Brute Force Interactions: Leveraging Intense Physical Actions in Gaming

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ABSTRACT

People use a wide range of intensity when interacting with computers, spanning from subtle to brute force. However, computer interfaces so far have mainly focused on interactions restrained to limited force and do not consider extreme physical and brutal interactions, such as those encountered in contact sports. We present an exploration on the topic of "Brute Force" that aims to support researchers and designers who want to leverage the benefits of such forceful interactions. We present the results of a survey on this topic and describe how the salient themes could be used to inspire design work, in particular in a mediated environment, augmented with computing technology. We describe how the themes inspired certain features, and how technological limitations were overcome during this process. We hope with our work we can encourage designers to expand their range of supported interactions to include these physically intense behaviors we call Brute Force that are exhibited in many activities in people's lives.

Author Keywords

Design space, blunt force, brute force, Exertion Interface, physical, tangible, videoconferencing, sports, social interaction.

ACM Classification Keywords

H5.2. Information Interfaces and presentation (e.g., HCI): User Interfaces.

INTRODUCTION

Human beings have participated in sports activities for thousands of years; however, the appreciation of sportive actions in the human-computer interaction field is relatively young. Sport has many advantages, with physical health benefits probably the most widely discussed in recent years, as it is believed to have potential to address the obesity issue (Pate et al., 1995). Sport has also been attributed with social benefits, such as the ability to acquire social skills (Morris et al., 2003) and support individual growth and community development (Gratton and Henry, 2001). Such social aspects have also been investigated within the HCI and CSCW community; hence we propose looking at the sports field might provide inspiration for these endeavors, too. However, not all sports are the same nor provide identical benefits. A wide range of perspectives on sports (physiological, sociological, ethical, etc.) indicates the complexity of the topic. For the purpose of this paper, we focus on sports that involve bodily activities in which participants voluntarily invest physical exertion. With this definition, we can further narrow down a subset of popular sports activities: contact sports. Contact sports are sports in which rules allow physical contact with the social other, and are often associated with extreme physicality or Brute Force. Sporting activities such as American football, ice hockey and boxing are characterized by their explicit support for body collisions and hence Brute Force, and although these sports can be dangerous for the participants' health, many players enjoy participating besides the risks (Anshel and Russell, 1994). Some even say that if the sport does not hurt, it was not a good game (Straub et al., 2003).

The purpose of this paper is to foster an appreciation of Brute Force actions within the field of HCI by highlighting their role in sportive activities and investigate their role in mediated environments. Smaller, less physically intense bodily actions have been previously researched, mostly from a games perspective: studies have explored exertion games that are played with additional input devices beyond mouse and keyboard, often within the context of supporting participants' weight loss efforts (Graves et al., 2008, Lanningham-Foster et al., 2006). These approaches,

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however, do not focus on the bodily actions the participants are involved in, but rather their physiological outcomes. We believe by adding extreme physical interactions to the range of interactions HCI researchers and designers consider, we can contribute to a greater appreciation of sportive activities and hopefully utilize their advantages when it comes to our interactions with computers. Brute force interactions are particularly interesting because they often involve body-to-body contact, and are associated with physical pain. Understanding why people voluntarily participate in these activities, besides the risks, might benefit from computational augmentation; we believe this could be one example how research could make a valuable contribution to this area.

OVERVIEW

We begin by describing the use of Brute Force in people's interactions, in particular during contact sports. We then describe the theoretical basis for our approach. We also examine relevant prior work and point out remaining issues and aspects yet to be explored. We conducted a survey to understand people's experiences and opinions of contact sports. We then show with an example application how technological augmentation can explore the notion of Brute Force, which was inspired by the themes that came out of the survey. We also explain how we used the conceptual themes to create specific design features, and how we overcame technological limitations in realizing these features. We conclude with an outlook on how our work can be expanded to further utilize Brute Force within the context of human-computer interaction.

BRUTE FORCE

By Brute Force in human-computer interaction, we mean interactions exhibited by users that are deliberately very forceful, and are of brutal character or quality.

Our work aims to sensitize our appreciation of the advantages of Brute Force as highlighted in many sport activities: boxing, rugby, wrestling, or many Asian martial arts activities could be characterized by a core element of Brute Force. These Brute Force interactions are associated with many risks to physical health (Anshel and Russell, 1994), but nevertheless, people participate in them despite the risk. It seems as if the sheer intensity these sports activities facilitate are an important factor that makes these sports so attractive to some. We want to introduce the concept of "Brute Force Interface" to have a common terminology for researchers and designers when they talk about these forceful interactions. Furthermore, by scientifically investigating these interactions, considering them equally as part of the many behaviors humans exhibit, we want to point out the value these interactions potentially have. Thirdly, we aim to create awareness that people use brute interactions in their daily lives, for good and for bad, and that these interactions can be augmented with computing technology.

CONTACT SPORTS

Contact sports are defined as sports in which contact between opponents is allowed. These contact sports, or collision sports, are activities in which contact is necessary and integral to play, in contrast to sports in which contact only occurs incidentally (Keller, 2007). These contact sports have certain characteristics that make a distinction with other sports activities worthwhile when we talk about Brute Force in an HCI context. For example, Straub et al. found that contact sport athletes can tolerate pain significantly longer than non-contact athletes (Straub et al., 2003), hinting towards an affective aspect of the bodily contact that is facilitated by the experience.

It should be noted, however, that Brute Force is not limited to contact sport or sport in general, but we focus on sports because this context serves us well to illustrate our thoughts. We acknowledge that contact sports have often been the subject of controversy, and not all users value the benefits, nor consider participating in them a viable option. However, we also notice that many people do engage in contact sports, besides the risks, and value them as parts of their lives. This makes Brute Force an activity that deserves our consideration, we believe, and ignoring it would devalue experiences many users engage in, often weekend after weekend on sports grounds and in gyms all over the world.

EXERTION VS. BRUTE FORCE INTERFACE

We have previously defined an "Exertion Interface" as an interface that "deliberately requires intense physical effort" (Mueller et al., 2003). A Brute Force interface has similar characteristics, as it can also "be physically exhausting when used for an extended period of time" (Mueller et al., 2003). In a Brute Force interface, the focus is on the intensity of the physical and bodily dimension, or, in other words, on the 'brutal quality'. Therefore, we consider Brute Force interfaces to be a subset of the Exertion Interfaces space.

RELATED WORK

Perhaps the earliest example of a networked Brute Force interface is the *Telephonic Arm Wrestling*, an art project from 1986 (White and Back). Two players arm-wrestle a mechanical device that measures and applies force across a dedicated phone line. Recent instances of this approach are now available in public museums, where the players are connected via a videoconference, being able to select to arm-wrestle another person on the other side of the country (Gizmag Article: Haptic Arm Wrestling hits the net, 2004). Unfortunately, no evaluation of the system has been reported so far, making the drawing of conclusions out of the use of Brute force in networked environments difficult.

Related work derived recently from a CSCW perspective, and the term *Computer Supported Cooperative Sports* (Mueller et al., 2007b) has been coined. To encompass social play, some use *Computer Supported Cooperative Play* (Ishii et al., 1999). For example, a networked gym system is *NetAthlon* (riderunrow.com), which allows riders of exercise bicycles to race against other remote riders, represented by three-dimensional avatars, using either a screen on the handlebar or a head-mounted display. Unfortunately, an investigation into the user's experience when investing Brute Force to pedal faster has not been conducted as yet. The *Virtual Fitness Center* (Mokka et al., 2003) uses a similar approach with exercise bicycles positioned in front of a video screen. The physical movements conducted on the exercise bicycle are used as input to modify the representation of 3D virtual environments from map information. Reversely, the map information affects the pedaling efforts. Despite the suitable hardware, this documentation does not provide any conceptual guidance how to utilize the physical interactions and what difference the mediation facilitates.

Tug-of-War can also support Brute Force; a networked version has been demonstrated in New York. At the New York Hall of Science two teams of high-school students were involved in a tug-of-war 13 miles apart from each other (New York Hall of Science - Press Room). This and many more physically demanding interfaces have been developed (Bragt, 2005), however, although they have been described in terms of technical challenges encountered during the development, they have rarely been investigated from an HCI perspective in a way that can aid us understand how to design for a Brute Force interaction.

The advent of a new style of computer games that utilize physical interactions has also arisen. Nintendo achieved a commercial success story by having introduced a controller that contains accelerometers and infrared sensors to support more physical interactions. In order to hit the virtual tennis ball, the player uses the controller like a racquet (Wii Sports). Another example is *EyeToy Kinetic* (eyetoykinetic.com), which tracks a user's body movements using a webcam to provide a personalized workout program in the living room. Microsoft has also announced to support Brute Force interactions in the future using additional sensors that they will incorporate into their gaming products (Gamestrailer, 2009).

Lawn and Takeda (1998) define an "action interface", which enables remote participants to play table tennis together. This action interface is very similar to our definition of Brute Force, however, the lack of force feedback and the limited support for fast bodily actions might limit the use of intense physical effort by users. On the other hand, Chi et al. have developed a system that directly aims to detect Brute Force interactions: the authors have developed augmented body protectors for martial art competitions (Chi et al., 2004).

INITIAL SURVEY

In order to understand people's perceptions and opinions of Brute Force and in particular its benefits in human-computer interaction, we decided to ask potential users. In informal preliminary discussions on the topic however, we realized that the term Brute Force creates many ambiguous associations and its use as a computer interface was too much of an unfamiliar field for non-researchers. We therefore focused our initial survey on the topic of contact sports, a common and familiar exhibition space for Brute Force interactions. In particular, we were interested in the subjects' experiences with contact and non-contact sports.

In a structured survey 24 participants reported on their contact sport experiences and opinions. The survey was conducted by email and participants were recruited via personal contacts and referrals. They did not receive any compensation for their participation. The average age was 31.6 years old, 17 participants are male, 7 female. These demographics indicate that it would be unfeasible to expect a representative view on the topic from this survey, however, our intention was not to provide a comprehensive account of contact sports, but rather an inspiring picture of what influences users' views and beliefs.

All but one volunteer reported that they had some sports experience (measured by participating at least 10 times). From this point onwards, we report on the 23 remaining participants. The volunteers mostly mentioned martial arts, (European) football, basketball and hockey when asked about their most prominent involvement with contact sport. In particular, jujutsu, karate, kick-boxing, tai chi, kung fu, taekwondo, capoeira and judo were mentioned, but also water polo, rugby, ice- and field hockey. The most common non-contact sport mentioned was running (or jogging), followed by tennis, going to the gym, pilates, walking/hiking, snowboarding, dancing, table tennis, volleyball, badminton and squash. People did not seem to have trouble identifying whether a sport was a contact or non-contact sport (although there was explicit space for expressing such concerns), but questioned if yoga or gym exercises count as sport. For our investigation, it is interesting to note that volleyball and basketball were once listed as contact as well as non-contact sport, indicating that a differentiation is not always obvious.

Contact Sports

The participants who enjoyed contact sports mentioned the following reasons:

- Competitiveness: contact sports were generally considered to be more competitive than non-contact sports. In regards to martial arts, one participant noted: "When it comes to martial arts, the competitive aspect

together with self-control and self-awareness plays for me an important role". Another volunteer noted: "Contact sports are more synonymous with teams and competitiveness". One participant believes that "all contact sports are competitive". Contact sports appear to facilitate a notion of competition in a way non-contact sports do not, at least for our participants.

- Intensity: contact sports were regarded as more intense, requiring more "high levels of exertion" than non-contact sports. People more likely associated strength and speed with these types of sports: "A reasonable degree of physicality is good fun …" In particular, one participant made an interesting observation of himself: "I like the exercise and the challenge. Directly competing with another person for a ball or puck leads to me exercising more (and noticing less how tired I am) than exercising by myself". If this notable point could be generalized to inform a computationally augmented interface, the result might lead to an application with superior health benefits, we speculate.
- Directness: As indicated in the previous point, people attributed a sense of directness, especially when considering associated competition, with contact sports. This is especially apparent in martial arts. One participant noted: "contact sports […] feel more like you versus other people...non-contact are often more like you versus yourself?? [sic]". Being able to directly affect and be affected by a human opponent could be a design goal, according to our participants.
- Injuries: the only negative comment contact sports received (although by the majority of participants), is the fear of injury in contact sports. Non-contact sports were considered less dangerous or harmful for the body. One participant noted: "With contact sport, I expect to get hurt. My brother was a nightmare to practice fencing with because he had no fear - he was confident and aggressive (in a nice way), and he used to frighten me […] with a contact sport, you expect contact which might be forceful, and therefore painful." However, one participant noted: "[In contact sports] you are more likely to get injured in a physical way i.e. concussion, broken bones; [in a non-contact sport] you are more likely to get tissues injuries i.e. strained muscles, pulled hamstrings. Each sport has its downfalls." On the other hand, when asked about non-contact sports, participants judged them to be "a lower risk of injury." One participant noted: "it feels like you are less likely to get hurt. They are more often based on speed, skill and tactics rather than including sheer strength [...]" These observations could influence the design process of physical interactions by suggesting the use of technological augmentations to minimize the fear of injury.
- Social aspect: many participants saw a correlation between contact sports and team sports. The participants valued a psychological aspect that is facilitated when playing with others, which seemed to be interlinked with the physicality of both parties' bodies. For example: "[I like the] connection between contact and the 'mental game', i.e. ability to influence the psyche of the opponent by the use of contact". Another participant noted: "[I like contact sports because of the personal physical challenge and direct physical competition, particularly trying to out-think the opponent while engaging in a difficult physical activity". This interrelation between the psychological component of sports play and physical contact seems a salient aspect that our participants valued. Furthermore, they associated contact sport with team activity, teambuilding, "being a team member" and social interaction: "I think there might be more contact sports that are team-oriented than non-contact sports", "…it encourages team work and exercise" and "What I most liked about [karate and fencing lessons with family] was the social aspect and fighting my brother". One volunteer said: ""I would think contact sport is like a team sport, whilst non-contact sport is more individual." Another participant noted "you focus on the team game rather than your person[al] exertion and fitness" and also "[contact sports mean] [e]ngaging and challenging with each other instead of just yourself. There is also a personal exchange that can be very rewarding and bonding with the other person [sic]." For one participant, the social aspect was important regardless of the sport: "… having friends to exercise with still contributes to my enjoyment of a sport (non contact or contact)". Several participants like to see their children participate in such social sports activities: "I would probably encourage my children to engage in contact sports as it might help them to develop social skills." This social aspect was an important salient theme for our participants.
- Fearlessness: Interrelated with the aspect of supporting basic instincts and injuries is the notion of fear and risk that seems challenging in particular in contact sports, as one participant put it: "[contact sport] usually emphasize strength and aggression more than non-contact sports. [They] possibly also emphasize 'courage' or 'fearlessness' more, i.e. running backwards to catch a ball takes more guts if you know that someone that weighs 120kg is allowed to run into your blind side and smash you. [sic]" A participant who enjoyed non-contact sports noted: "The thought of being able to overcome your own fears and limits and THEN overcome those of an opponent make non-contact sports very interesting, more complex than merely beating the competition." Another participant also saw this aspect from a negated viewpoint, noting that non-contact sports "usually emphasize skills and speed more than strength, aggression and courage". One volunteer noted: "I think contact sports emphasize courage and aggression more than non-contact sports", however, he also pointed out base- and ski-jumping as contrary examples, but asks the question "Maybe the

main difference between contact and non-contact then is that contact is usually more dangerous?" For a designer, this element of danger and risk, coupled with an associated fearlessness and courage could be a guiding design theme that our participants might value.

- Spectatorship: Participants noted that they prefer watching contact sports, because they are more "visually appealing" and "entertaining" when compared to contact sports. Watching physical pain seems to have appeal for some: "contact sports are more fun to watch I guess, e.g. an ice-hockey game with full-on body checks, etc". However, "[which sports I watch has] more to do with their popularity in the media than anything else though I think, but perhaps they are popular [because] it takes an element of courage and fearlessness to play them." This strengthens our assumption that sports, especially sports that excite and emotionally involve, can provide a welcoming contrast to our daily lives that lack an adequate amount of occurrence of emotional characteristics.
- Organizational: most participants who enjoy non-contact sports highlighted the minimal organizational burden these sports, in contrast to contact sports, typically require: they often do not necessitate the presence of another player or team, and can be exercised typically without a specialized court or pitch, for example running, cycling or pilates. One comment was: "Most of my non-contact sports require little planning ahead. I can do them spontaneously, without considering other people's schedules." "I like the independence of not scheduling it, but [can go to] the gym whenever I want…" one participant summarized. This resonates well with our previous approaches (Mueller et al., 2007b), which enables participants to experience sports activities with remote partners, reducing any organizational burden.

It should also be noted that at least two participants mentioned that they generally do not categorize between contact and non-contact sports or generalize sport in any manner, but rather judge sports individually. For many, both types of sports have benefits: "While non-contact sports help to develop social interplay and behavior together with the ability to solve problems in a team, contact sports help to develop physical self-awareness to use one's forces with responsibility" one participant noted, and another said "Any physical activity is less dangerous to health than no physical activity", a quote that resonates well with our intentions.

Figure 1. Remote Impact.

SURVEY RESULTS AS DESIGN INSPIRATION

We have taken our survey results and used them as inspiration for a new system in order to illustrate how computational augmentation can facilitate Brute Force interactions while simultaneously address some of the shortcomings our participants associated with the topic. Our aim was not to recreate an existing Brute Force activity, nor did we intend to create the ultimate system on the topic. Rather, by presenting a functional prototype, we aim to demonstrate how the gap between conceptual themes and design (Antle, 2009) could be narrowed in regards to Brute Force, in order to encourage other researchers to work on an increased understanding of the topic and inspire designers to create novel systems. With this approach, we hope to be able to contribute to a fostering of the associated benefits of Brute Force.

We begin by describing our prototype "Remote Impact" [Figure 1], before we explain how the aforementioned conceptual themes inspired specific features. More information on the user experience when interacting with Remote Impact has been shown on video (Mueller et al., 2009a), more details on the sensing system has been reported elsewhere (Mueller et al., 2008a), and work–in-progress leading towards the current paper has been reported previously (Mueller et al., 2008b). For objectives and more conceptual challenges in the design process the reader should be referred to Mueller et al. (2007a).

REMOTE IMPACT

Gameplay

Our prototype of a Brute Force interface supports two participants, located in two geographically different locations. The gameplay of Remote Impact is as follows: The two remote players each face a sensitive playing area, on which the shadow of the remote person is projected, as well as their own shadow, in a different shade of grey.

These shadows appear to be created by a light source behind the players, i.e. if the players step closer to the interaction area, their shadows increase in size. If the players face the interaction surface, it appears as if the other person is standing next to them, because the shadows show the silhouettes of two people. The players can also hear each other through an echo- and noise-canceling videoconferencing-quality speakerphone that uses VoIP technology.

Once the game starts, both players try to execute impacts on each other's shadow. They can target any area of their partner's body, and administer hits with their hands, feet, arms, legs, or their entire body. They can hit with a flat hand or use their fists. An impact on the remote person's shadow area is considered a successful hit. The higher the intensity of the hit, the higher the points scored. If a hit is placed within the shadow area of the remote person, a visual indicator is displayed on the impact spot and a sound effect is played to indicate for both players that a successful hit occurred. If the player missed, a different visual appears, indicating that no points were added to the score. The player with the most points wins the game.

DESIGN DECISIONS

We now present specific features of Remote Impact that were inspired by the themes we gathered through the survey, and explain how we realized some of the more challenging ones with the limitations of today's technology. We use the same headings that helped us to structure our survey results.

- Competitiveness: Remote Impact is a competitive game, as most contact sports are of a competitive nature and our participants suggested that Brute Force lends itself to more competitive interactions. The points scored by each player are always visible to both parties, and a timer ensures that all participants know in advance when a winner will be announced. As the intensity of the hit is also considered to determine the score (see "Intensity" below), final scores are generally high, making a draw unlikely, further fostering a competitive aspect.
- Intensity: We implemented an intensity measurement system that is open-ended, i.e. we imposed no limit on how many points a player can score with a hit except determined by his/her strength. Allowing players to explore their maximal physical intensity they can exhibit has previously been identified as beneficial to an engaging user experience (Mueller, 2007). As we also wanted to avoid restricting players in the way they use their limbs, the design challenge was to create a large-scale sensor system that can cope with measuring extreme physical intensity, while at the same time allow for several of these intense measurements to occur. In other words, we needed to develop a multi-touch capable sensor system that can differentiate between varying intensity. Our newly developed sensing system works as follows: each station consists of a dedicated impact area, consisting of two layers of foam and several layers of fabric. The foam we used is the softest we could source to ensure maximum deformation upon impact. It is protected by a silky soft polyester lingerie fabric because its smoothness was required to minimize friction with the impact cover, which is made out of double stitched ripstop material, usually used in parachutes and therefore very strong and durable, but soft and lightweight. Its white color also reflects the projection well. Stretch sensors are attached around the surface material, and each sensor is connected to a data acquisition board that measures change in applied voltage via a simple circuit. The resulting data is analyzed with a PC that performs normalization and signal analysis. Peaks above a certain threshold from sensors in the vertical and horizontal direction determine the location of impact, the height of the peak allows for conclusions about the intensity, resulting in a three-dimensional impact plane.
- Directness: Remote Impact's gameplay is of a non-parallel nature (Mueller et al., 2009b), meaning that it allows for tactical elements such as offense and defense through a shared virtual space, in which the representations of the players, the shadows, "meet". In other words, the actions of one player depend on the other player; a player can only be as good as the other player allows him/her to be.
- Injuries: By physically separating the players, we reduce the chance of injuries caused by another player. We aimed to retain the physical impact that is characteristic of Brute Force and hence provided rudimentary feedback by having players hit a mattress, in contrast to "thin air" as often experienced in vision based systems (eyetoykinetic.com). A full-fledged force feedback system might provide better feedback as associated with Brute Force, but probably comes with a much larger technological investment, and might increase the risk of injuries.
- Social aspect: Remote Impact requires at least two players to participate in the game. It supports social interaction through an always-on audio conference, so players can discuss the game and also non-game related content after the game, similar to a locker room conversation or discussions afterwards at the local bar.
- Organizational: Remote Impact supports geographically distributed players, allowing existing player pairs to play together, even though they might not reside at the same location anymore. Supporting networked play also allows to extending the potential player base, as players could pick out of several Remote Impact stations to find a player that is available.
- Spectatorship: We wanted to allow for a visual ability to observe the other person's bodily actions, however, encountered a technical challenge: when designing for

body-to-body interactions between remote participants the cone-shape capture area of any camera that is used in videoconferencing systems can be a problem. Systems that use videoconferencing components such as reported previously (Mueller, 2002) assume the actors stay at a certain distance, away from the projection screen, which often has a hole for the camera, capturing the local action. In contrast, in a body-to-body interaction, the user wants to, and is encouraged to, come as close as possible to the other person, i.e. their visual representation. However, the conical capturing area of the videoconferencing camera, or in fact any lens-based system, captures only a limited area of the person once she/he gets closer, often only the chest area, and ultimately resulting in "no capture" once the user blocks all available light entering the lens. We therefore opted for an alternative approach to visualize the surface actions on the remote end: a camera mounted behind the user captures his/her actions. This captures all body movements, even when interacting with the surface area close-up. However, instead of distributing the video stream of the participant's back to the remote end, we use image analysis to detect the contours of the person and display his/her silhouette in its place, reducing the unfamiliarity of videoconferencing a person's backside. The user is able to determine the other person's body interactions in life-size, even when this person is standing close to the projection surface.

- Fearlessness: We believe our current Remote Impact system does not facilitate a notion of fearlessness as much as we would have liked. To add more of a 'fear' component to our prototype, we have contemplated adding electric shocks through an additional layer of conductive fabric. Pain through electric shock has been explored previously in artistic new media projects or to augment computer games since early James Bond films, however, here, we would investigate the effect fear of physical harm could have on mediated Brute Force interactions. This could form part of future work.

CONCLUSIONS

We have presented an exploration on the topic of Brute Force within the context of human-computer interaction, particularly inspired by the Brute Force interactions that often occur in contact sports. We have presented themes coming out of a user survey on the participants' experiences of Brute Force in sports. We have then shown with an example application how these themes can inspire technologically augmented designs. We presented Remote Impact, a novel prototype that allows two players in geographically distant locations to exhibit Brute Force interactions together, motivated by the benefits these interactions facilitate. We showed how the themes out of the survey can be turned into design features and explained how we overcame technological limitations in realizing their implementation. This resulted in a novel multi-touch system that can also sense intensity exhibited by users' hitting actions or extremely powerful movements such as throwing the entire body at the interface, similar to what one might see in wrestling. We have also overcome the hurdle of achieving a close-up contact using a videoconference, usually limited by the conical capture area afforded by the focal characteristic of lenses.

Our next step is to evaluate how our prototype matches the initial ideas we identified through our survey. Conducting studies with users will reveal what potential the concept of Brute Force has and where the opportunities for novel applications lie. So far, we have demonstrated that it is possible to design for an interaction that supports body-to-body interactions, overcoming general limitations of camera-based videoconferencing systems. By facilitating interactions similar to ones known from contact sports, as identified through a survey, we aimed to support a mediated Brute Force experience. We hope our work helps establish a dialogue around these ideas in the research community. We also hope this work can excite other researchers and designers about the potential of using Brute Force Interfaces in their applications.

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