Introduction

**Image-guided Needle Interventions**
- Hand-eye coordination and mental registration
- Longer duration for complex procedures
- Multiple punctures and radiation exposure

**2D Image Overlay**
- Consist of mirror-monitor attached together
- Successful pre-clinical trials conducted

**Previous Image Overlay Systems**
- Static
  - Displayed a cross-sectional image in the virtual overlay plane
  - Fixed to scanner or mounted upon large mechanical articulated arm
  - Limited precision of movement and long calibration time
  - Prone to misalignments, deformation, and vibrations
- Adjustable

**Mobile Image Overlay System**
- Mobile, light weight (1.0kg) and smaller dimensions (13 cm X 23 cm)
- Display device - Galaxy Tab 3.0 (10.1‘)
- Mirror - Beamsplitter with Reflection/Transmission ratio - 75/25

**Design of Mobile Image Overlay System for Image-Guided Interventions**
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**Workspace Analysis**

<table>
<thead>
<tr>
<th>60-degree configuration</th>
<th>90-degree configuration</th>
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<tbody>
<tr>
<td>Design principle</td>
<td>Similar to earlier design</td>
</tr>
<tr>
<td>Viewing angle</td>
<td>7.5 degree</td>
</tr>
<tr>
<td>Clearance above patient</td>
<td>0.0cm</td>
</tr>
<tr>
<td></td>
<td>5.0cm</td>
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</tbody>
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**Direct Automatic Calibration**
- Laser plane marks the overlay plane
- Align two plane with alignment tool
- Adjust laser source with three DOFs
- 5mW power output (FDA Class IIIa)

**Laser Plane Alignment**
- Designed for needle placement experiment
- Location registered w.r.t planar marker
- Landmark registration error $1.35 \pm 0.14$ mm
- Actual needle placement experiment pending

**Needle Insertion Validation**
- Light weight, smaller dimensions and automatic calibration
- System can be handheld and / or fixed with positioning arm
- Needles up to 12.5 cm length can be used
- Real-time tracking with improved accuracy of overlay plane tracking
- Evaluate needle placement accuracy and optimize clinical workflow

**Summary and Future Work**

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