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| --- | --- |
| Roles of Team Members | |
| Names | Roles |
| Jinling Qiu (Leader) | * Mechanical Part (connect work station to the robot) * Streaming transfer, robot control * Evaluation and test the model * Presentation Preparation |
| Yanrui Lee | * Code Reproduction * Transferring model from Pytorch to Universal platform * Evaluation and test the model * Presentation Preparation |
| Yulin Huang | * Code Reproduction * Transferring model from Pytorch to Universal platform * Evaluation and test the model * Presentation Preparation |
| Leen AlShelh | * Code Reproduction * Transferring model from Pytorch to Universal platform * Evaluation and test the model * Presentation Preparation |
| Jie Li | * Mechanical Part (connect work station to the robot) * Streaming transfer, robot control * Evaluation and test the model * Presentation Preparation |

Minimally invasive surgery (MIS) has expanded significantly in modern medicine, driven by advancements in robotics and technology. MIS involves a surgeon using elongated instruments and a surgical camera inserted through small incisions, resulting in reduced trauma to the patient compared to open surgery (mcafee2010minimally, allan20183). Research indicates that MIS often leads to better outcomes, such as shorter patient recovery times and increased surgical efficiency (mcafee2010minimally). However, MIS is also limited by factors such as reduced tactile feedback and depth perception, which can complicate the surgeon’s tool manipulation and contribute to increased cognitive workload, especially when the surgeon relies solely on visual feedback. (allan20183, allan2017visual,) Moreover, the training process for new surgeons is lengthy, as it takes considerable time for them to master the techniques. (allan20183 allan2017visual, hein2021towards)

To address the limitations of open surgery and MIS, robotic assisted minimally invasive surgery (RMIS), such as the Da Vinci system, was developed with enhanced dexterity, additional degree of freedom, clearer 3D vision and cancels out tremors. (plerhoples2012aching, allan2017visual, allan20183) This technology enables surgeons to perform procedures with minimal trauma to critical structures and provides a clear view of various pathologies. (allan2017visual)

During **MIS**, the surgeon might have limited view due to instrument obstruction, which can negatively impact the outcome especially with the surgeon depending entirely on visual feedback. \cite{kassahun2016surgical} When instruments block the camera's line of sight, it can result in unexpected and unintended damage to adjacent tissues, possibly harming vital anatomical structures such as vessels, nerves or ducts. Consequently, this may result in longer surgeries, increased morbidity and potential long-term complications. \cite{allan2017visual} \cite{allan20183} Although the latest Da Vinci model has haptic feedback, allowing surgeons to have force-related input (**saracino2019haptic)**, the clinical implications are not fully understood. With that in mind, pose estimation can allow the surgeon to have more precise and intended movement during the surgery, reducing the percentage of iatrogenic injuries. (allan2017visual, hein2021towards) Furthermore, the surgeon may experience a high cognitive load, causing mental and physical fatigue due to constant adjustment of camera and instrument position to maintain a clear view of the anatomy. (allan20183, allan2017visual, shugaba2022should) This can divert the surgeon's attention to tasks other than the surgery. Therefore, recent research in estimating instrument position is being conducted as it "can enable skill analysis, phase detection, motion estimation, tool–tissue interaction and pave the way towards image-guided interventions.” (hein2021towards) Nowadays there are many external devices like depth camera, electromagnetic trackers etc. available for space estimation in surgical instruments but they are not practical in in-vivo surgeries because of space and hardware constraints\cite{enhancedmarker}.

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