1. Introduction
Sketch Master is an online sketching game application, which enables users to enjoy their sketching process and practice their sketching skills as well. It allows users to sketch from their memory of random pictures. Then user data of sketching will be collected and analyzed to develop other further applications. The study of the relation between human memory and sketching behavior is an innovative research in this field. The play mode setting of this sketching game could vary to meet different users' need and make the game more interesting to play. Play mode includes: single, multiple, co-sketch and pass on. Single mode means practicing sketching by yourself while multiple mode means having a sketching competition among different users. Co-sketch means complete a drawing through cooperation between different users while Pass-on means you sketch on a randomly unfinished drawing and pass it on to other users.

2. Related Works
We reviewed several sketching related applications on different platforms. Some applications are made for sketching only. ‘Sketchbook Pro’ is a paint and drawing software on both Windows and iOS platform. It provides a complete set of tools for users. Similar applications like ‘Paper53’ and ‘Noteshelf’ also have the same function. They are both drawing tools and notebooks. This kind of applications inspires us a lot about how to provide a good interface and tools for users. ‘Draw something’ is a sketching game which used to be a very popular social sketching game application. One player is provided three words and chooses one to draw. The second player will view the drawing and try to guess the word. There are some projects about sketching focusing on studying people’s drawing approaches and behaviors. Aeron Koblin’s ‘the Sheep Market’ collected 10,000 sheep drawing processes. We can learn the process of people drawing from this database.

3. Implementations
The system has two distinct components that needed to work together in real time: (1) clients that interfacing with tablet input for collecting the drawing data; (2) a centralized service facilitating communication between all the other pieces. First, a TCP/IP server was implemented using a publish/subscribe model to provide a framework for routing messages between the different clients in our prototype. Clients when registering would provide the server with a description of their capabilities, which would then be used to determine what kinds of messages, if any, to deliver to that client. When collecting a stroke, the client is responsible for passing information in three segments to the server: the starting point, the packet points, and the ending point of the stroke. The client that received the data will push notifications (incoming, unsolicited TCP/IP messages) for raising events and regenerating the strokes when applied.

4. Scenarios
This game has four different playing modes.

Mode 1 is single player. Players can choose photo they want to sketch and practice more in this game mode. To play single mode, player first needs to enter the single player mode via home screen. And then System provides 3 level (easy, medium, hard) and each level have 6 photos to allow player choose. Before displaying the photo, it shows 3 seconds counting down and then the photo will show on screen for 30 seconds. Player needs to remember the photo as much as possible. Reminder will be given to player in last 5 seconds. The photo disappears and then canvas is showed on players’ screen. Player needs to sketch the photo from memory using the provided canvas functions in 3 minute. During the game, players will have 2 chances to spy the original photo. They will get a score after finish the sketch. The score is determined by how similar their sketch compare with the original photo. They could also be able to review the playback of their sketch process and how other players draw the same photo in the feedback phase. The work can be share to Facebook or twitter as picture, or YouTube as video and store to game system for later review.

Mode 2 is multiple mode. In multiple mode plays need to compete with others. System will team 2, 3 or 4 players randomly (waiting time limits to 15 s, exceed 15s display ‘ah-oh, nobody playing right now. Please try later or try single mode.) And then the game will begin. System will choose a photo randomly for all players. The playing process it the same as single mode: 30 seconds to remember the photo and 3 minutes to sketch it. But during the game, player has 1 chance to spy the original photo and 1 chance to spy competitor’s sketch. After the competition is over, players’ drawing process and the final work can be reviewed and liked by other players in the system. Review time is an hour. After an hour, people with most likes win the game. The system will send all competitors the final result.

Mode 3 is cooperation mode. This is a game mode that need 2 players cooperate with each other to finish only one sketch. The original photo is selected by system automatically and game process is similar to single and multiple mode. But 2 players will sketch on one canvas, which means, during the game, player could be able to see another player’s real-time drawing motion. Each player has 2 chances to spy the original photo. Different color code will be given for each player’s cursor, the cursor color code will display in cooperators’ screen for 3s and then turn to true color. The feedback phase is the same as single mode.

Mode 4 is pass-on mode. The pass-on mode is like its name: the sketch will pass from one player to another player and each player
can draw 3 strokes. System will randomly give a keyword to the first player, after the first player draw 3 strokes and confirm, the sketch will randomly pass to two players, and these two players will not be given any hint, but use their imagination to continue sketch and pass to other 4 players like binary tree. Players can review the ‘drawing tree’ to see how it develops to different sketches if they participated in the pass-on process. This mode is in concept phase at this game design project because of limited time.

Figure 1. The front page when the player enter the system. This will allow the player to select the modes and preferences.

Figure 2. After the players select the modes, they will enter the page in which they will need to select the difficulties and photos for remembering.

Figure 3. The sketch panel in which they can pick colors, brushes and select the spy mode.

Figure 4. When they enter the spy mode, they can either watch the original photo or what other player is drawing. The location of the scope also indicates the area where the players forget.

Figure 5. The result page. The system will generate the scores according to OpenCV match template algorithms.

Figure 6. The player can also get the sketches from other players, and save the image in this page.

5. Future Directions and Conclusion
Sketch Master is the first version of an online interactive sketching game developed on windows platform. The prototype was demonstrated for two days during class and initial user reactions were very promising. Even though we collected feedbacks from users throughout the class demo, we have not conducted a formal user study because of limited time. This game application is an open platform, so big amount of user data collecting is accessible.

The next step of our research is to collect user data of sketching
behavior. User data includes the process of how people approach their sketch process from the memory of pictures. After a certain amount of user data collecting, we will analyze all the data and explore the relation between human memory and sketching activity. Additionally, we might record which part of a picture is most difficult to remember and then explore the characteristics of human memory. According to what we found, we can also improve the UI/UX of related applications. After enough data collecting and analysis, we may apply them into training people to sketch. Other future applications are still in discussion.