Intel RealSense
RGB-D camera
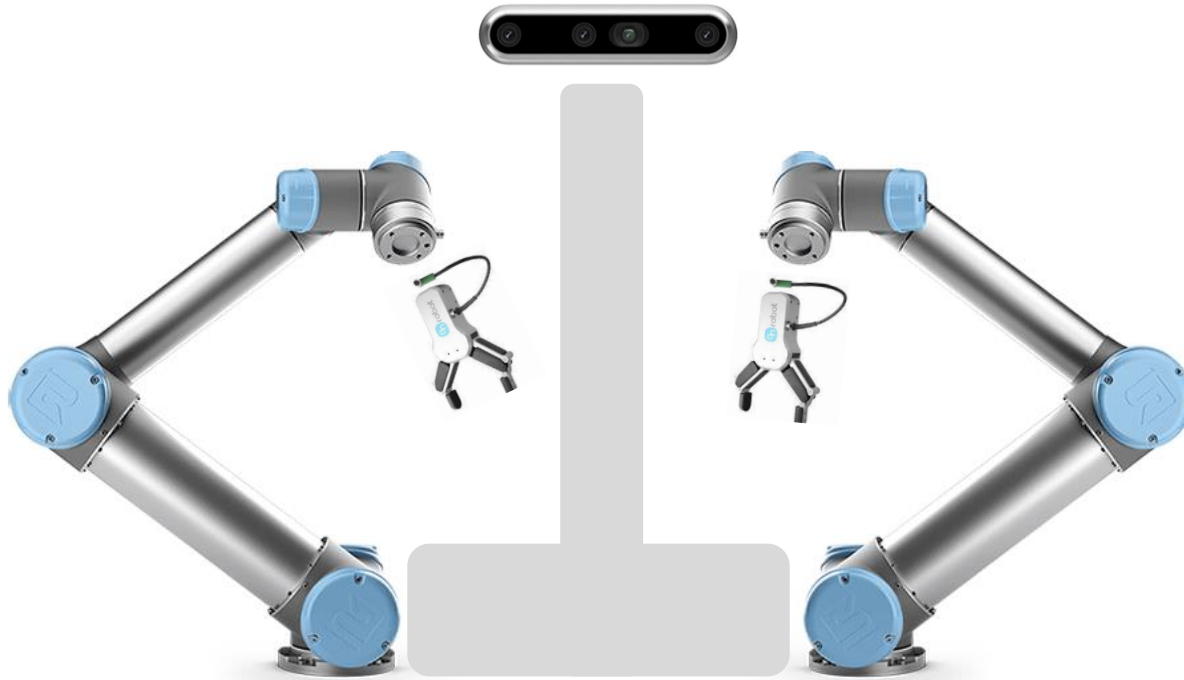
Two units of Universal Robotics'
UR5 Manipulators
- **6 DOF(EACH)**
- **5 KG PAYLOAD (EACH)**
- **850 mm Reach**

Name of product / innovation:
ADAM
(Advanced Dual Arm Manipulator)

Solution
HYBRID APPROACH OF ONE SHOT IMITATION LEARNING AND TELEOPERATION IN DUAL ARM MANIPULATOR ROBOT

Demonstrations are an extremely convenient form of information we can use to teach robots to overcome these two challenge one is dexterity and communication. Using demonstrations, we can unambiguously communicate essentially any manipulation task, a robot system can achieve more productivity by adapting a form of human robot interaction, most commonly robot **teleoperation** and **imitation learning**.
We have proposed a **hybrid approach** to combine **teleoperation** and **imitation learning** to leverage the strengths of both methods and improve the efficiency and effectiveness of robot control, this hybrid approach can leverage the strengths of both methods and provide a more flexible and adaptive control system
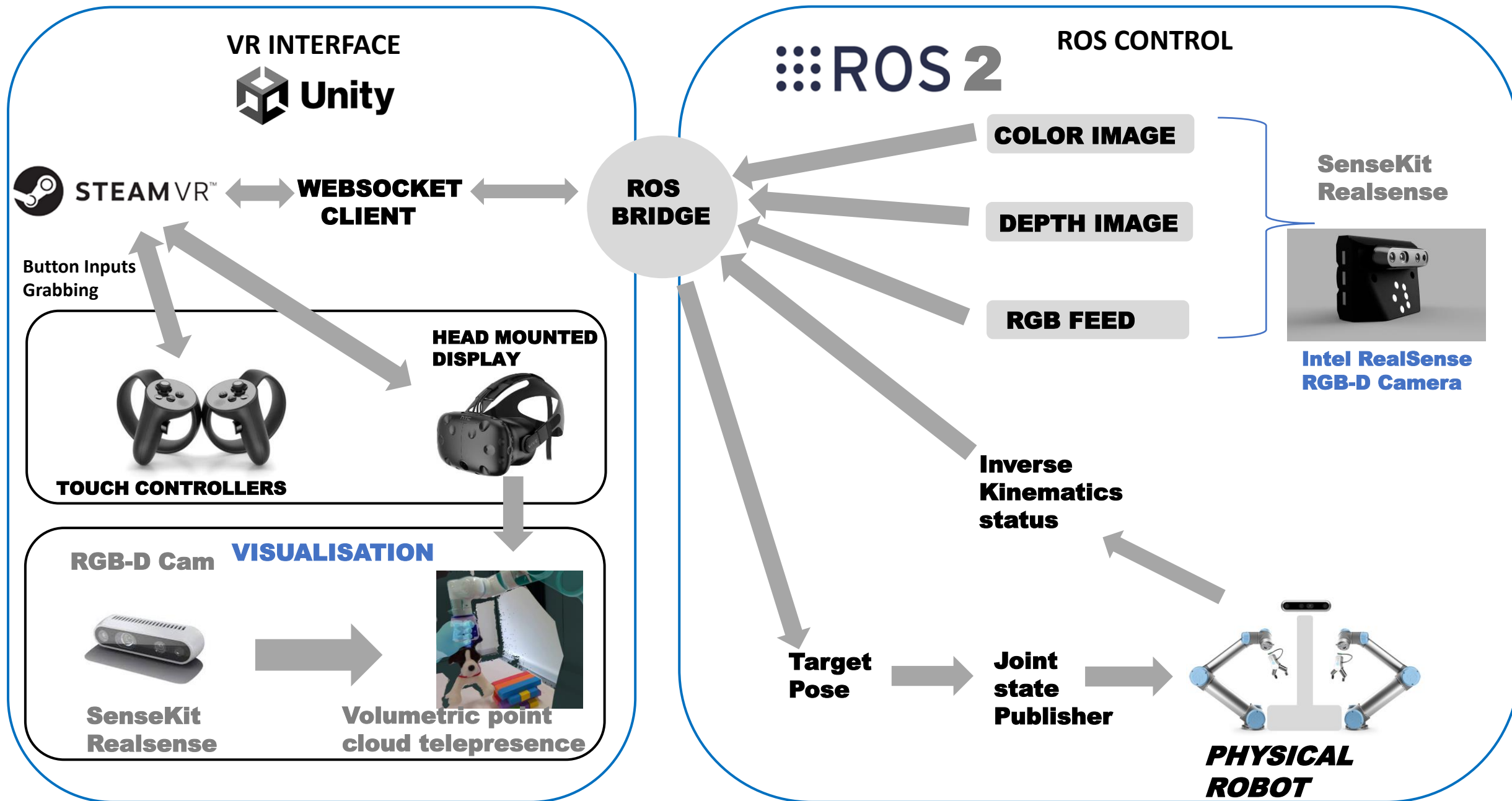
Fig. High Level Software Architecture for VR based Teleoperation

TELEOPERATION USING VR SYSTEM

- An oculus rift VR System is connected to a computer running the Unity 3d game engine
- Unity builds a local copy of our robot based on its URDF
- Unity connects to a ROS network over the Internet via a RosBridge WebSocket connection
- The pose and wrist cameras of the robot are sent via this WebSocket connection, as well as the color and depth image of a Intel RealSense mounted to the robot's body
- The color and depth image are built into a point cloud in Unity via a custom shader
- When the user holds down a controller, the pose of the user's controllers are sent back to the robot, which uses an inverse kinematics solver to move the robot's end effectors to the specified poses
- ROS connects processes of programs, known as nodes, that perform different functions.
- Nodes communicate by streaming data over channels, or topics, on a local TCP network, known as a ROS network
- Nodes create publisher objects to publish data over the network on a topic, or subscriber objects to subscribe to a topic
- ROS provides an API to create nodes in C++ or Python
- The Oculus Rift connects to Unity through a software package called SteamVR
- Unity is a game engine that is used for many popular 2D, 3D, and Virtual/Augmented/Mixed Reality applications\
- It has a built-in physics engine that can handle contact dynamics, as well as material simulation (such as water, sand,or cloth)
- SenseKit Realsense offers volumetric capturing and streaming
- The current position and orientation of the controller are converted from the Unity coordinate frame to the ROS coordinate frame and published over a topic to a node in the ROS network that queries the robot's built in IK solver and moves the robot if a solution is found

ONE SHOT IMITATION LEARNING

- One-shot imitation learning is a type of machine learning where an agent is trained to perform a new task by observing a single demonstration or example of the task
- robots should be able to learn from very few demonstrations of any given task, and instantly generalize to new situations of the same task, without requiring task-specific engineering
- Demonstrations are an extremely convenient form of information we can use to teach robots to overcome these two challenges
- We will train a policy on a broad distribution over tasks, where the number of tasks is potentially infinite
- In order to train the neural network policy, we will make use of imitation learning algorithms such as **behavioral cloning** and **DAGGER(Dataset Aggregation)** , which only require demonstrations rather than reward functions to be specified
- The use of soft attention over both types of inputs made strong generalization possible
- we add noise to the actions in order to have wider coverage in the trajectory space
- architecture consists of three modules: the demonstration network, the context network, and the manipulation network
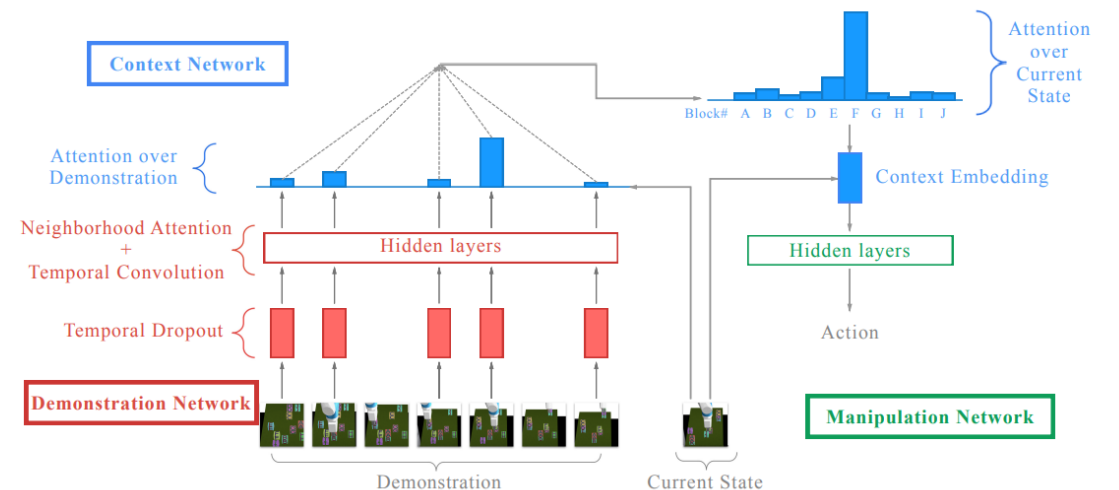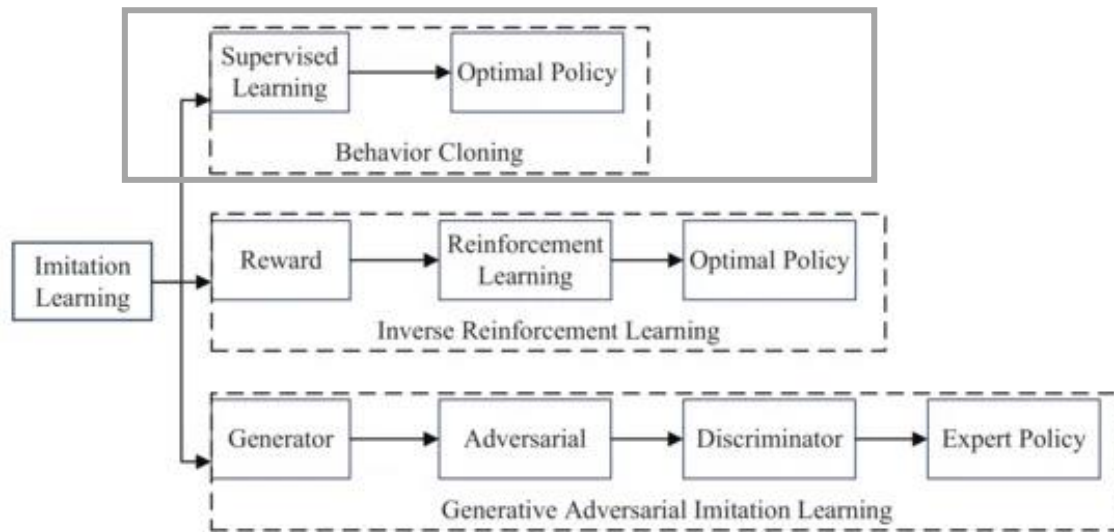
USECASES

VR Based Control of Dual Arm Manipulation

Easy Task Automated

High Risk Task Manually operated

Maintenance & Repair

Explosive Ordinance Disposal

Underwater Expedition

One Shot Imitation Learning

Teleoperation

Payload Handling

Space Maintenance & Repair

Space Maintenance & Repair

Payload Handling