Towards A Clinical Prostate MR Fingerprinting Protocol

Philips Research Europe
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Declaration of Financial Interests or Relationships

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I have the following financial interest or relationship to disclose with regard to the subject matter of this presentation:

Company Name: Philips Research Europe
Type of Relationship: Employee
Introduction

Prostate MRI

- mpMRI: reliable lesion detection in peripheral zone (PZ)
- Goal: A quantitative and reproducible technique.

Challenges in Prostate-MRF

- Fat-induced blurring
- $B_1^+$ inhomogeneities
- Long reconstruction times

Classification:
Separate NPZ from cancer region based on T2 and ADC values.\(^2\)

![Diagram of Peripheral zone (PZ) of the prostate\(^1\)]


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Methods

Prostate MR Fingerprinting in less than 5 minutes.

• Fully-integrated $B_{1}^{+}, \text{pre-scan}'$ using iDREAM\cite{3}

• Integration of Dixon-based water/fat separation with MRF

• Flow compensation to suppress signal from artery blood flow

• Fast GPU-based reconstruction for direct visualization on the scanner

\cite{3} K. Nehrke et al. ISMRM 2022, #3314 #2593 Towards A Clinical Prostate MR Fingerprinting Protocol
MRF & water-fat separation

MRF-Dixon methods:
- Acquire data at multiple echo times (while varying MRF sequence)
- Field inhomogeneity $\Delta B_0$ either from pre-scan\(^4\) or estimation\(^5\)
- Spiral deblurring using CPR\(^6\)
- Applications: Fat suppression or separation (e.g. fat images in MR-HIFU)

Water:
- $T_1$, $T_2$, $M_0$, SUM

Fat:
- $T_1$, $T_2$, $M_0$, SUM

Joint Water-Fat Separation & Deblurring\(^7\)

References:
- \(^4\) K. Koolstra et al. Magn reson med 2019
- \(^5\) T. Nolte et al. Magn reson med 2019
- \(^6\) LC. Man et al. Magn reson med 1997
- \(^7\) D. Wang et al. Magn reson med 2018
Experiments @ 3T

Set-up

- Evaluated on six healthy volunteers
- Comparison with MESE T2 mapping
- Flow compensation evaluation

MRF protocol details

- 15 slices in 04:25 mins

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>TE1</td>
<td>3.45 ms</td>
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<tr>
<td>TE2</td>
<td>4.60 ms</td>
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<tr>
<td>TR</td>
<td>17 ms</td>
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<tr>
<td>Acq. window</td>
<td>9.3 ms</td>
</tr>
<tr>
<td>Interleaves</td>
<td>1 / 29</td>
</tr>
<tr>
<td>Resolution</td>
<td>1.1 x 1.1 x 5</td>
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<tr>
<td>FoV</td>
<td>(80 + 200 + 80)^2</td>
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</table>

MRF acquisition details

- Single-spiral with a pseudo-golden-angle rotation
- Two TEs alternating along the MRF train

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Results I

ROI analysis of NPZ:

- MRF + T2 MESE reference *)
- Observed strong variations wrt. volunteers; good agreement in T2

*) TR = 5 s, 14 echoes, TEn = n*16 ms, 160° const. refocusing, 0.96 x 0.96 x 3 mm³, SENSE R=7, scan time = 06:00min
Results II

Flow compensation:

- Spiral artifacts from both arteries (✔️) can be suppressed.

(a) T1 water-only wo/ flow compensation

(b) T1 water-only w/ flow compensation
Summary & discussion

Main achievements

• Development of MRF prostate protocol at clinically relevant resolution and acquisition time.
• Extension by water/fat separation and $B_1^+$ correction.
• Fully-integrated workflow without reconstruction latency.

Outlook

• Further improvement of flow suppression using REST slabs
• Improvement of spatial resolution
• Clinical investigations ongoing

Related work

• Radial Prostate-MRF[8]

Thank you!
Questions?