

# Systematic Approach for Kinetic Effect on XBOX 360

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**Abstract**— This paper proposes a new systematic approach for kinetic effect on Xbox 360. Generally kinetic is known as code programming natal. It is a new software technology on Xbox 360 and more over a gaming concept. Kinetic enables advanced gesture recognition, facial recognition and voice recognition. It has a capability of tracking simultaneously up to six people, including two active players for motion analysis with a feature extraction of 20 joints per player. However, Prime Sense has stated that the number of people the device can "see" (but not process as players) is only limited by how many will fit in the field-of-view of the camera. Kinetics astonishing activity creates completely a new world. It is a good and innovative product and creates new standards for motion control.

**Keywords**— Kinect, XBOX 360, Tracking, Recognition, Microsoft.

## I. INTRODUCTION

### a. What is Kinect

Kinect for Xbox 360 or simply Kinect is a motor sensing input device by Microsoft for the Xbox 360 video game console. Based around a webcam-style add-on peripheral for the Xbox 360 console, it enables users to control and interact with the Xbox 360 as shown in Fig.1 without the need to touch a game controller, through a natural user interface using gestures and spoken commands. The project is aimed at broadening the Xbox 360's audience beyond its typical gamer base. Kinect competes with the Wii Remote Plus and PlayStation Move with PlayStation Eye motion controllers for the Wii and PlayStation 3 home consoles, respectively. A version for Windows will be released in Early 2012.



Fig.1: XBOX 360

Kinect was launched in North America on November 4, 2010, in Europe on November 10, 2010, in Australia, New Zealand and Singapore on November 18, 2010, [ and in Japan on November 20, 2010. Purchase options for the sensor peripheral include a bundle with the game Kinect Adventures and console bundles with either a 4 GB or 250 GB Xbox 360 console and Kinect Adventures. After selling a total of 8 million units in its first 60 days, the Kinect holds the Guinness World Record of being the "fastest selling consumer electronics device" 10 million units of the Kinect sensor have been shipped as of March 9, 2011. Microsoft released a non-commercial Kinect software development kit for Windows on June 16, 2011, with a commercial version following at a later date. This SDK will allow .Net developers to write Kinecting apps in C++/CLI, C#, or Visual Basic .NET.

### b. Technology on Xbox 360

Kinect is based on software technology developed internally by Rare a subsidiary of Microsoft Game Studios owned by Microsoft, and on range camera technology by Israeli developer Prime Sense, which developed a system that can interpret specific gestures, making completely hands-free control of electronic devices possible by using an infrared projector and camera and a special microchip to track the movement of objects and individuals in three dimension as shown in Fig.2 . This 3D scanner system called *Light Coding* employs a variant of image-based 3D reconstruction.



Fig.2: A slide from Microsoft's E3 Conference showing a diagram of the technologies in Kinect

The Kinect sensor is a horizontal bar connected to a small base with a motorized pivot and is designed to be positioned lengthwise above or below the video display as in Fig.3 . The device features an "RGB camera, depth sensor and multi-array microphone running proprietary software", which provide full-body 3D motion capture, facial recognition and voice recognition capabilities. At launch, voice recognition was only made available in Japan, the United Kingdom, Canada and the United States. Mainland Europe will receive the feature in spring 2011. The Kinect sensor's microphone array enables the Xbox 360 to conduct acoustic source localization and ambient noise suppression, allowing for things such as headset-free party chat over Xbox Live.



Fig.3: Microsoft Kinect sensor on a Television

The depth sensor consists of an infrared laser projector combined with a monochrome CMOS sensor, which captures video data in 3D under any ambient light conditions. The sensing range of the depth sensor is adjustable, and the Kinect software is capable of automatically calibrating the sensor based on game play and the player's physical environment, accommodating for the presence of furniture or other obstacles.

## II. PREVIOUS WORK

The technology behind Kinect was invented in 2005 by Zeev Zalevsky, Alexander Shpunt, Aviad Maizels and Javier Garcia. Kinect itself was first announced on June 1, 2009 at E3 2009 under the code name "Project Natal". Following in Microsoft's tradition of using cities as code names, "Project Natal" was named after the Brazilian city of Natal as a tribute to the country by Brazilian-born Microsoft director Alex Kipman, who incubated the project. The name Natal was also chosen because the word *natal* means "of or relating to birth", reflecting Microsoft's view of the project as "the birth of the next generation of home entertainment".

Three demos were shown to showcase Kinect when it was revealed at Microsoft's E3 2009 Media Briefing: *Ricochet*, *Paint Party* and *Milo & Kale*. A demo based on *Burnout Paradise* was also shown outside of Microsoft's media briefing. The skeletal mapping technology shown at E3 2009 was capable of simultaneously tracking four people, with a feature extraction of 48 skeletal points on a human body at 30 Hz. It was rumored that the launch of Project Natal would be accompanied with the release of a new Xbox 360 console (as either a new retail configuration, a significant design revision and/or a modest hardware upgrade). Microsoft dismissed the reports in public and repeatedly emphasized that Project Natal would be fully compatible with all Xbox 360 consoles. Microsoft indicated that the company considers it to be a significant initiative, as fundamental to the Xbox brand as Xbox Live, and with a launch akin to that of a new Xbox console platform. Kinect was even referred to as a "new Xbox" by Microsoft CEO Steve Ballmer at a speech for the Executives' Club of Chicago. When asked if the introduction will extend the time before the next-generation console platform is launched (historically about 5 years between platforms), Microsoft corporate vice president Shane Kim reaffirmed that the company believes that the life cycle of the Xbox 360 will last through 2015 (10 years).

During Kinect's development, project team members experimentally adapted numerous games to Kinect-based control schemes to help evaluate usability. Among these games were *Beautiful Katamari* and *Space Invaders Extreme*, which were demonstrated at the Tokyo Game Show in September 2009. According to creative director Kudo Tsunoda, adding Kinect-based control to pre-existing games would involve significant code alterations, making it unlikely for Kinect features to be added through software updates. Although the sensor unit was originally planned to contain a microprocessor that would perform operations such as

the system's skeletal mapping, it was revealed in January 2010 that the sensor would no longer feature a dedicated processor. Instead, processing would be handled by one of the processor cores of the Xbox 360's Xeno CPU. According to Alex Kipman, the Kinect system consumes about 10-15% of the Xbox 360's computing resources.<sup>1</sup> However, in November, Alex Kipman made a statement that "the new motion control tech now only uses a single-digit percentage of the Xbox 360's processing power, down from the previously stated 10 to 15 percent." A number of observers commented that the computational load required for Kinect makes the addition of Kinect functionality to pre-existing games through software updates even less likely, with concepts specific to Kinect more likely to be the focus for developers using the platform.

- On March 25, Microsoft sent out a save the date flier for an event called the "World Premiere 'Project Natal' for the Xbox 360 Experience" at E3 2010. The event took place on the evening of Sunday, June 13, 2010 at the Galen Center and featured a performance by Cirque du Soleil. It was announced that the system would officially be called Kinect, a portmanteau of the words "kinetic" and "connect", which describe key aspects of the initiative. Microsoft also announced that the North American launch date for Kinect will be November 4, 2010. Despite previous statements dismissing speculation of a new Xbox 360 to accompany the launch of the new control system, Microsoft announced at E3 2010 that it was introducing a redesigned Xbox 360, complete with a connector port ready for Kinect. In addition, on July 20, 2010, Microsoft announced a Kinect bundle with a redesigned Xbox 360, to be available with the Kinect launch.
- On June 16, 2011, Microsoft announced its official release of its SDK for non-commercial use.
- On July 21, 2011, Microsoft announced that the first ever white Kinect sensor would be available as part of the "Xbox 360 Limited Edition Kinect Star Wars Bundle", which also includes custom a Star Wars-themed console and controller, and copies of Kinect Adventures\ and Star Wars Kinect. Previously, all Kinect sensors had been glossy black.
- On October 31, 2011, Microsoft announced launching of the commercial version of *Kinect for Windows program* with release of the SDK to companies. David Dennis, Product Manager at Microsoft, said, "There are hundreds of organizations we are working with to help them determine what's possible with the tech".

### III. WORKING & DESIGNING

#### a. Architecture of Kinect on XBOX

Because the Kinect sensor's motorized tilt mechanism requires more power than can be supplied via the Xbox 360's USB ports, the device makes use of a proprietary connector combining USB communication with additional power. Redesigned Xbox 360 S models include a special AUX port for accommodating the connector, while older models require a special power supply cable (included with the sensor) that splits the connection Through reverse engineering efforts, it has been determined that the Kinect sensor outputs video at a frame rate of 30 Hz as shown in below Fig.4

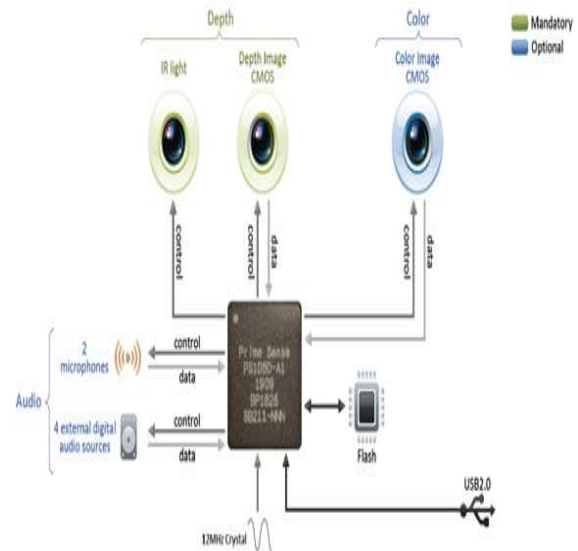


Fig.4: The Architecture of the Kinect on XBOX360

The RGB video stream uses 8-bit VGA resolution (640 × 480 pixels) with a Bayer color filter, while the monochrome depth sensing video stream is in VGA resolution (640 × 480 pixels) with 11-bit depth, which provides 2,048 levels of sensitivity. The Kinect sensor has a practical ranging limit of 1.2–3.5 m (3.9–11 ft) distance when used with the Xbox software. The area required to play Kinect is roughly 6m<sup>2</sup>, although the sensor can maintain tracking through an extended range of approximately 0.7–6 m (2.3–20 ft). The sensor has an angular field of view of 57° horizontally and 43° vertically, while the motorized pivot is capable of tilting the sensor up to 27° either up or down. The into separate USB and power connections; power is supplied from the mains by way of an AC adapter.

## b. Launch of Kinect on XBOX

A January 2010 promotional banner indicating the expected release of Kinect (then "Project Natal") by holiday 2010. Microsoft had an advertising budget of US\$500 million for the launch of Kinect, a larger sum than the investment at launch of the Xbox console. The marketing campaign *You Are the Controller*, aiming to reach new audiences, included advertisements on Kellogg's cereal boxes and Pepsi bottles, commercials during shows such as *Dancing with the Stars* and *Glee* as well as print ads in various magazines such as *People* and *InStyle*.

On October 19, Microsoft advertised Kinect on The Oprah Winfrey Show by giving free Xbox 360 consoles and Kinect sensors to the people in the audience. Two weeks later, Kinect bundles with Xbox 360 consoles were also given away to the audience of Lat Night With Jimmy Fallon On October 23, Microsoft held a pre-launch party for Kinect in Beverly Hills. The party was hosted by Ashley Tisdale and was attended by soccer star David Beckham and his three sons, Cruz, Brooklyn, and Romeo. Guests were treated to sessions with Dance Central and Kinect Adventures, followed by Tisdale having a Kinect voice chat with Nick Cannon Between November 1 and November 28, Burger King gave away a free Kinect bundle "every 15 minutes". A major event was organized on November 3 in Times Square, where singer Ne-Yo performed with hundreds of dancers in anticipation of Kinect's midnight launch. During the festivities, Microsoft gave away T-shirts and Kinect games.

## c. Pseudocode

The Pseudocode representation of Kinect on XBOX is as shown below

```
float RawDepthToMeters(int depthValue)
{
    if (depthValue < 2047)
    {
        return float(1.0 / (double(depthValue) * -0.0030711016 +
3.3309495161));
    }
    return 0.0f;
}
```

```
Vec3f DepthToWorld(int x, int y, int depthValue)
{
    static const double fx_d = 1.0 / 5.9421434211923247e+02;
    static const double fy_d = 1.0 / 5.9104053696870778e+02;
    static const double cx_d = 3.3930780975300314e+02;
    static const double cy_d = 2.4273913761751615e+02;
    Vec3f result;
```

```
    const double depth = RawDepthToMeters(depthValue);
    result.x = float((x - cx_d) * depth * fx_d);
    result.y = float((y - cy_d) * depth * fy_d);
    result.z = float(depth);
    return result;
}

Vec2i WorldToColor(const Vec3f &pt)
{
    static const Matrix4 rotationMatrix(
    Vec3f(9.9984628826577793e-01f, 1.2635359098409581e-
03f, -1.7487233004436643e-02f),
    Vec3f(-1.4779096108364480e-03f, 9.9992385683542895e-
01f, -1.2251380107679535e-02f),
    Vec3f(1.7470421412464927e-02f, 1.2275341476520762e-
02f, 9.9977202419716948e-01f));
    static const Vec3f translation(1.9985242312092553e-02f, -
7.4423738761617583e-04f, -1.0916736334336222e-02f);
    static const Matrix4 finalMatrix =
rotationMatrix.Transpose() * Matrix4::Translation(-
translation);
    static const double fx_rgb = 5.2921508098293293e+02;
    static const double fy_rgb = 5.2556393630057437e+02;
    static const double cx_rgb = 3.2894272028759258e+02;
    static const double cy_rgb = 2.6748068171871557e+02;
    const Vec3f transformedPos =
finalMatrix.TransformPoint(pt);
    const float invZ = 1.0f / transformedPos.z;
    Vec2i result;
    result.x = Utility::Bound(Math::Round((transformedPos.x *
fx_rgb * invZ) + cx_rgb), 0, 639);
    result.y = Utility::Bound(Math::Round((transformedPos.y *
fy_rgb * invZ) + cy_rgb), 0, 479);
    return result;
}
```

## IV. ADVANTAGES ON SOFTWARE

Requiring at least 190 MB of available storage space, the Kinect system software allows users to operate the Xbox 360 Dashboard console user interface through voice commands and hand gestures. Techniques such as voice recognition and facial recognition are employed to automatically identify users. Among the applications for Kinect is Video Kinect, which enables voice chat or video chat with other Xbox 360 users or users of Windows Live Messenger. The application can use Kinect's tracking functionality and the Kinect sensor's motorized pivot to keep users in frame even as they move around. Other applications with Kinect support include ESPN, Zune Marketplace, Netflix, Hulu Plus and Last.fm

Games that require Kinect have a purple sticker on them with a white silhouette of the Kinect sensor and "Requires Kinect Sensor" underneath in white text. Games that have optional Kinect support (meaning that Kinect is not necessary to play the game or that there are optional Kinect minigames included) feature a standard

green Xbox 360 case with a purple bar underneath the header, a silhouette of the Kinect sensor and "Better with Kinect Sensor" next to it in white text.

Kinect launched on November 4, 2010 with 17 titles. Third-party publishers of available and announced Kinect games include, among others, Ubisoft, Electronic Arts, LucasArts, THQ, Activision, Konami, Sega, Capcom, Namco Bandai and MTV Games.

a. Kinect Fun Labs

At E3 2011, Microsoft announced *Kinect Fun Labs*: a collection of various gadgets (mini games). These gadgets includes *Build A Buddy*, *Air Band*, *Kinect Googly Eyes*, *Kinect Me*, *Bobblehead*, *Kinect Sparkler* and *Avatar Kinect*.

b. Kinect for Windows SDK

On February 21, 2011 Microsoft announced that it would release a non-commercial Kinect software development kit (SDK) for Windows in spring 2011, which was released on June 16, 2011; a commercial version is planned for a later release date. The SDK includes Windows 7 compatible PC drivers for Kinect device. It provides Kinect capabilities to developers to build applications with C++, C#, or Visual Basic by using Microsoft Visual Studio 2010 and includes following features:

1. Raw sensor streams: Access to low-level streams from the depth sensor, color camera sensor, and four-element microphone array.
2. Skeletal tracking: The capability to track the skeleton image of one or two people moving within the Kinect field of view for gesture-driven applications.
3. Advanced audio capabilities: Audio processing capabilities include sophisticated acoustic noise suppression and echo cancellation, beam formation to identify the current sound source, and integration with the Windows speech recognition API.
4. Sample code and Documentation.

c. Open source drivers

In November 2010, Adafruit Industries offered a bounty for an open-source driver for Kinect. Microsoft initially voiced its disapproval of the bounty, stating that it "does not condone the modification of its products" and that it had "built in numerous hardware and software safeguards designed to reduce the chances of product tampering". This reaction, however, was caused by a

misunderstanding within Microsoft,<sup>1</sup> and the company later clarified its position, claiming that while it does not condone hacking of either the physical device or the console, the USB connection was left open by design.

The first thing to talk about is, Kinect was not actually hacked. Hacking would mean that someone got to our algorithms that sit inside of the Xbox and was able to actually use them, which hasn't happened. Or, it means that you put a device between the sensor and the Xbox for means of cheating, which also has not happened. That's what we call hacking, and that's what we have put a ton of work and effort to make sure doesn't actually occur. What has happened is someone wrote an open-source driver for PCs that essentially opens the USB connection, which we didn't protect, by design, and reads the inputs from the sensor. The sensor, again, as I talked earlier, has eyes and ears, and that's a whole bunch of noise that someone needs to take and turn into signal.

On November 10, Adafruit announced Héctor Martín as the winner, who had produced a Linux driver that allows the use of both the RGB camera and depth sensitivity functions of the device.<sup>1</sup> It was later revealed that Johnny Lee, a core member of Microsoft's Kinect development team, had secretly approached Adafruit with the idea of a driver development contest and had personally financed it. In December 2010, PrimeSense, whose depth sensing reference design Kinect is based on, released their own open source drivers along with motion tracking middleware called *NITE*. PrimeSense later announced that it had teamed up with Asus to develop a PC-compatible device similar to Kinect, which will be called *WAVI Xtion* and is scheduled for release in the second quarter of 2011.

d. Third party development

A demonstration of a third party use of Kinect at Maker Faire The visualization on the left, provided through Kinect, is of a user of a jacket with wearable electronic controls for VJing. Numerous developers are researching possible applications of Kinect that go beyond the system's intended purpose of playing games. For example, Philipp Robbel of MIT combined Kinect with the iRobot Create to map a room in 3D and have the robot respond to human gestures, while an MIT Media Lab team is working on a JavaScript extension for Google Chrome called *depthJS* that allows users to control the browser with hand gestures. Other programmers, including the Robot Locomotion Group at MIT, are using the drivers to develop a motion-controller user interface similar to the one envisioned in

the film *Minority Report*. The developers of MRPT have integrated open source drivers into their libraries and provided examples of live 3D rendering and basic 3D visual SLAM. Another team has shown an application that allows Kinect users to play a virtual piano by tapping their fingers on an empty desk.<sup>1</sup> Oliver Kreylos, a researcher at University of California, Davis, adopted the technology to improve live 3-dimensional videoconferencing, which NASA has shown interest in.

Alexandre Alahi from EPFL presented a video surveillance system that combines multiple Kinect devices to track groups of people even in complete darkness. Companies So touch and Evolve have developed presentation software for Kinect that can be controlled by hand gestures; among its features is a multi-touch zoom mode. In December 2010, the free public beta of HTPC software *KinEmote* was launched; it allows navigation of Boxee and XBMC menus using a Kinect sensor. Soroush Falahati wrote an application that can be used to create stereoscopic 3D images with a Kinect sensor. For a limited time in May 2011, a Topshop store in Moscow set up a Kinect kiosk that could overlay a collection of dresses onto the live video feed of customers. Through automatic tracking, position and rotation of the virtual dress were updated even as customers turned around to see the back of the outfit.

## V. CONCLUSION & FUTURE IMPLEMENTATION

Kinect also shows compelling potential for use in medicine. Researchers at the University of Minnesota have used Kinect to measure a range of disorder symptoms in children, creating new ways of objective evaluation to detect such conditions as autism, attention-deficit disorder and obsessive-compulsive disorder. At the Institute of Forensic Medicine Virtopsy Project at the University of Bern in Switzerland, researchers have devised a way for surgeons to manipulate imaging techniques (such as MRI) to guide surgery, using a Kinect to capture their hand motions to direct the imaging, freeing their hands from having to use computer keyboards, thus also reducing the chance of contamination. This technique is already working at Sunnybrook Health Sciences Centre in Toronto, where doctors use it to guide imaging during cancer surgery.

IGN gave the device 7.5 out of 10, saying that "Kinect can be a tremendous amount of fun for casual players, and the creative, controller-free concept is undeniably appealing", though adding that for "\$149.99, a motion-tracking camera add-on for the Xbox 360 is a tough sell, especially considering that the entry level variation of the Xbox 360 itself is only \$199.99". *Game*

*Informer* rated Kinect 8 out of 10, praising the technology but noting that the experience takes a while to get used to and that the spatial requirement may pose a barrier. *Computer and Video Games* called the device a technological gem and applauded the gesture and voice controls, while criticizing the launch lineup and Kinect Hub.

CNET's review pointed out how Kinect keeps players active with its full-body motion sensing but criticized the learning curve, the additional power supply needed for older Xbox 360 consoles and the space requirements. Engadget, too, listed the large space requirements as a negative, along with Kinect's launch lineup and the slowness of the hand gesture UI. The review praised the system's powerful technology and the potential of its yoga and dance games. Kotaku considered the device revolutionary upon first use but noted that games were sometimes unable to recognize gestures or had slow responses, concluding that Kinect is "not must-own yet, more like must-eventually own." TechRadar praised the voice control and saw a great deal of potential in the device whose lag and space requirements were identified as issues.<sup>1</sup> Gizmodo also noted Kinect's potential and expressed curiosity in how more mainstream titles would utilize the technology. *Ar Technica's* review expressed concern that the core feature of Kinect, its lack of a controller, would hamper development of games beyond those that have either stationary players or control the player's movement automatically.

The mainstream press also reviewed Kinect. *USA Today* compared it to the futuristic control scheme seen in *Minority Report*, stating that "playing games feels great" and giving the device 3.5 out of 4 stars.<sup>11</sup> David Pogue from *The New York Times* predicted you will feel a "crazy, magical, omigosh rush the first time you try the Kinect." Despite calling the motion tracking less precise than Wii's implementation, Pogue concluded that "Kinect's astonishing technology creates a completely new activity that's social, age-spanning and even athletic." *The Globe and Mail* titled Kinect as setting a "new standard for motion control." The slight input lag between making a physical movement and Kinect registering it was not considered a major issue with most games, and the review called Kinect "a good and innovative product," rating it 3.5 out of 4 stars.

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