PoCoMo: Projected Collaboration using Mobile Device

Mr. Rakesh S
Assistant Professor
Department of Computer Science and Engineering
Rural Engineering college, hulkoti

Miss. Simran Talikoti
Student
Department of Computer Science and Engineering
Rural Engineering college, hulkoti

Miss. Umme Salma K Gadakar
Student
Department Of Computer Science and Engineering
Rural Engineering College Hulkoti

Abstract—The system and method we propose facilitate playful social interactions among multiple projected characters, leveraging mobile projector-camera setups and computer vision algorithms. Through hand movements, participants can guide these characters, which can interact with objects and other characters, creating a mixed reality environment resembling lifelike entities. With the increasing popularity of personal projection devices, they are expected to be used for various social applications that have not yet been explored. Our system introduces a new approach that facilitates playful social interactions among multiple projected characters. The prototype includes two projector Amera systems using existing hardware and computer vision algorithms to enable a variety of applications and scenarios. Through our system, users can observe and interact with different characters projected around them, each exhibiting unique behaviors guided by hand gestures, responding to stimuli to create a mixed reality experience. Index Terms—Projection from mobile devices, cooperative gaming, social engagement, hybrid virtual characters, animated elements, and enhanced reality.

I. INTRODUCTION

The use of mobile devices for social and recreational purposes is rapidly expanding. Modern mobile phones offer the computing power necessary for high-quality animations through embedded graphics processors, as well as constant internet connectivity via 3G networks.

Improved mobile pro jection technology allows for more seamless social interactions among users in close proximity using mobile phones. Our lab has developed PoCoMo, a system that initiates the exploration of social scenarios made possible by collaborative mobile pro jections within the same physical space. More and more people are using their phones to have fun and connect with others. Nowadays, phones are super powerful, with fancy graphics and Identify applicable funding agency here. If none, delete this. internet that's always on.

Plus, new technology lets us project stuff from our phones, making it easier for us to play together in the same place. Our lab made PoCoMo to try out fun ideas using this mobile projection technology for socializing and playing with friends nearby.

The primary objective of the proposed system is to facilitate natural and spontaneous interactions among users and their surroundings. Through the use of mobile phones, projected characters are

displayed in alignment with the phone's

camera view, aided by software tracking their positions.

Consequently, when two characters are projected within the same vicinity, they promptly react to each other, considering the features of the local environment. Implemented on readily available hardware and standard ized software libraries, PoCoMo aims to encourage devel opers to adopt the technology and offers example scenarios.

These scenarios advocate for the adoption of projector-enabled mobile phones. Although several phone manufacturers offer experimental models with projection capabilities, none, to our knowledge, have positioned the camera in line with the projection area. Anticipated advancements in mobile phone technology are expected to introduce models supporting this alignment for augmented reality (AR) purposes in the near future.

PoCoMo employs a standard object tracking technique [5] to detect the presence of other projected characters and to extract visual features from the environment for gaming purposes. The algorithm is designed to be lightweight, allowing operation in resource constrained environments without significantly compromising usability.

Expanding the capabilities of mobile phones to project display information in the surrounding environment and respond to other players introduces new possibilities for mixed real ity interactions that have been relatively underexplored.

Our focus lies particularly on social scenarios involving acknowledgment, relationship building, and exchange during games between two users in close proximity. This paper outlines the system design, implementation specifics, and initial usage scenarios.

II. A. Related Works

Since 2003, advancements in portable projection systems have spurred research into geometrically aware collaborative systems focused on orientation. For instance, ILamps and RFIG by Raskar et al. addressed geometric complexities to merge images from multiple projectors into a unified dis play.

The Hotaru system utilized static projection to emulate multiple projections. Various researchers have proposed the flashlight metaphor for interacting with the physical world, where projections reveal portions of the virtual environment. Cao et al. developed techniques for dynamically displaying contextual information using the flashlight metaphor.

Ruzkio and Greaves explored interaction with personal projection but primarily relied on an external 6-DOF tracking system and a single-user approach.

Furthermore, researchers have investigated playful applications enabled by portable projection technologies. Yoshida et al. introduced Twinkle, a handheld projector-camera system where a character interacts with drawings on a whiteboard, but it does not interact with other systems in the vicinity.

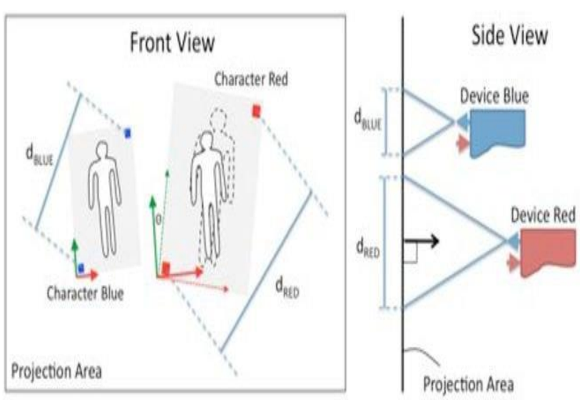
MotionBeam, developed by Willis et al., introduced a method for controlling projected characters via handheld devices. Additionally, VisiCon and CoGAME are collaborative games involving robot control using handheld projectors, with the camera mounted on the robot rather than embedded in the mobile phone.

III. SYSTEM OVERVIEW

PoCoMo comprises a compact mobile projector-camera system, utilizing a commercially available cellular smartphone equipped with a pico-projector and video camera. In the current prototype, both the projector and camera are aligned within the same field of view through a plastic enclosure and a small mirror. This configuration enables the system to track both the projected image and a portion of the surrounding surface, with all algorithms executed locally on the phones.

Figure 1. (a) Users hold micro projector-camera devices to project animated characters on the wall. (b) The characters recognize and interact with one another.

Figure 2. Character rigs, and component parts for animation.



The characters within PoCoMo are designed with separate articulation for component parts, allowing them to trigger different sequences based on the proximity of other characters, thus creating a lifelike appearance in the environment. Various scenarios have been developed to showcase the system's potential for playful collaborative experiences:

Character Acknowledgment: Projected characters respond to each other's presence and orientation, expressing interest in interaction by turning towards each other and smiling. - Icebreaker Interactions: Once characters acknowledge each other, a gradual approach by one character towards another can initiate a gesture • Mutual Exploration: As characters traverse the environment, they initiate a walking cycle synchronized with the rate of positional change. When characters are in each other's view, their walking cycles align approximately, fostering a sense of shared space and offering feedback on proximity.

• Gift Exchange: Characters can discover and leave gifts for each other at notable landmarks within the environment. This feature serves as an illustration of collaborative interactions that span multiple sessions and are linked to specific physical locations.

A. Detection and Tracking Method

In our system, each device projects a character that needs to be detected and tracked, both by its own device and by other participating devices within the same projection area. To achieve this, we implemented a straightforward marker-based tracking algorithm, drawing inspiration from the foundational work on Active Appearance Models (AAM) and color-based tracking techniques. Each character is distinguished by the color of its markers, such as one character having blue markers and another having red markers.

The detection algorithm scans the image for circular mark ers by initially applying a threshold on the Hue, Saturation, and Value, and then extracting contour poly-lines. Following principles from AAM, we create markers of a predefined shape, typically circles, and match their contours to the blobs identified in the masking stage. The two regions with the highest rankings are identified as the markers. In subsequent iterations, akin to prior work, we incorporate the distance of the region to the previously detected markers as a weight in the ranking equation.

B. Equations

The red character searches for blue markers, while the blue character searches for red markers. Additionally, each character also scans for its own markers for calibration pur poses. w(R) = Rarea ”d Rcenter,Rˆ(center)”e(Rcontour) The characters feature markers positioned diagonally across the projection surface, specifically at the top-right and bottom-left corners. By assuming parallel alignment between the camera plane, projector, and projection plane, this setup facilitates the determination of the projected character’s rotation angle and size. These assumptions streamline detection processes compared to assuming arbitrary projective transformations, while still ensuring an engaging user experience. This layout also enables each system to discern the relationship between the self-character and the friend character, allowing for ad justments in projection size and rotation to achieve alignment, as illustrated in . To optimize resolution, the larger projected character strives to match its size and rotation with that of the smaller one. However, our current projectors are limited by their brightness (12 lumens), necessitating exaggerated scale and size for our current projected markers. Costanza et al.’s work highlights the importance of integrating marker design with visual content. In future iterations, we aim to incorporate markers into character design and utilize them to provide user feedback regarding the character’s state.

$a + b = \gamma$ (1)

C. IMPLEMENTATION DETAILS AND CODE

Character Interaction: Following Gaze. During the initial sensing phase, the projected character exhibits an attentive gaze, with its eyes tracking the potential location of the other character. The presence of another character is confirmed when both markers have been detected in the scene for at least 20 frames within the last 40 frames. Upon detecting the presence of another character, the active character turns to face the friend character. If the characters remain in proximity for 80- 100 frames, they will wave towards each other. If they are properly aligned, they will attempt a handshake, determined by the friend character’s center point falling within a normalized range.

Handshake: The handshake involves a 10-frame key-frame animation transitioning from a standing pose. To synchronize the animation, the initiating character briefly displays a third colored marker.To synchronize the timing of key frames, the second character interprets the signal and initiates its sequence accordingly. The handshake sequences of both characters are designed to have animations of equal length to ensure interoperability.

Gift Exchange: Characters can also leave gifts for each other on specific objects. This occurs when a character remains stationary near an object for over 3 seconds. An animation commences, depicting the character leaning to place a box on the ground, prompting the user to select an object to leave behind, such as an image or any file stored on the phone. The system extracts SURF descriptors of key points on the object in the scene and transmits the data, along with a batch of descriptors, to a central server. The present's location is recorded relative to prominent features like corners and high contrast edges. When a character is in present-seeking mode, it scans the scene for features matching those stored on the server. If a strong correlation is detected, the present gradually appears. We anticipate that users will leave gifts in locations where they have previously interacted, providing context for searching for virtual items within the scene.

D. Gestures

system integrates with the phone's motion sensing capa bilities, including an accelerometer and gyroscope. When the device detects consistent motion in a particular direction, the characters initiate a walk sequence animation. However, the accelerometer technology in our prototype provides only derivative motion readings, occurring at the beginning and end of the motion rather than continuously. Consequently, we utilize two cues: Start of Motion and End of Motion, to trigger the commencement and cessation of the walk sequence. Addi tionally, the system responds to shaking gestures, interrupting the character's current operation.

E. Hardware

We selected the Samsung Halo projector-phone as the foundation for our system due to its Android operating system, offering a flexible development environment. The tracking and detection algorithms were developed in C++ and compiled

into a native library, while the application's user interface was created in Java using the Android API. To implement the computer vision algorithms, we utilized the OpenCV library.

F. The Prototype

To ensure alignment between the camera and projection, we devised a casing containing a mirror tailored to fit onto the device. The progression of prototype development is illustrated in Figure 4. Initially, the prototype was affixed directly to the device, after which we advanced to a comprehensive casing encompassing the entire device to facilitate its handling. Eventually, we engineered a rounded case crafted from durable plastic to safeguard the mirror and enable its detachment from the phone.

G. FUTURE WORK

Forth coming iterations, we intend to enhance detection ro bustness and integrate markers with projected content. Ad ditionally, we aim to create animations tailored to specific user profiles and transition the application to devices featuring broader fields of view for both the projector and camera. Fur thermore, we will conduct a user study to evaluate interaction fluidity and refine scenario implementations.

CONCLUSION

In summary, we introduce PoCoMo, a system facilitat ing collaborative interactions through projected characters on mobile devices. PoCoMo operates as an integrated mobile platform, devoid of external devices or physical markers, and requires no setup, offering versatility for play in any location. Through PoCoMo, users engage in collective interac tions within shared physical spaces, interacting with animated mixed-reality characters. Leveraging projectors for multiplayer gaming enhances the naturalness and spontaneity of shared experiences. While similar systems cater to practical tasks like sharing or inventory management, our focus is on exploring innovative social interactions enabled by mobile projectors. We encourage developers to contribute additional scenarios and games within the realm of collaborative mobile projection.

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REFERENCES

1. Raskar,R., Lee, J., Moore, R., Nagendran, A.,Wilburn,B.(2003).iLamps: Geometrically aware and self-configuring projectors. In ACM SIGGRAPH 2003 Papers (pp. 809-818).
2. Yoshida, T., Hirose, M. (2009). Twinkle: handheld projector-camera system that provides touching interface in the real world In Proceedings of the 17th ACM international conference on Multimedia (pp. 959-960).
3. Costanza, E., Kunze, K., Schiele, B. (2009). Towards ac tivity recognition using wearable sensors in augmented reality games.In Proceedings of the 2009 international conference on Mixed and Augmented Reality (pp. 135-144).
4. Willis, K. D., Ens, B. J. (2013). MotionBeam: An Interaction Technique for Handheld Projectors Using Motion Parallax. In CHI'13 Extended Abstracts on Human Factors in Computing Systems (pp. 2317-2322).
5. Haringer, M., Schmalstieg, D. (2016). PocketSens ing: Context-aware mobile projector-camera units for user independent interactions. In Proceedings of the 2016 CHI Con ference Extended Abstracts on Human Factors in Computing Systems (pp. 2046-2053).
6. Zund, F., Maier, P., Loffing, D., Rukzio, E. (2017). GestureCube: A Tangible Interaction Approach for Projected Augmented Reality Environments. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (pp. 5274-5285).
7. Weissker, T., Winkler, C., Rukzio, E. (2018). Augmented reality gaming: A study about user acceptance of projected interactive game fields. In Proceedings of the 20th Inter national Conference on Human-Computer Interaction with Mobile Devices and Services (pp. 1-12).
8. Majidi,A., Rekimoto, J. (2018). Proximity Toolkit: A Multi-device Environment for Supporting Proxemic Interac tion Using Projected Interactions. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-13).