**ELECTRICAL & COMPUTER ENGINEERING**

School of Engineering 

**Engineering Design Specification Report**

**Modular Bluetooth Xbox Kinect Data Transfer Device**

**Team: ECE 409**

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**Signatures**

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**II. Executive Summary**

This project seeks to alleviate issues a user may encounter when trying to set up multiple Microsoft Kinects with their PC. For example, a previous computer vision project encountered the problem of having to install multiple USB hub PCI cards; instead of having to install multiple cards in a computer, a user would rather have an easy, modular solution. In our project, we will virtualize a Microsoft Kinect on a host PC by transmitting its data from a Raspberry Pi. The Kinect is connected to the Raspberry Pi, and the data is received through a program interface. The Pi will then transmit the data to the host computer via Bluetooth.  
 Our project sponsor is Dr. Yuichi Motai. His specialty is in robotics and computer vision, and therefore, is helping us form realistic and informed project goals. The project is being made to help our professor and his researchers use and set up projects involving multiple kinects, wirelessly, and without having the obstacle of installing a PCI card for each Kinect.

Our final deliverable will be a system that allows a Microsoft Kinect to be plugged into a Raspberry Pi that transmits Kinect data to the host computer via Bluetooth. The host computer then separates the information it receives, and virtualizes the Kinect. Through this, a user should be able to connect, within memory limitation, as many Kinects as they need using multiple Raspberry Pis. The project sub-deliverables include: a software which parses the raspberry pi data, a software which virtualizes the kinect using this data, an API which sends the information from the Pi to the computer, and an apparatus built with the Raspberry Pi that allows for each connection of the kinect.

III.  **Project Description**

1. The goal of our project is to be able to easily set up cheap and robust wireless cameras with a computer. The applications for this could be security, 3D mapping, and much more.
2. As research in computer vision becomes more and more accessible, users will desire solutions and setups that are easy, convenient, and cheap. Usually, some combination of the two can be had, but not all three at once. In the case of our lab environment, we are able to connect multiple Microsot Kinect’s to a computer, which are cheap and easy, but not convenient as each Kinect requires their own USB hub. Our project seeks to make a solution that would hit all three of these targets. It would extend the ease and affordability of the Kinect, while adding convenience. It would do so by transmitting the Kinects output wirelessly to the computer, instead of being directly plugged in. This way, multiple Kinects could be connected to the same computer, without needing to install new PCI cards for new USB hubs. It would do so by being connected to a Raspberry Pi, which then sends the data to the PC.
3. To achieve our end goal, we have several intermediate steps. We first have to determine some parameters from both the Raspberry Pi and the Microsoft Kinect. The Microsoft Kinect comes in two revisions, the V1 and V2. While V2 is more powerful, it require a much higher bandwidth, which the Pi cannot offer. We must first identify how much of a difference in bandwidth there is between the two revisions. We must then find out what is actually sent in a packet of data from the Microsoft Kinect. This allows us to determine what kinds of things we can cut out, and how to format our resulting data. For the Rapsberry Pi, we must figure out how it can compress data, and how it can buffer data coming in from a stream. Once we figure this out, we must figure out how much the transfer speed of Bluetooth constrains us, and use that to figure out how much information needs to be cut out from the Kinects video feed. Upon identifying these parameters, we must then ensure that the Kinect can connect to the Pi, and that the Pi can connect to the computer. We will then create software for the PC and the Pi to handle their new forms of input. Finally, we will present a product that utilizes two pieces of software which connect a Kinect through a raspberry pi to a computer via Bluetooth.

To measure our progress, we can follow our Gantt chart timeline, and ensure our sub goals match up with what we are intending them to be.

1. [COVERED ABOVE]
2. This apparatus can end up being very beneficial to users, as it allows them to connect the Kinect to a PC in a modular fashion. This could allow for multiple Kinects to not only be connected to a desktop, but also a laptop, or a tablet, or maybe even a Macintosh. The increase in modularity also allows user to come up with new applications and uses for the Kinect, all at a low cost of entry. In general, this should allow computer vision research to be accelerated due to its convenience and cost.
3. The typical user for such a system would mostly be students, researchers, and industry professionals. Due to the technical nature of the Kinect, there is a learning curve involved in understanding how exactly to use it. While it is by no means abhorrently difficult, it still require an average understanding of coding and IDE usage. For this reason, our apparatus would mostly be relegated to these groups. This apparatus could also be used by game developers and gamers, for unique gameplay experiences.
4. Due to the modular nature of the product, it would potentially be able to be set up in any environment. One common environment would be a lab setting, but an auditorium, or building may even be viable options. The ability to make the setup wireless is certainly a powerful one.
5. Though the intention for the product is not be a marketed one, it could be bundled as a wireless setup kit, which would include the Kinect, an adapter, a Raspberry Pi, the appropriate wires, and a sizable battery. Since it is made up entirely of existing components, with the only unique feature being the software, this could also be explained as a tutorial or a DIY project.
   1. This device would see as many uses as Kinect research, which is steady, but not especially strong.
   2. Currently, one can set up a wireless webcam easily with Raspberry Pi’s or 360 degree cameras. IN the former case, it is not very robust. In the latter case, it is not very affordable. Within the price point of the Kinect, with the features it offers, this wireless setup would be unique.
   3. If a price was to be attached to the product, something in the realm of $120-$150 would be adequate. This is around the sum of all the components, with some room given to offset development time/cost.
6. The special features of this product are the wireless capability, and potentially the ability to strip information from a “live” (potentially buffered) feed of data from the Kinect. This could allow users to customize their Kinect setups as needed, and with computer constraints
7. Finally, as this is simply a combination of products, built using freely available software, this idea itself is not entirely unique. It can be bundled as a kit, with proper approval from all parts manufacturers to resell.

**IV. Engineering Design Specifications**

a. Customer Requirements

i. Human factors considerations

Humans will interact with our product purely as a safe and legal manner if the user follows the specifications provided. Some factors that have been considered are: Safety, manufacturing, operation, and maintenance. Safety: the product serves as a relatively lightweight addition to an existing product. The safety concerns are minimal and are similar to other small electronics. Manufacturing: The manufacturing of the product is simplistic. The product is simply a microcontroller housed in a plastic shell. Operation: The operation of the product will be kept basic for the user’s sake, with most of the connecting being done automatically by the software. Maintenance: software updates can be provided for the OS side. Hardware maintenance will be up to the user.

ii. Metrics for customer satisfaction

Customer satisfaction will be based off of if the customer found as much value from the product that they perceived during purchase. The value that the user derives will be based on what use the user finds. The potential uses of this product are too many to count, and new uses are sure to develope. This is due to the fact that any previously existing use of the Kinect 2.0 with Windows 10 will now be able to be completed using bluetooth. As an example, the most obvious use of this product is to use bluetooth Kinect 2.0 cameras to set up a network of surveillance for any purpose that the user desires.

iii. Single use (consumable device) or reusable

Reusable.

iv. Sterile or non-sterile product

Non-sterile.

b. Functional Requirements

i. What should the product do

This project seeks to alleviate issues a user may encounter when trying to set up multiple Microsoft Kinects with their PC. Instead of having to install multiple USB hub PCI cards in each computer they want to use, a user would rather have an easy, modular solution. In our project, we will try to virtualize a Microsoft Kinect on a host PC by transmitting it’s data from a Raspberry Pi. The Kinect is connected to the Raspberry Pi, and the data is received through an API. The Pi will then transmit the data to the host computer via Bluetooth.

ii. Performance metrics

Video quality, connection range, data compression and decompression speed, gui quality and software responsiveness.

c. Engineering characteristics (units, ranges, limits with allowable tolerance ranges, etc)

i. Size, dimensions, weight (should be constant with target market application norms)

The product will be a rectangular prism. The product will be lightweight with dimensions of approximately of 9x6x3 cm.

ii. Mechanical properties

The product is of electronic nature, there will be no moving parts.

iii. Material properties

The only materials used are going to be 3D printed rigid plastics

iv. Electrical, non-electrical requirements

The Raspberry Pi 3 will have green, blue, and red LEDs flashing on the board. The green LEDs will represent when the Raspberry Pi is connected to the Kinect V2 or Kinect V1. The blue LEDs will represent when the Raspberry Pi is transmitting data via bluetooth. The red LEDs will represent when the Raspberry Pi is disconnected from Kinect V1 or V2 and when it's disconnected from the bluetooth enable computer.

d. Production Methods

i. Appropriate manufacturing methods based on scale of components and design requirements

The only component of the prototype is the shell. The shell is going to be 3D printed plastics. The other components are purchased and programed.

When the product goes to production, a more elegant solution for the manufacturing of the shell will be created.

ii. Quality Requirements with Allowable Tolerance levels

The shell must be able to effectively and safely secure the Pi microcontroller, while still remaining elegant in aesthetics.

iii. Packaging and Storage Requirements

The shell must be able to effectively and safely secure the Pi microcontroller, while still remaining elegant in aesthetics. The product can be shipped in standard cardboard packaging with the standard safety methods.

iv. Brief cost analysis

Microcontroller - $35.00

Shell - $2.50

Prototype cost: $57.50

e. Constraints

i. Does this product have to function with specific other products? i.e. If computer program is part of design, what is spec on required hardware, etc.

The product must deal with the constraints of two other products. The first being the Xbox Kinect. The constraint that this brings is the massive amounts of data that the Kinect collects and puts out. This constraint is solved by using compression and data mimicking techniques. The second constraint is the Windows 10 operating system. This constraint is worked around by designing the software from the ground up in Windows 10 to ensure compatibility.

ii. Does solution have to utilize specific materials or manufacturing processes?

No

**V.** **Project deliverables**

**Project Plan**

In order to have successful completed prototype by December, we will follow our Gantt chart timetable and update as accordingly, refer to the addendum. Our goal is to spend no more than two weeks or less per activity on the Gantt chart, unless stated otherwise. In addition, along with the Gantt chart, we have identify our two major issues that we must overcome for us to proceed to production. We have decided to allocate two group members per issue. Below are the following issues we have determined to be our highest priority,

1. The Collect Log Info from the Kinect (Partners Ayush & Millad)

a. Determine what data is originating from either Xbox One Kinect V2 or Xbox 360 Kinect V1

b. Determine the type of raw data originating out of the Kinect V2 or Kinect V1 stream

c. Determine the data size collected in X amount of time i.e. In five minutes will the data size be in mb, Gb, or TB

2. Limit Data on the Raspberry Pi 3 (Partners Eric & Dat)

a. Determine the stream of data we want to limit/compress

b. Determine how the compression algorithm without reducing the quality of the stream

c. Determine the storage of original data vs reduce data i.e. does the compression algorithm actually reduces the size

**Informing Technical Advisor**

- Our technical advisor will be informed by our weekly emailed progress memorandums along with handing in hard copies or emailing our progress memorandums to our instructor if necessary. In addition, we have agreed and planned to meet weekly on Thursday at 11 am with the advisor to inform any setbacks, recent milestone achievements or our general overall completion progress.

**User Evaluation**

- Towards the completion of our prototype and the final project, we will follow the usability evaluation methods and base on the evaluation results, we will modified our final project accordingly. The usability evaluation method includes the following,

1. Reporting Usability Test results

a. Quantitative Data

i. Success rates

ii. Task time

iii. Error rates

iv. Satisfaction questionnaire ratings

b. Qualitative Data

i. Observations

ii. Problems experienced

iii. Comments/recommendations

iv. Answers to open-ended questions



