

## **Human Computer Interaction (Hindi mein)**

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**IoT and HCI - Lecture 9, Part 2**

**Lec35**

[Sangeet] Toh namaskar main Dr. Abhijeet Mishra aapka swagat karta hoon HCI course mein. Pichle saptah mein maine aapke saath discuss kiya tha ki HCI IoT kya hote hain? Individually maine in dono par maine baat ki thi. Phir maine dono ka mel bataya tha. Kitna zaroori hai in dono ka mel. Kaafi tarike ki maine applications aapke saamne rakhi thi. Aur usse related maine aapko kaafi saare margdarshan diye the ki aap kis area mein zyada kaam karne ki zaroorat hai. Kis tarike se kaam karne ki zaroorat hai. Kaise HCI ki techniques ko apnana hai. Kahan-kahan isko apply karna hai. IoT kitna zaroori hai hamare rozmarra ke zindagi mein waghera waghera. Toh aaj is course mein is bhaag two mein basically ab main aapke saath kuch case studies present karunga jo ki HCI bhi hain aur IoT bhi hai. Dono hi hai. Dono hi us kaam ko darshati hain. Aap dekhenge ki kaise usko humne kiya hai, create kiya hai, kya tarika apnaya tha, woh sab cheezein hum is lecture mein baat karenge. So aaj ka agenda hamara jo hua hai woh hamara case studies hai jismein hum do projects ke baare mein baat karenge. Ek hai Hapty Track aur doosra hai Movie Tangibles aur yeh dono hi mere kaam hai aur yeh dono hi kaam HCI plus IoT ki duniya mein laagu hote hain. So pehli case study hum jo discuss karne ja rahe hain is Hapty Track. Jaisa ki maine ismein neeche darshaya hai. Iska is is kaam ka maksad kya hai? Is kaam ka maksad hai enable karna. Matlab start karwana, shuruwat karana friction experience ki VR mein. Toh pehle dekhte hain kyun zaroorat hai VR mein. Toh pehle yeh samajhte hain ki friction kyun zaroori hai hamari life mein? What is the need of friction in our life? Right? Toh friction hamari life mein kis-kis tarike se madad kar raha hai? Hamari yeh chalne mein madad karta hai, pakadne mein madad karta hai, dhakkamukki maarne mein, darwaze ko madad karta hai. Right? Toh aur aise bahut saare kaam hum apni daily routine mein karte hain jahan par hum friction ke bina woh kaam hum nahi kar sakte. Toh friction ka yeh role hai. Even aap kisi surface ke textures ko samajhne ke liye friction ka role friction ka use karte hain. Right? Even pen ko pakadne ke liye aap friction ka use karte hain. So friction ke bahut use hain. Ab chuki ab hum ek virtual reality ki duniya mein bhi pravesh kar chuke hain. Abhi tak toh hum desktop wale world mein the. Jahan par hamare paas ek screen thi, ek keyboard tha, mouse tha jiska apna CPU tha aur hamara interaction is area mein hota tha. Aur iske saath hum interaction iske through karte the. Basically not interaction we give input aur hum keyboard aur mouse se karte the. Right? Yes you can say interaction because what is the difference between input and interaction. So input is the process ek tarika jisse aap de rahe ho input. Right? Ismein koi aap expectation nahi kar rahe ho ki aapko

kuch milega. Aap de rahe ho. For example it's like aapne pen ko ya mouse ke clip ko just randomly daba diya. Toh that is input. But what is interaction? Interaction is that aapne kuch input diya kisi bhi system ko and us system ne aapko kuch uska feedback diya. This is called interaction. Right? Okay. So, coming back to this. Wapas se hum apne lecture pe aate hain. Toh maine yahan par thoda sa clarification kiya aapke saamne ki input kya hota hai? And what is interaction? Input could be input agar aap ek leman ke term mein baat karein ki unidirectional activity hai but interaction bidirectional activity hai. Okay? So ab maine aapko bola ki ab hum ab hum desktop ke saath-saath VR world mein bhi enter kar chuke hain. Jahan par hamare paas ek aadmi hota hai, user hota hai aur ek ek VR headset pehne woh khada hota hai. Right? VR headset. Ab yeh VR headset ke through ek bahut badi duniya dekh raha hai. Hum ab us duniya mein suppose karo maan lo ki yeh ek friction ke baare mein padhna chahta hai. Toh content toh usko display ho raha hai iske screen mein. But usko yeh feel nahi kar pa raha. Feel kaise karein? Ab for example yeh aap iske saamne wood la ke rakh do. Right? Iske saamne ek metallic surface la ke rakh do. Toh aapko kitne surfaces iske saamne la ke rakhne pad rahe hain. Right? Just to enable ki aap usko provide kara sako ki bhai is wood ka surface ka friction bahut zyada hai. Iska surface ka friction bahut kam hai. Ab aap feel kar lo aur experience le lo ki this is friction. But yeh enable karne ke liye aapko kitni kitni madad karni hai. Kitni aap keh sakte ho kitna aapko kaam karna pada. In terms of arrangement of wood in terms of arrangement of metal surface and related all items which is required for VR. Right? So yeh sab jo requirements thi jo ek friction ki learning ko badhane ke liye thi ismein kaafi barrier hai jo ki maine abhi aapko bataya kya barrier hai bahut saari cheezein chahiye table chahiye different type ki table chahiye material surface chahiye and so on. Toh maine aur yahi logon ne paaya ki agar hum kisi tarike se friction ke programmable effect ko agar enable kara dein kisi tarike se agar hum enable kara dein isko hum start kar dein VR mein VR world mein agar hum enable kara dein ki user ek hi surface pe zero friction mid friction high friction tarike ke effects ko experience kar sake toh uska enhancement aur uski learning toh hogi hi hogi. Saath hi jo requirements hain usko poora karne ke liye kya poora karne ke liye? Programmable friction ki feel ko poora karne. Agar for example mujhe abhi high friction feel karna hai toh main woh feel kar loon. Agar mujhe mid friction karna hai toh main woh feel kar loon. Without need of surface instrumentation aur usko destroy karne ke bajaye us surface pe bina kuch kare hum us pe agar enable kar dein toh kitna achha hoga. Usse yeh saari requirements zero ho jayengi aur khatam ho jayengi. Right? Toh yahi logon ne paaya ki agar hum variable friction functionality support karti hai performance and emotions and point ko woh create work kar create kar degi realistic feel provide karti hai kisi objects ka kar sakti hai aur deeper immersive experience bhi provide karti hai. Toh yeh saare kya bolte hain positivity jo yeh variable friction functionality provide karta hai uske liye humne kya kiya? Pehle ke kuch kaam dekhe. Toh aap dekho yeh ek approach hai jiske through aap shoe pe variable friction functionality enable kar sakte ho. Kar sakte ho. Toh yeh ek another approach hai jiske through aap dobara se aap kuch dobara se wahi same friction variable friction functionality ko aap enable kar sakte ho surface ke upar. But aap dono approach ko agar dekho toh aapko kya milega? Aapko milega. Dekhiye kitna saara ismein mechanics involved hai. Agar aapko kisi ek leman for

example koi bhi A person hai agar usko yeh variable friction ko use karna hai VR mein toh woh kaise use karein? VR is IoT device. Agar usko use karna hai. Kaise karein? Toh yeh toh kar nahi sakta. Aur imagine bhi nahi kar sakte. Koi yeh karega. Yeh bhi nahi koi kar sakta. Itna kaun modification karega yeh sab upgrade karne pe. Toh humein ek light weight simple device chahiye jo ki jisko leverage karke koi bhi kar sake. Right? These are the following limitations. Previous approaches ki complex hai. Jaisa ki maine bataya ease of integration not at all possible. Balki create karenge. Agar kisi bhi object ke neeche agar un approach ko laga doge jo peeche de rakhi hain. Obviously is object ka jo size hoga woh kya ho jayega? Badh jayega. Toh balki ho jayega cause deployment issue because aapko neeche lagana kya pata iske neeche jagah hi na ho isko lagane ki how will you add those things? Toh aap nahi kar paoge isliye humne is work mein ek approach ko dhoondha jiska humne naam diya Hapty Track. Jo ki enable karta hai friction experience ko bhi aa gaya jo ki electroadhesion phenomena pe laagu hota hai electroadhesion hota kya hai yeh ek popular technique hai jismein adhesion effect koi bhi object ka jahan jiske upar aap electroadhesion aap apply karte ho uska surface ke saath uska variable ho jaata hai jaise jaise aap is pe supply change karte ho. Main aapko abhi iske baare mein aur samjhaunga aage ki slide mein. So jaise ki yeh aapka koi device hai. Yeh ek metal plates hain. One two yeh gap hai. This is the gap. Right? It's like a parallel plate capacitor configuration. Right? Isko aap supply de rahe ho. Toh jaise hi yeh surface ke contact mein aata hai, yeh iske surface ko polarize kar dega. Yahan par ek force of adhesion develop ho jayegi. Toh maine kya paaya ki maine testing ki. Maine yeh paaya ki bhai jaise-jaise yeh force ko is board ki supply ko main isko change kar raha hoon. Toh main main dekhna maine yeh paaya ki yeh jo force hai iske beech mein jisko hum force of adhesion bolte hain. Right? Jisko force compressive se aap isko link kar sakte ho. Because yeh compressive force hai. Yeh isko apni taraf kheench raha hai. Kaun sa surface? Surface B surface A ko apni taraf kheench raha hai. It's like a compression. But agar aap koi isko move karna chahega toh friction ka formula yeh hota hai. Right? Toh yeh friction ki force yeh force of compressing force change hogi with supply. Yeh supply board hamara yeh hai. Isse hamari friction force change hogi aur is friction force ke change hone se friction o sorry is compressive force ke change hone se friction force hamari change ho jayegi. Yeh humne paaya is working principle aur yeh maine yahan par kuch fabrication process bataya. Abhi main aapko iske baare mein dikhaunga iski working kaise hoti hai. Toh yeh basic equipments isko chahiye yeh device banane ke liye. Aap dekh sakte ho aluminum foil hai, paper hai, just scale just to cut it or you can also manually cut. Koi ek particular tarike ki shape ki requirement nahi hai. Aap isko thoda randomly bhi cut kar sakte hain. Toh right? Aur this toh peeche ka jo process hai usko follow karke fabrication process ko follow karke maine yeh kuch yeh banaye aapke saamne. Right. Phir maine technical evaluation create kiya connect kiya jiska purpose tha evaluate karna ki kaise friction device aur surface ke beech mein vary karega input supply ke saath and kaun sa minimum size hai jo ki reliable adhesion provide karega across all surfaces. Right? Yeh aur for testing maine is tarike ke surfaces ko maine uthaye kyunki normally paaye jaate hain home pe. Kisi bhi indoor settings mein aap is tarike ki surfaces ko aasani se paa sakte hain. Yeh mera testing setup tha jahan par maine without manual intervention ko add kare. Maine evaluation

create kiya. Evaluation kiya. Technical evaluation kiya ki jaise-jaise time badh raha tha. Friction force kaise change ho rahi hai with supply. Right. Toh, yeh mere testing results aaye. Jahan par maine isko maine modify kiya. That is modify matlab supply voltage ko maine variable banaya. Yeh upar wali line aur neeche wali line yeh denote karti hai ki main apni sab controlling board ko supply toh main zero se 5 volt ke beech mein hi de raha hoon. Lekin jo mera device hai usko jo supply ja rahi hai woh 0 to 2 kilovolt ke beech mein ja rahi hai. Ab aap keh rahe honge yeh toh bahut zyada hai lekin yeh 2 kilovolt multiply by microampere current now you can company you will you will get it. Aapko aap samajh lo .01, .03 milliwatt which is nothing. Aapko koi current nahi lagega ya aisa koi heavy shock kuch nahi lagne wala. Right? Kyunki at the end jo matter karta hai woh power mein matter karti hai. Kitna power hai, kitne powerful device hai woh. Right? Toh maine jaise aapko bataya hai 2 kilovolt agar maximum hai toh microampere mein current hai aur iska agar aap multiplication karege toh .01 ya .2, .3 milliwatt ke aaspaas aapko power aayegi jo ki bilkul negligible power hai power hai aapko shock lagne ki. Right? Toh maine yeh dekha ki jaise-jaise voltage badh rahi thi friction bhi friction effect device ka surface ke saath woh bhi badh raha tha aur is yeh bahut fruitful result tha hamare liye kyunki aur phir maine is pe kinetic test bhi kiya. Jahan par maine device ke beech mein friction ke graph ko sorry force jo bhi offer ho rahi thi usko maine device ka surface ke beech mein jo bhi supply isko maine move karaya aur uski supply ko variable banaya usko aur uske accordingly maine friction force ko calculate kiya. Toh maine dekha ki jab-jab main friction supply voltage ko badha raha tha toh friction force badh raha tha. Kam kar raha tha toh friction force ghat raha tha. Right? Toh isse mujhe dikha ki main kabhi bhi kisi bhi moment apni friction force ko change kar sakta hoon. Ek mere ko yeh confidence mila. Doosra main kisi bhi surface pe yeh test kar sakta hoon. Doosra confidence mere ko yeh mila. Toh, yeh mere device ka maine is tarike se approach kiya. This is the way main kis tarike se main isko aage badha raha hoon aur aage karne ki koshish kar raha hoon. Right? Phir mere question the. Phir maine user ke saath evaluation kiya. Uska jo purpose tha user evaluation. Ab mujhe yeh pata lagana tha ki kya minimum voltage pe maine jaise ki aapko pata hai zero se 5 volt meri range thi. Toh kis minimum voltage pe user ko friction force feel hui. Toh pehle toh mujhe woh pata lagana tha. Right? And doosra phir mujhe agar koi room agar left hai for example zero se 5 volt hai. Yahan kahin feel ho rahi hai. Toh abhi itna voltage level abhi bhi baaki hai. Toh kya koi doosra level hai jahan par friction force  $F_2$  will be different from  $F_1$ ? Toh woh uske liye phir maine doosra experiment kiya. Yeh mera poorra testing setup tha. Right? Yeh maine ek light weight device rakhi thi apne object ke upar apne device ke upar. User jis users ke saath kara raha ho woh usko sahi se pakad sake without putting any bias related to their weight unke hand ki wajah se. Total three females total eight participants which includes three female. Yeh unka hamara demographic information hai. Toh in total mere aath participants the do question jo maine aapko bataya aath surfaces kyunki maine yeh test aathon surfaces pe kiya tha. Uske baad mere ko jo total experiment jo maine karne mujhe humein humein karne pade woh total 128 the. Yeh mera pehla result hai. Jaisa ki maine bataya zero se 5 volt ke beech mein jo mera pehla point mila jis pe  $F_1$  is different from  $F_0$  woh 1.77 hai. Toh since 1.77 corresponds to 1.8 toh maine 1.8 volt maine consider kar liya iske liye. Right? Doosre mein mere

ko mila 3.2 toh maine isko 3.2 le liya. Right? Uske baad mere ko koi bhi doosra point nahi mila. Toh that means 0 to 5 volt ki range mein mere ko teen point mil gaye. Jahan par friction difference tha zero, F1, F2. That is low, mid, high. Phir maine user validation create kiya kyunki mujhe abhi toh mujhe yeh pata chala tha ki do point aise hain jahan par friction alag hai. Toh mujhe abhi inko validate karna tha ki people sahi kya log sahi mein isko experience kar pa rahe hain. Phir maine isko test karne ke liye maine apna is equation ka maine use kiya. Jahan par friction force toh aa hi rahi hai. Mujhe thoda weight ka bhi effect lana tha. Kyunki koi bhi banda mere device ke saath direct play toh karega nahi. Obviously kuch yeh kisi ke object ke neeche hi lagayega. Toh that means us object ka apna weight hoga. Toh mujhe ab yeh validate karna tha kya is weight ke saath bhi friction force offered by my device kya woh log usko sahi se pehchan lenge? Is perceivable. So, yeh pata lagane ke liye maine 100 gram tak testing ki. And yeh mera pooraa ek setup tha. Right? In total to conduct this experiment. Maine 10 participants liye the. Usmein do question the. Eight surfaces the. Four types of weight the and total 640 experiments humein karne is cheez ko validate karne ke liye aur yeh hamari overall findings nikli across ki log 90% accuracy ke saath static friction ko pehchan le rahe the and 85% accuracy ke saath kinetic friction ko pehchan lenge. Toh yeh ek bahut achha result tha jo ki demand karta hai no instrumentation to the surface, no explicit modification on the user and still providing variable friction functionality into the VR. Toh VR mein aap is tarike se ab aap case samjhiye suppose yeh IoT because VR headset is nothing but IoT device. Yeh ek IoT device hai. Ab yeh banda yeh jo user hai yeh IoT device pehen ke baitha hai. Right? Ab usko friction ke baare mein samajhna hai. Toh yeh scene jo hai yeh user dekh raha hai iske andar. Ab usko friction ke baare mein samajhna. Woh kuch nahi karega. Woh yeh block ko ek-ek karke is area mein rakhega. Ab woh ab itna easy setup hai ki ab us tarike ke setup ki requirement hi nahi hai. Like for example jo wooden benches hum use karte the in order to understand about friction in schools. Toh for example agar ek school mein 30 benches hain for 60 students considering ek table pe do log hain. Haan toh 30 benches in one school multiply by considering 100 school. Toh aap isko keh sakte ho 3000 benches right 3000 benches corresponds to wooden category now kitna wood ka wastage ho raha hai ab aap isko pooraa ka pooraa zero kar sakte ho. Make it zero just based on my approach that a device that is can be integrated jisko aap easily integrate kar sakte ho VR mein aur VR mein aasani aasani se mere approach ke through friction ke baare mein samajh sakte ho. Right? Obviously mere is work ki ek limitation hai. Metallic surface mein kaam nahi karega but uske liye aur progress aur invention ki aavashyakta hai. I hope aap mein se koi na koi usmein aage aayega. Jo is limitation ko fulfill ya pooraa karega. Jisko is kaam mein thoda sa interest aaya hai, please mere baare mein information maine aapko share ki hai. Aap please mere se baat kar sakte hain. Aap mere ko email kar sakte hain. Ab doosra area main jo baat karne ja raha hoon, woh Movie Tangibles doosri case study. Ismein main kya kar raha hoon? Main handheld tools. Miniature manipulation experience ka enable kar raha hoon. Miniature manipulation. What are handheld tools? Handheld tools? Toh let's understand first first understand that aaj jaise ki maine pichle case study mein bataya ki virtual reality education field mein bahut use ho raha hai. Bahut zyada sab learning ke liye usko use kar rahe hain. Lekin VR controllers jo aate hain haath mein

jisko leke hum virtual reality mein khelte hain game khelte hain seekhte hain ya kuch bhi operation perform karte hain woh capable nahi hai to provide all this kind of manipulation experience jo ki yeh wale ismein exist karte hain. Right? Jaise yeh raha miniature manipulation. Yeh raha manipulation, yeh raha manipulation. Kyun? Kyunki unke paas sirf button pressing experience hi hota hai. Toh ab isko kaise enable karein? Bhai ab ab aap toh yeh expect kar nahi sakte ki koi bachha ya koi bhi engineer ya koi bhi person itni saari objects ko woh khareedega. Phir unke baare mein samjhega ya usko use karega ek VR world mein. Yeh toh possible nahi hai. Matlab kabhi bhi possible nahi hoga. Hum imagine bhi nahi kar sakte. Toh kaise karein ki ek hi device yeh saari cheez ka understanding de de ki kaise isko manipulate karna hai, kitna manipulate karna hai. Right? Toh ab isko karne ka kaam isko kaam ko karne se pehle humne maine maine kya kiya? Pichli work work ko dekha ki woh kis tarike ki kaam ko kar rahe is tarike se enable kar sakte hain. Agar hum unki approach ko agar hum dhyaan mein lein toh jaise ki isne dekho kaafi saara ek invention rotary wala type ka kiya hai rotary jismein aap rotary kar sakte ho. Ismein aap sliding kar sakte ho. But in dono mein problem kya hai ki electronic parts hain. Integration ki demand karta hai. Complex software based prototyping ka involvement hai. Aur isliye technical expertise ki bhi demand hai. Ab yeh cheez hum phir se expect nahi kar sakte kisi bhi user ke paas ki yeh saari cheez ki facilities hongy in a resource limited settings. We all are present in our in our society and so how kis tarike se woh yeh experience ko enable kar sakti hain. Kyunki in approaches mein toh limitations hain. Toh main phir maine hamari approach ko invent kiya jiska humne naam diya Movie Tangibles jo ki work karti hai detecting changes in magnetic field intensity using smartphone whenever magnet moves over a sensor. Toh ek abhi aapko baare mein isko aur definition create karta hoon main. Clear karta hoon. So, maine kya kiya hai? Ek yeh smartphone case type aapko dikh raha hoga. Ek yeh aapka ek yeh sketch hai. Toh maine kya paaya hai ki mujhe woh miniature manipulation karni hai. Jaise maine like for example kisi mein linear translation hai. Maine design space ko bolte hain design space study aur kisi mein rotary hai. Right? Ab woh cheez mere ko agar enable karni hai toh maine ek magnet magnetometer ek device maine dekha. Mobile phone ke andar ek magnetometer ek device hoti hai jo ki mostly yahan present hoti hai. Toh maine dekha agar magnet ko agar main yahan seedha move kara doon toh ismein variations hote hain iske signals mein aur woh variation itne achhe hote hain for example zero to ki aap usko aasani se read kar sakte ho. Yeh 2k microtesla aasani se aap usko read kar sakte ho aur woh linear bhi hote hain. Toh maine dekha ek case banate hain chalo aur ab rotation isko move toh hamesha linear hi karana padega. Theek hai? Ab lekin mujhe deni kisi ko rotation feel hai. Toh maine rack and pinion mechanism ka use kiya aur is equation ka use karke ek model banaya. Kaise banaya dekhte hain. Toh pehle maine jaise maine aapko bataya tha pehle maine design space ki study ki. Study se mujhe nikla ki ya toh kisi mein linear translation type ka motion hota hai ya kisi mein rotation type ka motion hota hai. Hum uske basis pe maine yeh mechanism create kiye. Like linear translation hai toh aap aise move kara do ek hook bana ke. Ek rotation hai toh aapne rack and pinion mechanism ko attachment de do kyunki iske saath lag jayega and yeh aage peeche move hoga. Actual movement toh yeh translation hi ho raha hai. Lekin user ko jo feel milegi woh rotation milegi kyunki woh ghuma raha hai.

Theek? Yeh hamara actual case hai. Toh, yahan par aap dekho. Toh, yeh iske andar ka view yeh raha. Yahan par ek strip hai iske andar jismein ek magnet attach hai. Yeh aapka rack and pinion mechanism hai. Yeh aapka holder hai jo yeh nikla hua. Aur aap isko move karao toh rotation translation feel aayegi. Agar aap isko use karoge toh aapko rotation feel aayegi. Yeh iska view aur in other format mein hai. Then maine technical evaluation create kiya. Ab ismein goal kya tha ki mujhe pehle yeh pata lagana tha ki mera magnet ka distance jab woh aise-se move karega magnetometer se ke saath, kya since B is inversely proportional to R ki jaise distance kam hoga kya magnetic field badhegi? Mujhe yeh discuss karna tha. Yeh evaluate karna tha ki tabhi main isko deploy ya user ke saamne rakh sakta hoon VR world mein. Toh, usko karne ke liye maine yahan pe kuch marking create ki. Phir maine yeh maine ek application ka use kiya jismein jo ki data record mein bahut aasani se role play kar sakti hai. Phir maine isko conduct karne ke liye maine ek sirf slider manipulator liya kyunki mera aim tha distance aur magnetic field ke beech mein relation janana. Mujhe yahan pe field ki koi zaroorat nahi thi. Right? Aur toh maine do ek do scenario mein maine data collect kiya. Ek near to electromagnetic device, ek away from the electromagnetic device. Phir maine paaya ki jaise-jaise [Sangeet] aapka distance kam ho raha tha decreasing waise-waise magnetic field badh rahi thi. Phir maine in dono ka correlation nikala aur yeh bahut same the. Inmein koi changes koi significant effect nahi tha inki measured values mein. They were almost same. Right? So is equation ke findings ke basis par maine ek model ki ek equation nikaal li jo ki represent kar rahi hai ki agar agar main slider ko is position pe laake rakhunga. For example agar main slider one se lekar six this is three. Agar main slider ko four position pe laake rakhunga yahan se toh us corresponding jo magnetic field ki value hogi woh yeh hogi. Right? Ya us magnetic field pe jo position hogi woh yeh hogi VR mein. Toh usko paane ke liye mujhe equation chahiye thi jo ki maine aapne dikhaya. Phir maine humne user evaluation kiya jahan par hamara aim tha ki user se yeh janana ki agar aap manipulate kar rahe ho VR mein toh kya aapko realism kuch feel ho raha hai? Toh humne is cheez ko teen condition mein create kiya. Controllers, bare hand, Movibles jo ki hamari approach hai aur uske liye humne 15 participants ko humne recruit kiya tha. Ismein humne chhah tarike ki applications create ki thi aur ismein teen application thi translation wali aur teen application thi hamari rotary rotary wali. Toh har ek tool ke corresponding ek application ka humne usmein kaam involvement kar diya tha jisse ki log engage ho jaaye jab woh hamare Movie Tangibles ko try karein, approach ko try karein. Toh jaise ki vernier caliper ke liye humne banaya tha ki unko vernier caliper se isko yahan par thickness measurement ka ek operation perform karna hai. Right? Yahan par as per the tool yahan par unko cut karna hai aur ek cutter ki jo blade hai usko aage peeche karna hai aur usko set karna hai according to the thickness of this sheet jo ki wahan dikh rahi thi. Similarly yahan par sand karna hai. Rotary mein again ek ball ke size ko measure karna hai. Again yahan par ek hole create karna hai aur ismein ek IC ko desolder karna hai PCB mein se. Toh us tarike ke application application ko humne design kiya aur logon ko logon iske saath application khele unse is humne do questions pooche ki unko feeling kaisi thi? Was it realistic? Har scenario mein maine poochha VR controller mein bhi bare hands mein bhi aur Movibles mein bhi aur simply hum unse ek question aur poochha ki fatigue kya aapko kuch thakaan

mehsoos hui hamare approach ko use karte hue? Toh in do question pe humein result prapt hue hue the woh main aapko abhi present karta hoon aur linear translation yeh yahan pe kuch scenes dikh rahe hain ki log kaise har ek scenario mein kaam kar rahe hain aur yeh hamara obtained result tha. Agar aap dekho dhyan se toh Movie Tangibles kyunki hamesha hi woh high realism ke bar ko usne touch kiya hai aur low fatigue ke experts ko touch kiya hai. Agar aap neeche dekho toh seven corresponds to low fatigue and seven corresponds to extremely realistic in comparison to other other two cases like bare hand and approaches VR controllers. Phir humne is par ek statistical analysis ki thi Wilcoxon's laga karke toh usne usne bhi confirm kiya ki hamari jo approach hai woh high realism low fatigue experience provide kara rahi hai. Obviously is work mein ek limitations bhi hai ki bhai magnet ki presence hai toh aapke kuch credit cards, magnetic hard disk ismein possible nahi hai ki unke saamne isko use kiya jaaye. But generally woh use nahi bhi hote hain. Right? And abhi ke case mein is approach mein aap ek hi samay ek samay mein ek hi type ka manipulation aap use kar sakte ho. Kya ek samay mein do type ka kar sakte hain? Toh in questions ko answer dene ke liye mujhe agar aapke paas koi sujhav hai please mere tak pahunche. Kyunki hamare paas bahut saare tools aise bhi hote hain jahan par hum jismein do tarike ke mechanisms involve hote hain. Hum unko abhi bhi enable nahi kar pa rahe hain. Toh yeh abhi bhi ek limitation hai. Bahut badi limitation hai aur jiske hum solutions ko dhoondne mein lage pade hain. And finally shape obviously abhi sirf humne is pe manipulation pe hi baat ki hai. Is poora is poore work mein shape ki humne kahin baat nahi ki hai. Toh shape ko kaise enable karen? Yeh ek doosra challenge hai. So aapne abhi dekha ki main aapke saamne do case studies rakhe. Ek rakha maine aapke saamne Haptic Track aur ek rakha maine aapke saamne Movibles. Ab aapne yeh dono dekha ki dono hi ek objects hain. Ek physical form factor ke type ke objects hain. Right? Lekin dono hi kitne barriers ko kam kar rahe hain. Kiske liye kam kar rahe hain? Users ke liye. User kahan isko use karenge? Ek IoT device mein. IoT device kya hai aapki? VR, smartphone if it is in if it is AR. Toh these are IoT devices. Ab aapko link karna hai. HCI is all about how much you are kitna aap user ko digital data se in a low barrier settings mein aap unko engage kara rahe ho. Kyunki agar barrier high hoga digital interaction mein toh user kabhi engage nahi hoga digital data se. Pehli cheez agar barrier bahut low hoga toh user can be engaged with a digital data ya digital interaction digital world. Toh yeh hamari ek priority hai. Bahut important priority hai. Duniya digitalization ki taraf badh chuki hai. Aane wala samay aur digitalize hone ja raha hai. Agar digitalize hota chala gaya aur humne usko physical aur digital world mein jo gap hai agar woh badhta chala gaya toh aap samajh sakte hain ki jisko physical cheezein samajh mein aati hai physical tarike ke duniya mein jo physical world mein real world mein jis tarike ke woh kaam ya interactions perform karta hai batchit karte samay objects ko chhoote samay feel karte samay agar wahi cheez humne enable nahi kiya digital world mein toh usko bahut difficulty aane wali hai. Because you can't expect aap nahi sam... aap yeh generalize nahi kar sakte ki throughout the world ki throughout the world people ke har logon ke paas woh knowledge hogi. Woh gyan hoga. Woh abhi ke daur mein abhi is moment hum generalize nahi kar sakte. Humein nahi pata aane wale samay generalize is baat ko generalize kar payega nahi kar payega. But humein iska khayal bhi rakhna hai ki jo aapka physical world hai aur jo aapka

digital world hai iske beech mein gap bahut kam ho. Bahut bahut kam ho. Uske liye yeh saari invention bahut zaroorat hai. Main aasha karta hoon ki aapko mera yeh poora ka poora lecture jo mera case studies thi jisko through maine aapke saamne aapko samjhane ki koshish ki ki HCI aur IoT kitna zaroori hai? HCI is all about kaise barrier ko kam karein? IoT is about connection with the technologies, objects connection, things connection with the things, things connection with the humans and so on. Right? Toh in dono ka merge hona kitna zaroori hai jisse ki ek hum ek achhi duniya, achhi interactive duniya ka vistar kar sakein aur log aasani se ek doosre se digital world se door baithe logon se aasani se baat kar sake. Isse main aapko dhanyavaad karta hoon. Ab thank you so much. [Sangeet]