Dr. Martin

Proctor: …and then you'll see a bounding box around it. How it works is, you'll see, you'll have, like, what's highlighted blue here. Those are for translation, like the little handles, and then the bars that you see that are white in this, but they're highlighted yellow here. Those are for rotations. And then you're just going to try to pick up these, excuse me, pick up these blocks and place them using it, and then we'll kind of just talk about it and go.

Participant: Okay. Are there particular user study questions I should be thinking about?

Proctor: Yeah, I'll ask you [them]. Basically, like, the first one as you're doing it; what do you like or you just like. You know, like negative things about it; positive things about it. Like just your thoughts on that. Then, there's a few other questions left you could base most of my questions off of what you're saying.

Participant: All right. And then, as far as the bounding box itself: what- I know you told me, like, what each thing does, its operation, but what is the bounding box actually bounding?

Proctor: So basically the gripper, it kind of goes around the whole thing here. But basically, the bounding box will control, you know, where this is. So: move this to the right, move this to the left, and then rotation and stuff: it'll be regarding to just the gripper part. So, it will rotate right here on this axis.

Participant: So is the bounding box supposed to be aligned with the gripper right now?

Proctor: It's-

Participant: Because right now…

Proctor & Participant: It's off.

Proctor: Yeah, it messes itself up. I tried resetting it. It won't…

Participant: So, is the interface- I pinch?

Proctor: Yes, you pinch. And it's a limitation of the HoloLens, but sometimes it won't directly see your pinch if- you have to kind of exaggerate it, sometimes. I mean, if it's not getting it, probably just try to exaggerate that pinch.

Participant: I see. Okay. Let me see if I can get all these… Okay. Okay. Okay, that's that one. Alright. Okay. Got it. All right. I think I get it. Okay. Okay, so the blues then are moving along a particular axis then?

Proctor: Yea; x-, y- and z- [axis].

Participant: Okay. Then, I do notice there's a dotted line that has these arrows that seem to be changing.

Proctor: Coming out of your finger?

Participant: Yeah.

Proctor: So, you can step back from it, if you'd like, and use that as, kind of, like, a pointer and then pinch. So, that will also work, so you can interact with it from far away. So, at the end of that line, you'll have to get it on the handle. It can be a little difficult- sometimes, it's easier to do that way; sometimes, it's more difficult to do it that way.

Participant: And what are the arrows? There's two arrows that come out of that.

Proctor: It kind of just shows you that you're actually on it.

Participant: Okay. Yeah. Okay.

Proctor: They turn red?

Participant: Yes.

Proctor: So...

Participant: So, the bounding box is colliding with…?

Proctor: So, that's just, kind of, like, a limit; like, like to say that you're- you can't go any further. It's going to- So, if you open your hand like this- I forgot to say there's a- there's a gripper thing you'll see.

Participant: Oh, gripper? I see an interface. Open. Closed. Oh, that. Okay.

Proctor: Yeah, yeah.

Participant: So, that's what you mean. So, I can pinch the slider…

Proctor: Yeah, you can pinch in the slider and how it works is: because when you close it, you'll see that the gripper goes… It might not work because it's red. You might want to…

Participant: Actually, I might want to have tested that first.

Proctor: Yeah, sorry. You'll open and close it; and, you'll notice that when you close it, the gripper went way down here, so it kind of limits that. Yeah. You'll kinda see that.

Proctor: So you'll run into [where] it'll show red before you actually are at the bottom; because, when it's open and when it closed, - sorry, I was gonna tell you about that - so it accounts for that extra space.

Participant: Well, I think we're going to have trouble; because, I can't get it, the gripper, where it's actually close enough; because it turns- the bounding box is now shifted too far down. But I think it's going to… Let me see.

Proctor: I'm trying to see what you see. Looks…

Participant: There. So, it's red, so I can't get any further.

Proctor: Try closing the grippers. See if you get... If you're able to grab hold of that…

Participant: So, I think it's shutting- There's a safety system that is preventing anything else. Now, if you have to reset…

Proctor: Yea, I'll try resetting it. I'll also try to get my previous *[unintelligible]* loaded up here. Oh, there you go.

Participant: Yeah. So it's like basically your bounding box is way down, like that, and it's off.

Proctor: Yea, move it up a little bit. That's also an issue with it. You'll see when I do this that the bounding box doesn't know where the robot- the hololens doesn't know where the robot is.

Participant: Right.

Proctor: So, the bounding box has to be set by us. And, then that leaves, obviously, human error to me.

Participant: Have you thought about using a fiducial marker on the robot?

Participant: Because, you kind of- With mobile robots, I know I have to do that with HoloLens, otherwise the lens has no idea where they are. And that's, I think, what you're running into here.

Proctor: Yeah. Okay. Get this. I'm new to this one. I'm new to this controller, so. That one, I know. This one, I haven't played with [it] as much.

Proctor: Another thing, I don't like it: if you want to set it up- Because, I didn't write this code. We have another student here that's actually developed this prototype that you're playing with; Miles. With the bounding box that when you create it, it has a certain amount of- They won't let you move it, but so far away from where you've actually created it. So, sometimes when you do that, you have to be, like, right here to create it; which is why I got hit in the head. It makes me feel-

Participant: A little bit concerned. It might look friendly, but it's still a robot arm.

Proctor: Yeah.

Proctor: Alright, here you go. Let me set this up right.

Proctor: It also creates it sideways for some reason…

Proctor: Every time. I don't know why it does that. I've set it, and it turns the gripper 45 degrees.

Participant: Well, it looks like we're at least more centered now, so maybe, maybe it will get down to the blocks now. I can adapt to it not being aligned correctly. I use a lot of user interfaces, and we end up adapting to theirs anyways.

Proctor: Yeah. I mean it should be okay. I don't know why it's doing that exactly.

Proctor: But it plays better now because it's right there at the bottom of the…

Participant: Yeah. Just instead of it being, like, two inches below, we're now just like right here. So, hopefully that will be plenty. So. Let's focus.

Proctor: Are you the computer engineering professor that does stuff with, like, a picture, like a LiDAR robot or something?

Participant: Oh, yeah, yeah, I do autonomous robotics. So all of my platforms, they get to mess with the ugly of the world. So we have LiDAR, GPS- Well, it depends on the robot. I've indoor mobile robots and outdoor mobile robots.

Participant: So, some feedback that I think that would help, like for the user, is knowing- that being able to, maybe, raycast- Where is the end effector? Because as far as I- as it's oriented, something that could be like a dotted line going from the center of mass of the robot. Well, the center, center of the gripper, actually. Center mass of the gripper, straight down, perpendicular.

Proctor: So, you got to align it.

Participant: Yeah, because I'm eyeballing [it]. I'm sure I could do it, but I think it would help with accuracy.

Participant: Also I've noticed- So yeah, the HoloLens is pretty… I think it could be even [that] the bounding box is probably too big; because, like, right there I had to reach up really high, but then I had to take attention away. So like, you can see what I'm looking at there. Like, it was up high and I had to look up, the bounding box actually would kind of disappear when I'm trying to grab this, the top of the box.

Proctor So. Look. Yeah, it's harder to get to those certain handles.

Participant: So in the extremities, I could see a challenge there. And then you have the Hololens limitation on- Okay, so now I'm in the red.

Participant: The pinching interface is a little tricky. Let's try this.

Participant: So, the bounding box definitely throws me off a little bit. Like I'm adapting, but as far as- Because it's off, that definitely is… Because like, now the way it's oriented when I go like [to] move it, it's then counterintuitive to my brain.

Proctor: And that was- yeah, it's not supposed to be like that

Participant: I'm pushing it…

Proctor: Yeah.

Participant: So I mean these are things where, I guess, you can look and see how the- what's going on with the transforms.

Proctor: Yeah. So like, improvements other than, obviously the bounding box being at 45 degree angle from the arm is [one], but, like, improvements that you've seen to make it look better, refine it. Just like one second.

Proctor: So, improvements other than that being not correct that you could see to make it easier for you to interact with it?

Participant: Right. So, it's like I said, some kind of indicator that would show me, the user, where the center of the gripper could be. That could very well be just dropping a line, you know. Probably, depending on- I don't know what your axes are, but I'd be assuming my end effector has [a] 3D axis like this.

Proctor: Yeah.

Participant: So, dropping it along the x-direction of your gripper's inertial frame. That would be a help. Especially because [of] the bounding- it could be projected through the HoloLens; but, also I noticed, just in general, the HoloLens: the field of view of it is actually smaller than I thought, in general.

Proctor: Yeah, there's, there's other solutions on the plate start-up companies and stuff that make way better than the HoloLens. The hololens is kinda.. It has a very- Like, when we did our original testing with students, and we tested multiple different interfaces to control it. From, like, joysticks to buttons; sliders, everything. They all allow them the same complaints. [That] were like: "the field-of-view is too small." "I can't actually do this and see what I need to see."

Participant: So yeah, but that's, kind of, beyond assessing this particular user interface. That's just in general.

Proctor: Yeah.

Participant: I think a challenge for all augmented reality is… So, right there. Actually, that was a case where: I was trying to keep attention on the robot, but my view is just a little bit below that. So, as I was picking up the arm, it went out of field-of-view and the robot stops. So, that right there, I was trying to lift it up, but then my view…

Proctor: So, one of the other suggestions someone gave is to have these handles. The ones in the back aren't very useful; because, you have to move through it to get to it.

So, you can't get to them really. [It] is to have moved them a little bit, so that they're more accessible to their user then.

Participant: I mean, I also wonder if it's just better to not even have them on the bounding box. [Instead] that you have a safety box around it that basically just tells the user, “hey, this is the space that's like a safe zone.” So, as long as I don't collide with anything in this safe zone, I'm good. But then, it's like, they could have something off to the side that they can manipulate with their hand. Like, I don't know. I saw something like in Minority Report that was something like that. It's some other object that you're able to manipulate.

Proctor: You actually shut down. So, like, like a separate gripper that you could manipulate and just the box-

Participant: I really don’t think it could be a gripper. It's just some other kind of way of pretending like- These are all, I get it, it's like you're grabbing. It's, it's the motion of trying to grab the arm and saying, “Hey, arm, get over here, do this. Twist.” But, it almost feels like if you could maybe grab some other objects; just like a ball in space and you're just moving it in some way, and like to twist the arm, you could rotate it. That requires some more, like, graphics programming and math that is going to transform what this motion is into that. But, I kind of wonder, now that I've been messing with this, I wonder if something where it's sort of, like, an assistive thing, off on the side, that is not bound to the box. So that, it's so I can keep it in my field of view, and then I don't have to worry about the robot leaving [my] field of view or like one of the hooks.

Proctor: I'll give you a little background [on this]. So, the idea of this is to be a precise movement. So, we kind of took away what we had. The idea will eventually be… Yeah, I guess you probably played the game operation? Where you, where you have like, you know. So, we'll have the tips of the gripper, have that conductive aluminum foil type of tape around it and the pieces will be wrapped in the same stuff; and, your goal will be to put those into places like, you know, a few millimeters of *[unintelligible]* around it, precisely, and not have them connect. And then, obviously, you'll hear, like, the eeeeh *(the alarm)* and stuff. So, that's kind of- The goal of this is to try to do more precise movements. When you have that version but it's not a bounding box, you have the box like it is now, but you can grab it anywhere. Then, you can lock particular axes and work

on just those [other] axes, and you can lock axes for rotation and just work on those as well. So it's, you're not- You know, you can single out axes, but you can grab the box anywhere. So, you're not actually going for like the handles, or, like, the little bars to rotate.

Participant: Yeah. So stepping away. I do think this works a little better, but it also, like, using this current interface- I do think because- It could just be because I'm taller or whatever; it might just be, I'm losing field of view; I don't know. But stepping further back, certainly, I'm able to grab things, I think, a little better, and then I can see everything. Well, actually, no. The hololens seems to have a hard time with the…

Proctor: It's detecting the technique.

Participant: Yeah. The bounding box itself, that's something that would have to be resolved to make this really usable; because now, I thought maybe the robot was not tied to how the bounding box is, but, as I'm watching its motion, it is. It's- So, now that I'm trying to grab... Instead of… Yeah, it's moving it off on some other angle; and, it's not- Because it's not a line, it's hard to get over that block.

Proctor: Yeah. We'll define this, what causes this issue, and fix that.

Participant: It's like, here is a perfect case where it'd be nice to have a little dotted line dropping down into the bounding box, so I could visually- Well, also, in my brain sort of map that to what that block is, so I do a better job of knowing where I really am. I think that would definitely help the interface.

Participant: Some other feedback [that] would be good too is: actually, I'm obscuring the gripper right now. So, I don't know if I actually- The only reason I know it's closed is because I hear the gripper straining. If there was a way to- So having in that interface, getting some feedback, and I don't know if you all have access to all the lines of information coming out of the arm, but having any sort of force feedback or, potentially, if not force feedback, there could be some sort of like torque limit that gets hit. That information can come back into the interface, so I know I actually have the block in my hand.

Proctor: We can set all the- We can set how much force the grippers will grab with and stuff. One thing that we did do, maybe you might like that more is- I was gonna say, instead of putting break on anything, we can limit how much force it would grab with. But, do you think buttons would be easier just to press [instead of the bounding box]?

Participant: It could be. Oops. “Battery is low. Charge your device.”

Proctor: Yeah, just hit “close.”

Participant: It could very well be just a: “open” [button], “close” [button]. That's certainly- When you're thinking about, you know, cognitive overload or something. Like, I've been a part of other user studies of, like, army people, and usually it is about [that] kind of overload. You don't want to have them think about too many things. So, I'm thinking about grabbing the block, but then I also have to worry about this slider and I'm also worrying about the bounding box. So like, there's all these things happening, but if I can offload some of those, so if there is a way that the gripper itself can sense when it has gripped then it would be better to probably just make it an open-close interface. Because then, I don't have to think about ten levels of grip. It's just: do it or don't.

Proctor: Yeah. Okay. And then one of the last questions we wanted to ask is, following this kind of thing is: in real world scenarios, where you think this might be useful or a solution to [a problem]? Anything you could think of? Just like, well, just, kind of, just to add to our paper. You know, anything that you could...

Participant: Um. I don't know; because, you can, you can do different algorithms for teaching manipulator arms a sequence; and, I don't need a HoloLens to do it. In its current form, the interface is too slow for me to be effective. So, if I think about being a factory worker trying to tell the robots to do something, so where- So like, in standard manufacturing, I don't think it'd be very useful if it's too slow and the interface is too hard to use for, say, something like that. But potentially, if you're talking about, like, a hazmat situation and, like, I can't be anywhere near these things. Now, then what are you doing with a HoloLens on you? Kind of exact question. But there might be- If there is some other interface that would let me to be more stand off from materials that would maybe be bad for a human then I think this type of interface would be more useful.

Proctor: You said the same thing as a guy before you. Yeah, pretty much.

Participant: Yeah, so. But, yeah, it's. This type of interaction is there's other ways to do this with an arm. Especially ones that are more sophisticated like this; that have more sensors in the arm, like a typical industrial robot out on, like, a BMW factory floor is not- Well, I could be wrong now, but at least several years ago, they wouldn't have been as kitted up as far as sensors in every joint. But now that you've got all those, there's ways, there's better ways to do this, to teach motions, if that's what you're getting after. If you're not getting after, like teaching the motions, then yeah, I think the best use case for me would be: “I have to stand off from something and manipulate it, but the automated algorithms can't do what I want it to do.” I have to do it like what you're saying, in a more precise way. That's where I think it would be useful.

Proctor: Alright, cool.

Participant: Well, I guess I'll put the block down.

Proctor: Oh wow, I've never seen that.

Participant: Yeah, well, these are 3D printed, right? Yeah, that's just rubber. Yeah, just gripped in the little grooves.

Proctor: Cool. Thank you so much.

Participant: Yeah, you're welcome.

Proctor: I appreciate all your time.

Participant: No problem. Hopefully that was useful for you.

Proctor: It was very useful.

Participant: All right, cool. Well, have a good one.

Proctor: You too, sir.