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Auto Hand V1.5 Documentation

Thank you for your purchase! Auto hand is a physics based hand controller that calculates hand pose on grab. The Hand Component will take a Transform to follow and will use unity physics to match the hand to its position and rotation using rigidbody movements. It can be easily connected to any controller. All you need to do to make an object interactable with the hand is apply the Grabbable component. For any questions or issues you can contact me at EarnestRobot@gmail.com

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FAQ

Will this connect to my VR controller?

Yes! You can connect the hands to a mouse and keyboard if you felt like it. The only exception is that *this asset is designed to be used with a single trigger for grabbing*, as opposed to a five-finger controller like the index (however this will still work with the index trigger/button input).
See **[CONNECT TO ANY CONTROLLER]**

I prefer to grab with a different button, how do I change this?

Each **Hand** from the included packages has an [Input] **Hand Controller Link Component** attached to it that has public button values for the finger bending axis, the grab/release button, and the squeeze/unsqueeze button.

Why isn't my custom hand in the right position/rotation relative to my real hand?

To adjust the hands pivot/position I recommend creating an empty object under the controller, assigning it the hand's follow, and offsetting its transform to get the hand to the ideal position

Layer Missing Error?

Make sure that you have either imported one of the sub packages and enabled the required settings from the setup wizard (**Window/AutoHand/Setup Window**), or manually import the required layers.
See **[PHYSICS SETTINGS]**

How can I use the Auto Pose system without physics/interaction?

The hand auto poses are generated in three steps:

1. The hand's body is aligned to the ideal grabbing pos/rot using physics and raycasts
2. The modular finger components bend until they hit the grabbing object
3. A fixed joint is created between the physics controlled hand and the grabbable

You can cut out steps one and three and just use the finger component to generate poses for whatever interaction system you're using. The finger components open/closed poses can be individually saved by right-clicking the component.
See [FINGER SCRIPT]

Difference between the Right/Left hand?

The left hand can be an inverted right hand (or visa versa) by scaling the transform.x to -1. Make sure to set the **Left** toggle value on the hand true of false accordingly

Why does the held object jitter sometimes?

- The **HandStabilizer** component is not attached to the correct camera.
- The Follow pos/rot speed on the hand is too high and the drag/angular drag is too low
- In order to reduce jitters you can increase the Default Solver Iterations under Unity's physics settings, 100 yields very good results.
- Rigidbody mass and drag will also affect jitter, objects of small mass and low drag are likely to wiggle more than objects of near equal mass to the hand. Strongly recommend making small size/mass objects one-handed grab only.

See **[PHYSICS SETTINGS]**

Why is there a follow delay?

Because the hand moves using physics updates, it can sometimes lag depending on hand and physics settings. Increase the **Follow Position Speed**, but not too much without increasing the **Rigidbody Drag** can cause jitters. I also strongly recommend decreasing the physics timestep to at least 1/60, 1/90 for very smooth results and less jitters at higher follow values.

See **[PHYSICS SETTINGS]** for more information

Why is it rotating so slowly?

The default **max angular velocity** in the **unity physics settings** is far too slow. I recommend increasing it to at least 40. The **hands follow rotation speed** can also be increased along with the **rigidbody angular drag** to find the right speed

See **[PHYSICS SETTINGS]**

Why is this object rotated and scaled weird when I grab it?

Unity sometimes has problems when rotating physics objects that are children of objects not scaled at (1, 1, 1). Make sure to unparent these objects and use Fixed Joints if you have to.

Sometimes when I grab an object it instantly releases.

This is likely because the Break Force on the Grabbable is too low for the mass/speed of the hand and the object when grabbing. Turn this value up or adjust the hands/objects mass.

Why isn't my hand smooth when I move it across surfaces?

Everything is based on Unity physics, so the **physics material** will affect how things interact. I recommend applying the Hand Physics Material to each collider on the hand.

[HAND SCRIPT]

The hand component is the core script that runs the hand. It has 5 essential functions to understand. The hand follows using physics settings

[FINGERS]

- **Fingers** [Finger]: The modular finger scripts attached to each fingers root under the hand

[FOLLOW SETTINGS]

- **Follow [Transform]:** The Hand's follow target, usually the controller
- **Position Offset** [Vector3]: Offsets the hands position but not its rotation pivot
- **Follow Position Speed** [Float]: When turned too high can jitter (increase rigidbody drag if jittering)
- **Follow Rotation Speed** [Float]: When turned too high can jitter(increase rigidbody angular drag if jittering)
- **Max Velocity** [Float]: The maximum allowed velocity of the hand in any direction
- **Max Follow Distance** [Float]: Will return the hand to the follow target at this distance

[HAND SETTINGS]

- **Left** [Bool]: Whether or not it's the left or right hand
- **Palm Transform** [Transform]: The transform that represents the forward and upward direction of the palm
- **Throw Power** [Float]: Multiplies throw velocity by this on release
- **Reach Distance** [Float]: Maximum distance for hand to grab

[POSE SETTINGS]

- **DisableIK** [Bool]: This will turn off all the automatic updates on the finger transform, like sway and bending, to allow things like animations
- **SwayStrength**[Float]: This will affect how much the fingers move with velocity
- **GripOffset** [Float]: This is how bent the fingers are (0-1) recommend a slight bend of 0.1-0.2 to allow for sway room

[ADVANCED SETTINGS]

- **Ignore Release Time** [Float]: How long the hand will ignore collision with the object its releasing, this is important for smooth throwing
- **Grab Spread Offset** [Float]: This will affect the width of the grab area, increase for more range but potentially worse automatic grabbing results
- **Finger Bend Steps** [Int]: How many physics checks are made when bending the fingers, decrease for slight performance increase but decreased pose quality
- **Grab Time** [Float]: How many seconds it takes for the hand to grab something at max reach distance (Rec. < 0.1)

[EDITOR SETTINGS]

- **Show Gizmos** [Bool]: Whether or not to show all the hand grabbing rays
- **Editor Auto Grab**[Bool]: When true the hand will try to check and grab what's in front of it in scene, in editor mode. Great for setting up static poses.
- **Use Layer Based Auto Grab**[Bool]: When true, the editor auto grabber will target the object it's targeting layer, instead of just the object it's targeting

[EVENTS]

- **OnGrab** [EVENT]: Called when the hand grabs this object
- **OnRelease** [EVENT]: Called when the hand grabs this object
- **OnSqueeze** [EVENT]: Called when the hand squeeze function is called
- **OnUnsqueeze** [EVENT]: Called when the hand unsqueeze function is called

Important Functions:

- **Grab()** The hand will grab the closest Grabbable object, if any, in front of hand within reach distance. It will then call the OnGrab event on the Grabbable object
- **Release()** The hand will the held object, if any, apply throw power. It will then call the OnRelease event on the Grabbable object
- **ForceReleaseGrab()** This will release the hand without calling OnRelease event or applying throw strength
- **Squeeze()** The hand will call the OnSqueeze event on the held object.
- **Unsqueeze()** The hand will call the OnUnsqueeze event on the held object.

[FINGER SCRIPT]

The Finger component is a modular script used as a core piece of the pose generation system. This component is responsible for containing the open/closed poses for the hand and it manages the finger bending/stopping algorithm for generating automatic poses.

You can use this component without the **Hand component** by saving the Open/Closed poses through right clicking the **Finger component** in the inspector.

[PUBLIC SETTINGS]

- **Tip Radius** [Float]: Radius for the fingertip, acts as a physics bumper, seen through the gizmos
- **Bend Offset** [Float]: Adjust the bend offset of the individual finger. 0 is no bend, 0.5 is half bend

Important Functions:

- **BendFingerUntilHit()** This will bend the finger until it hits something, then it will stop
- **UpdateFingerBend()** Takes input 0-1f, will bend the finger, if hits something it will stop
- **SetFingerBend()** Takes input 0-1f and will force bend the finger without doing physics checks (0 is open finger, 1 is fully closed finger)

[GRABBABLE SCRIPT]

The grabbable script should be attached to any object that the hand can pick up. It has public Unity Events that will be called by the hand when interacted with.

[HOLDING SETTINGS]

- **Body** [Rigidbody]: The rigidbody references, if left blank will default to local GetComponent. Allows for custom grab settings per collider.
- **Hand Type** [HandType]: Whether this can be held by right/left/both/no hand
- **Single Hand Only** [Bool]: Whether or not this object can be held with only one hand at a time
- **Release On Teleport** [Bool]: When true, the hand will drop this object when its max distance is reached. Should be true for objects too big to carry
- **Lock Hand On Grab** [Bool]: When true, the hand will become kinematic while grabbing
- **Maintain Grab Offset** [Bool]: When true, the hand will create an offset instead of returning back to the follow point, good for grabbable gadgets and grabbable joints.
- **Instant Grab** [Bool]: When true, the hand will instantly return to its follow position on grab
- **Pull Apart Break Only** [Bool]: When true, the hand will never call the joint break event unless being held by more than one hand
- **Make Children Grabbable** [Bool]: Each collider needs a Grabbable or a GrabbableChild with reference. When true, all the children colliders will be referenced to this grabbable component

[EVENTS]

- **OnGrab** [EVENT]: Called when the hand grabs this object
- **OnRelease** [EVENT]: Called when the hand grabs this object
- **OnSqueeze** [EVENT]: Called when the hand squeeze function is called
- **OnUnsqueeze** [EVENT]: Called when the hand unsqueeze function is called
- **OnJointBreak** [EVENT]: Called when the joint breaks, used to simulate pull-apart

Important Functions:

- **HandRelease()** This will force the hand to release this object and apply velocity
- **ForceHandsRelease()** This will force the hand to release this object and not apply velocity, like it was dropped not thrown.

[PLACE POINTS]

The Place Point Component is a tool that allows for custom grabbable placement settings through a trigger collider. For completely stable connection use isKinematic, for a physics breakable connection, use a rigidbody, for no connection just use neither.

[ALLOW/DENY SETTINGS]

- **Place Names** [String[]]: Only objects that have **names** that *CONTAIN* any of the given strings(Case sensitive) will be allowed to place
- **Blacklist Names** [String[]]: Objects that have **names** that *CONTAIN* any of the given strings(Case sensitive) will NOT be allowed to place

[PLACEMENT SETTINGS]

- **Place Radius** [Float]: The radius in which an object can be placed
- **Force Place** [Bool]: Whether or not the object will be forced released and put into the place point as soon as it enters the trigger
- **Parent On Place** [Bool]: Whether or not to parent the grabbable to the point when placed

[PLACED SETTINGS]

- **Start Placed** [Grabbable]: Leave blank for nothing, connects this grabbable on start, can be used to test offset
- **Placed Offset** [Vector3]: Offsets the position of the placed object allowed in this place-point
- **Make Placed Kinematic** [Bool]: Whether or not to make the grabbable kinematic in the place point until grabbed again
- **Placed Joint Link** [Rigidbody]: allows for the option of jointing the given rigidbody with the object in place, this will all the effect of a weighted connected when break force is adjusted.

*By default Place Points require a sphere collider, for more advanced place bounds, reduce the place radius to 0 and add custom trigger colliders to the object

[GRABBABLE POSES / POSE AREAS / POSE DRIVER]

<u>These components can all be used to create custom poses with the hand.</u>

- **Grabbable Poses** are used to set a custom saved grab pose.

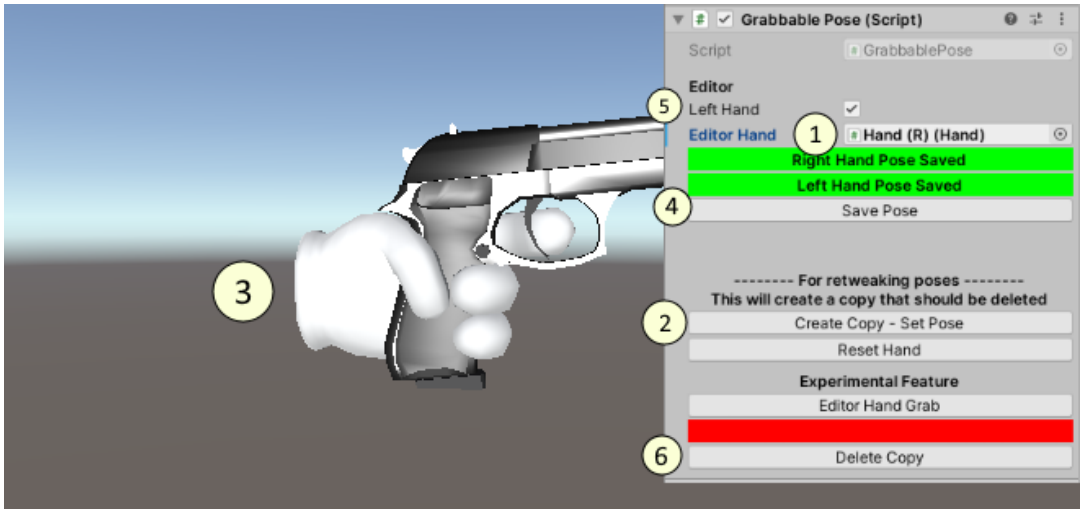
- **Pose Area** is a trigger collider that can be used to set the hands pose, while not holding, when in this collider. **STRONGLY RECOMMEND PUTTING A TRIGGER SPHERE AROUND HAND TO PREVENT POSE FLICKERING (SEE EXAMPLE HANDS)**

- **Pose Driver** is used to save and call a local pose through code

*THIS APPLIES TO THE **POSE DRIVER** AND **POSE AREA** COMPONENTS

1. Make sure you're in a scene view, attach a hand in the scene for editor copy
2. Create a copy for editing purposes

   By default Editor Auto Grab is enabled on the hand copy
3. Shape the hand, positioning the Hand Object, then adjust the individual finger rotations/positions, anything with or under a Finger Component Object to your liking
4. Save Pose
5. Do the same for the other hand (you can invert hand x Scale to -1 to do this)
6. Delete Editor Copy
7. (Optional) Apply overrides to prefab to save for all instances



[CONNECT TO ANY CONTROLLER]

This is for custom input setup outside of the included demo packages, if you are looking to use XR, SteamVR, or OVR follow the **SETUP** documentation instead.
All these packages come with a **HandControllerLink** script attached to each hand, that allows for custom input setting adjustments

Auto Hand will connect to any controller with ease. There are only up to 5 essential functions that should be linked to their respective controller events.

```
public class VRHandController : MonoBehaviour{
    public Hand hand;
    public VR_Controller controller;

    void Awake(){
        controller.TriggerClicked += hand.Grab;
        controller.TriggerUnclicked += hand.Release;
        controller.Gripped += hand.Squeeze;
        controller.Ungripped += hand.Unsqueeze;
    }

    private void Update(){
        hand.SetGrip(controller.GetTriggerPressValue());
    }
}
```

The controller link system demonstrates that in order to connect a controller to the hand all you would need to do is call the

- hand.Grab() function when the trigger is pressed.
- hand.Release() function when the trigger is released.
- hand.SetGrip(0-1) takes the controller trigger current press state and bends the fingers along with how much the trigger is pressed

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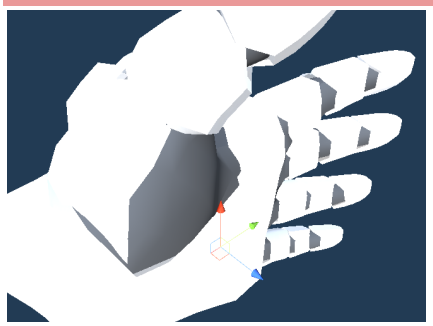
[CONNECT TO NEW HAND]

WATCH THE SETUP VIDEO

1. Create new prefab with a rigged hand model
2. Apply Hand component to root of hand prefab
3. Apply Finger component to the root of each finger transform
4. Add each finger to the fingers array on the Hand component
5. Add an empty gameobject to the last child of each finger and connect to the “tip” value on finger
6. Use on gizmos to see finger-tip radius
7. Adjust its position and the tip radius (value on Finger component) until the wire sphere gizmo covers the fingerprint of the finger and do this for each finger
8. Shape hand rig into its completely open position (flat open palm)
9. Click the *Save Opened Hand* button on the bottom of the Hand component
10. Shape hand rig into its completely closed position (Fist)
11. Click the *Save Closed Hand* button on the bottom of the Hand component
12. Create an empty gameobject and center it just above the palm of the hand with blue forward arrow pointed away from the palm of the hand and the yellow arrow pointed towards open finger
    IMPORTANT CHANGE TO PALM ROTATION NOT INCLUDED IN VIDEO
    
    palm transforms local rotation should be like this now including y axis pointed towards open fingers
13. Drap it into the "Palm transform" slot on Hand component
14. (Recommended) Add colliders to the skeleton (refer to hand prefab for example)
15. Turn off gravity on the hands rigidbody, increase the mass (recommended >= 10) and turn on continuous detection

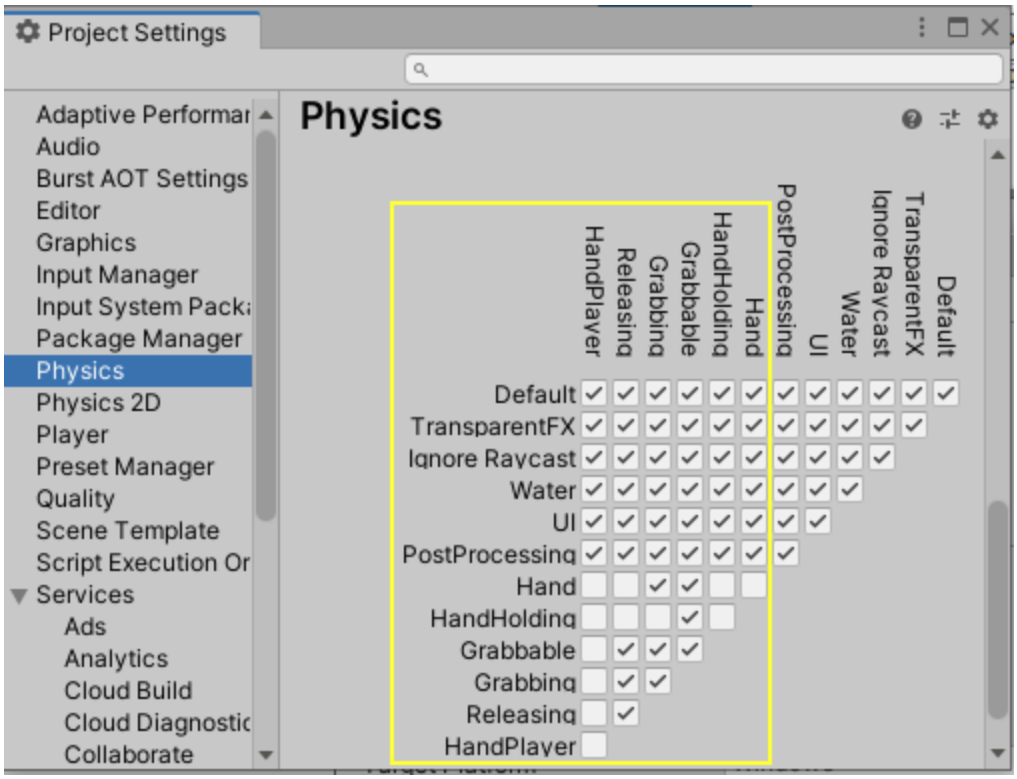
[PHYSICS SETTINGS]

Auto Hand at its core is a physics based system and requires some changes to the default Unity Physics Settings to work as designed. Some things are just general recommendations to improve the overall performance, but the physics layers are a requirement and help to prevent some critical bugs. You can change the name of the grabbable layers and more information on each one's significance near the top of the Hand.cs component.

* ALL SETTINGS SHOULD BE APPLIED WITHOUT OVERRIDING ANYTHING THROUGH THE SETUP WIZARD (should automatically popup or find at **Windows/Autohand/**)

Required layer settings

In Edit/Project Settings/Physics



These are the required physics layers. Don't worry about applying these layers to the objects in the editor, all layers will be applied through the setupwizard at runtime.

The strongly suggested physics settings

In Edit/Project Settings/Physics

- Enable adaptive force to allow for better rigidbody stacking
- Increase Default Solver Iterations for more precise stacking / reduced jittering
- Increase Default Solver Velocity Iterations for more precise throws and
- Increase Angular Velocity to at least 40 (default is too slow to match controller rotation speed)

*If you want to use the finger pose system without the physics interaction system, refer to **FAQ** or **Finger Component.**

[ADVANCED INFO]

- The Hand works by interpolating each finger between the saved opened and closed position. For the best results an open pose on the hand should be open to the point of being a flat hand. You can set the "Grip Offset" value to adjust the default pose of the hand so you don't have a pancake hand when not grabbing, and some room for movement sway, but still have good grabbing results.

- **Gadgets:** are designed using a base reader class with some value customizability. The **Hinge Angle Reader** base uses a Hinge Joint and reads its angle limits. The **Configurable Limit Reader** reads the Configurable Joint Limit. Usually the reader will default from (1 to -1) representing open/closed, with the center at 0.
  There are a handful of user friendly premade gadgets with easy to use Unity Events.
  - You can find all the included gadgets by searching for **PhysicsGadget.**

- Physics will work better with a reduced fixed timestep recommended min. 1/60, 1/90 for very good results

- You can bend individual fingers by changing their offset value on the Finger component

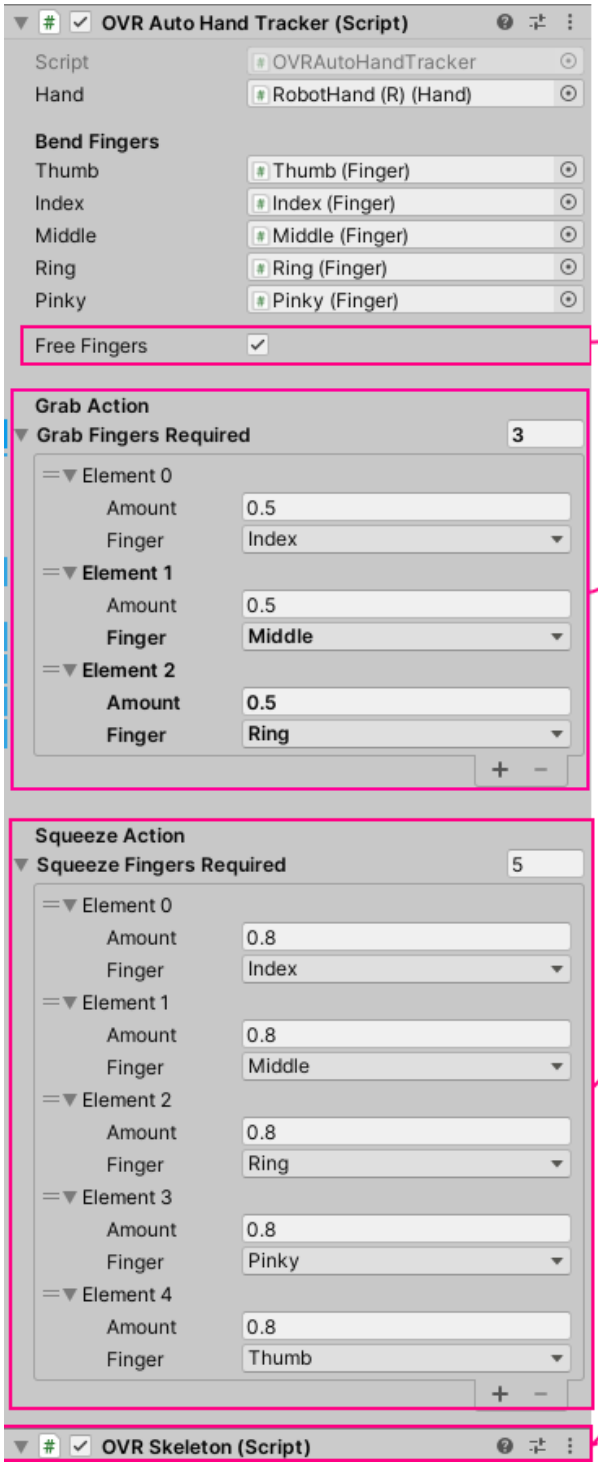
- The closer to the surface of the finger the fingertip is, the closer the grabbing results

- You can increase the hands “strength” by increasing the rigidbody mass

- Rigidbody drag can help reduce jitters and smooth movements when increasing follow speed. You can adjust the drag and the hand follow speeds to get different follow results.

- The follow speed, max velocity, and hand model rotation pivot will all affect throw feel

[HAND TRACKING CONTROLLER]



Whether or not fingers not required for grab action should have free movement while holding

Represents the fingers required being bent past a certian range to call grab action

Represents the fingers required being bent past a ceritan range to call squeeze action

This is required for Oculus Hand Tracking