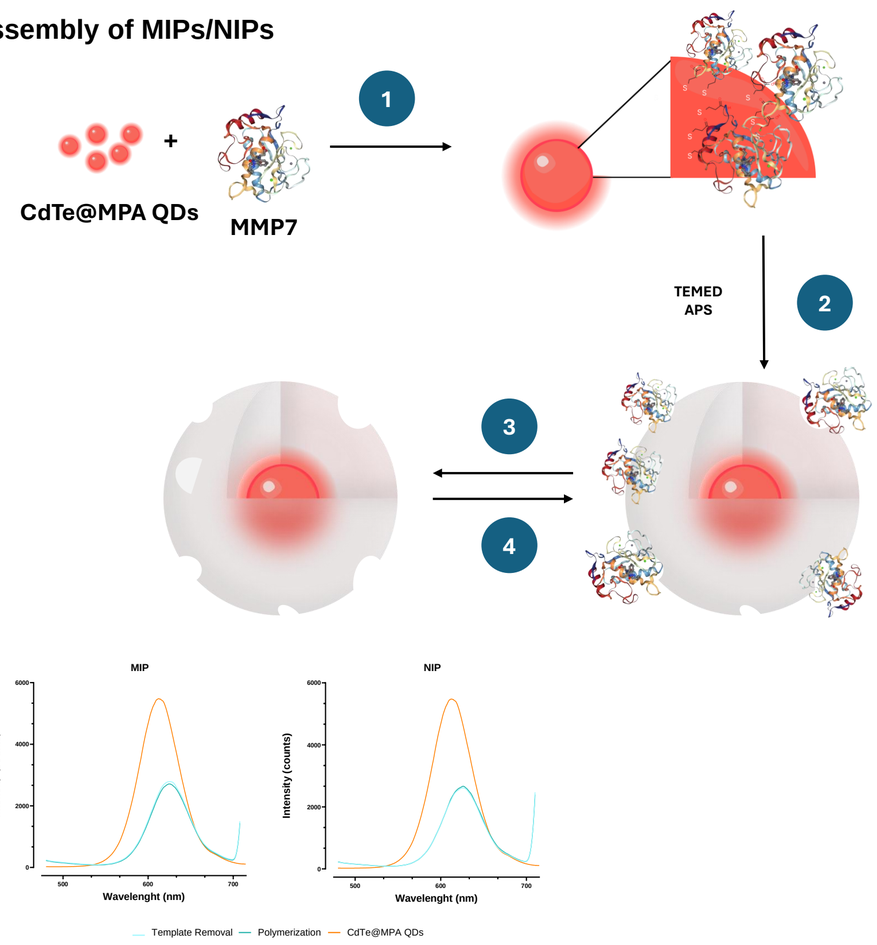
Aim

The creation of a sensitive Point-of-care Testing (PoCT) membrane for rapid turnaround of test results, with the capacity to produce a response quickly, employing standard test materials such as nylon filters, and utilizing plastic antibodies with fluorescent capabilities due to CdTe@MPA QDs. Developing an autonomous pipeline to process and evaluate the data collected by a sensitive CMOS sensor-based camera.

The application of this approach could be implemented with other clinical biomarkers. Easy to use portable device for low-income facilities and cheap disposable sensor.

Methods

Assembly of MIPs/NIPs



1 Surface imprinting
2 Polymerization
3 Template Removal
4 Rebinding

Membrane Preparation

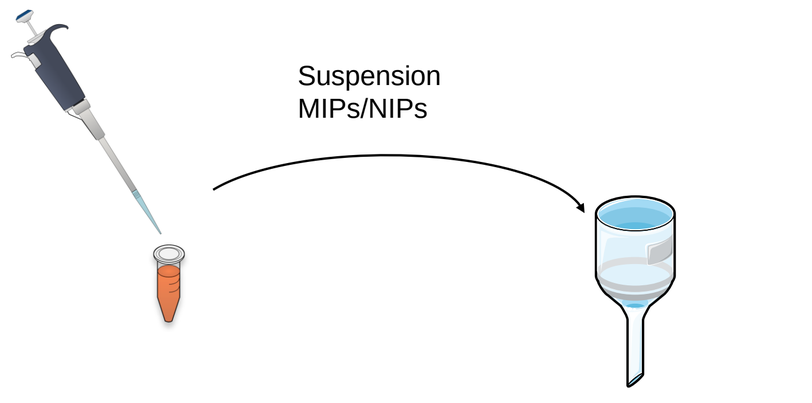
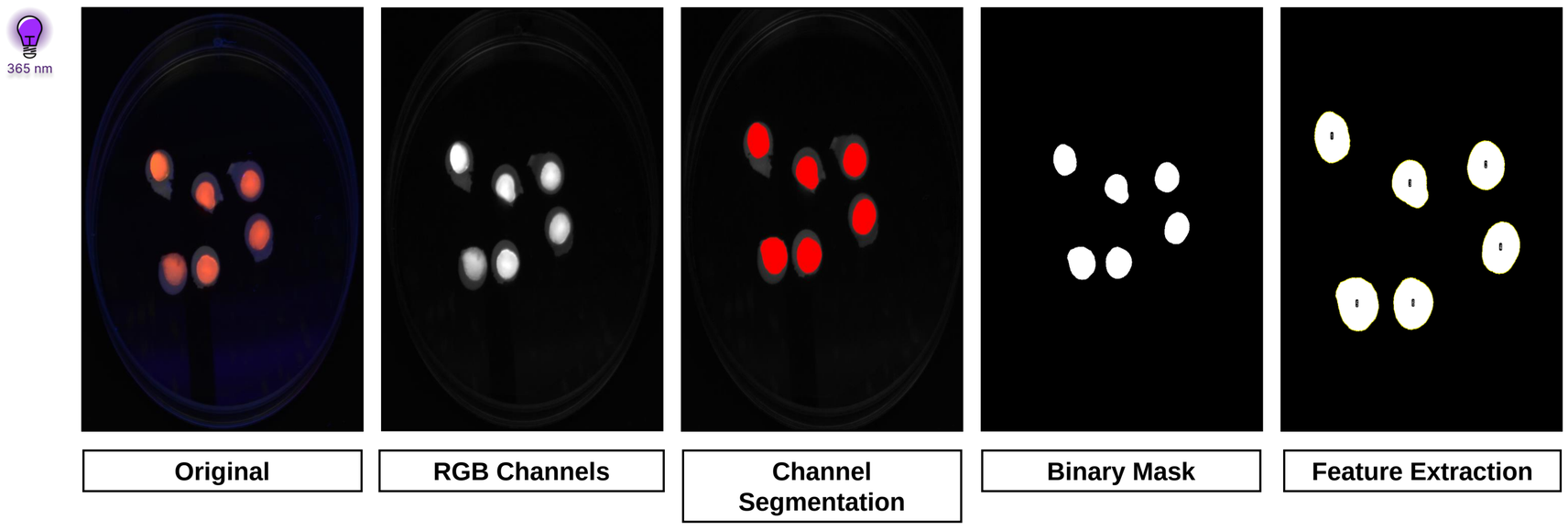
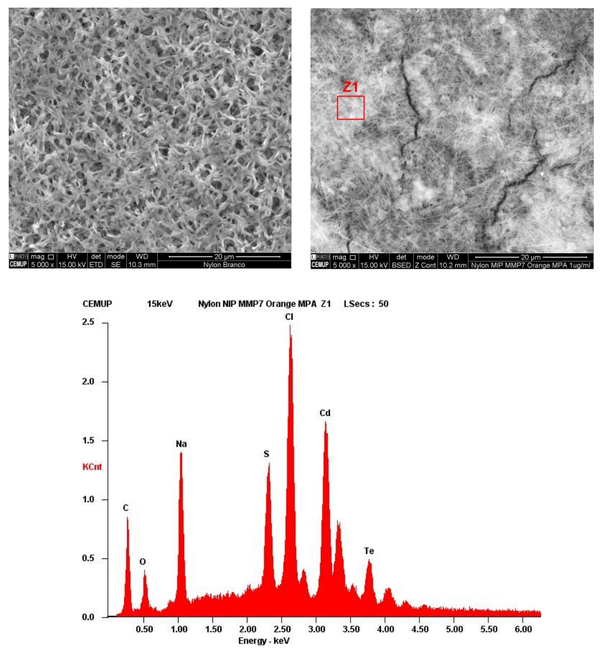


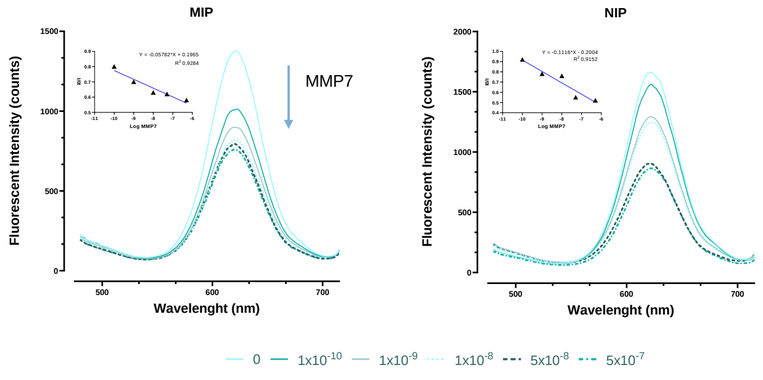
Image Segmentation and Analysis Pipeline



Membrane Characterization



Results and Discussion



- Serum calibrations influence system readings, but the system responds linearly when MMP7 is present between $1x10^{-10}$ – $5x10^{-7}$ g/ml.
- Image processing based on color segmentation enabled the development of a preliminary pipeline for gathering concise information about the area and color intensity.

Conclusions

Quantum Dots were successfully functionalized using molecularly imprinted polymers for MMP7 assessment. The MIPs/NIPs were also successfully incorporated into the nylon membrane, allowing for further research and possible calibrations, potentially leading to their incorporation into future point-of-care devices.

The pipeline developed, while still in need of improvement, ensures that the information is processed equally during this phase. This method provides insight into the color intensity region, allowing for the detection of modifications caused by the MMP7 biomarker in a patient drop sample.

References

[1]Van Doren SR. MMP-7 marks severe pancreatic cancer and alters tumor cell signaling by proteolytic release of ectodomains. *Biochem Soc Trans*. 2022;50(2):839-851. doi:10.1042/BST20210640

[2]Safari M. Recent Advances in Quantum Dots-Based Biosensors. IntechOpen eBooks. Published online January 18, 2023. doi:https://doi.org/10.5772/intechopen.108205

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