

# 3D Scanner

PDR

Team 8

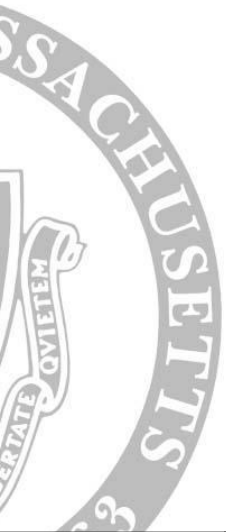
Oct. 23, 2015

Vangjel Frasheri

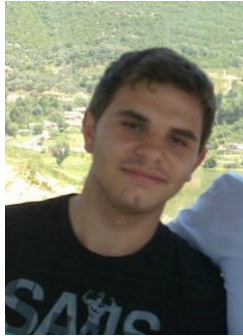
Siyam Lin

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Advisor: Professor Tessier



# Team Members



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CSE



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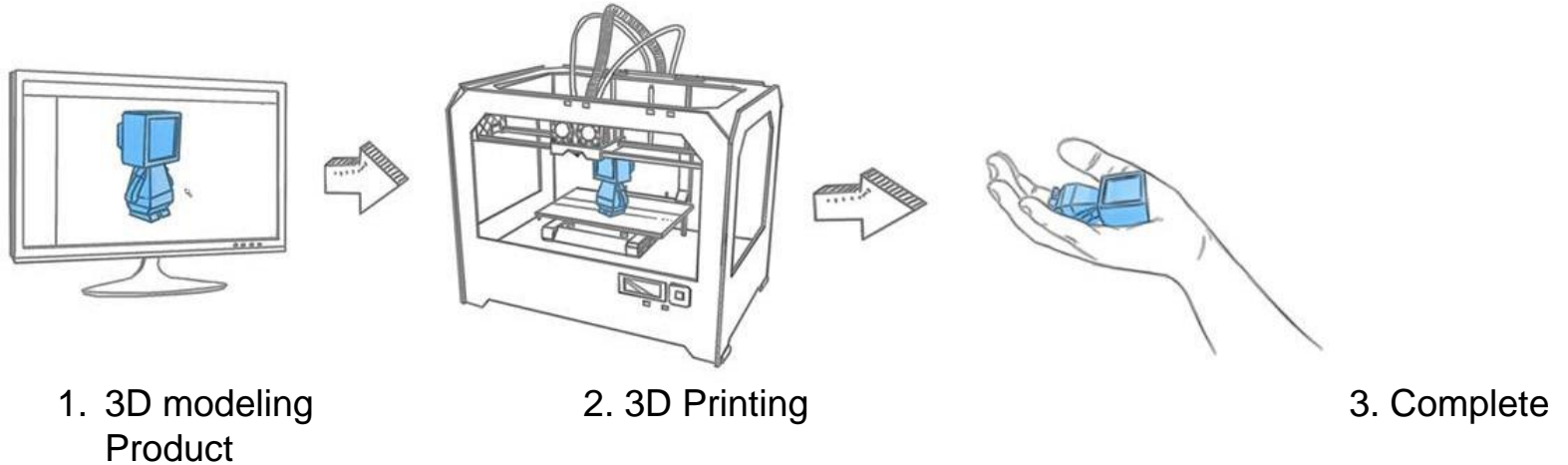
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## Problems



- 3D design prototype model requires CAD software (eg. Pro/Engineer, Solidworks, Autodesk ect..)
- Creating CAD models can be time consuming and can be very difficult to learn at the first time
- In fact, thousands of companies are using 3D scanners and software

<http://dimensionnxg.com/2015/03/08/3dprinting/>



## Problems

- Hardware and software separation
- wastes a lot of time
- requires a PC
- requires lots of human interaction with computer



## Problems

- Expensive processing software
  - \$400-\$2000+



### Cubify Sense Handheld 3D Scanner

**\$399.00** from 10+ stores

★★★★☆ 14 product reviews #1 in 3D Scanners

December 2013 · 3D · Handheld · Portable

Portable, Full Color 3D Scanner, Maximum Scan Volume: 118 x 118 x 118", Minimum Scan Volume: 8 x 8 x 8", Working Distance: 15-60", Two Cameras for ...



### Matter and Form MFS1V1 3D Scanner

**\$548.99** from 10+ stores

3D · Portable

A moving HD camera head equipped with dual lasers and a rotating platform makes **scanning** three-dimensional objects fast and accurate. After a one ...



### Fuel3D SCANIFY Handheld 3D Scanner

**\$1,490.00** from 4 stores

3D · Handheld · Portable

Portable, full color 3d scanner, scan volume: 8 x 12", operating distance: 14 to 18", maximum resolution: 350 microns, uses xenon led flash bulbs ...



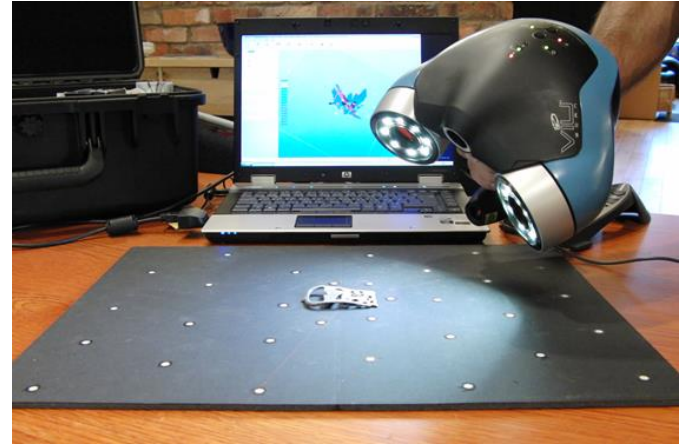
# Our Implementation

- Fully Automatic
- PC-free device(embedded lcd screen)
- On the fly preview
- Affordable
- Output STL(**STereoLithography**,files needed by the 3D printer)File directly to various devices



## All in One

- ▶ Currently no stand alone scanner
- ▶ Must be wired to computer
- ▶ In need of some other device to run





# Requirements

The scanned object looks like the original minus the minor details (such as painted lines or carvings)



## Requirements

- Perform all tasks without the need of another computer



# Requirements

Input object (12cm(length) \* 12cm(width) \*20cm(height))

Output:

1. STL file
2. Able to display the image on the LCD
3. Able to store output STL files



# How does 3D scanner works

## 1. 3D Laser scanning

### a. Laser triangulation

- A laser line point to scan across a target sample
- A camera sensor picks up reflected light
- System calculates the distance from the object to the scanner

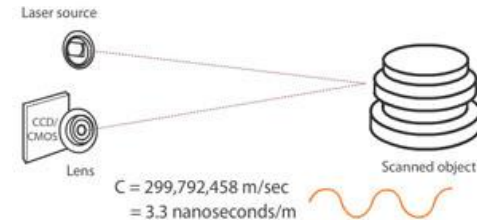
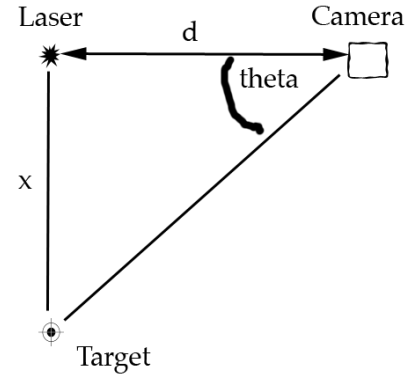
### a. Time of flight laser scanners

- The distance of the object can be estimated by knowing how long a laser takes to reach an object and reflect back to a sensor

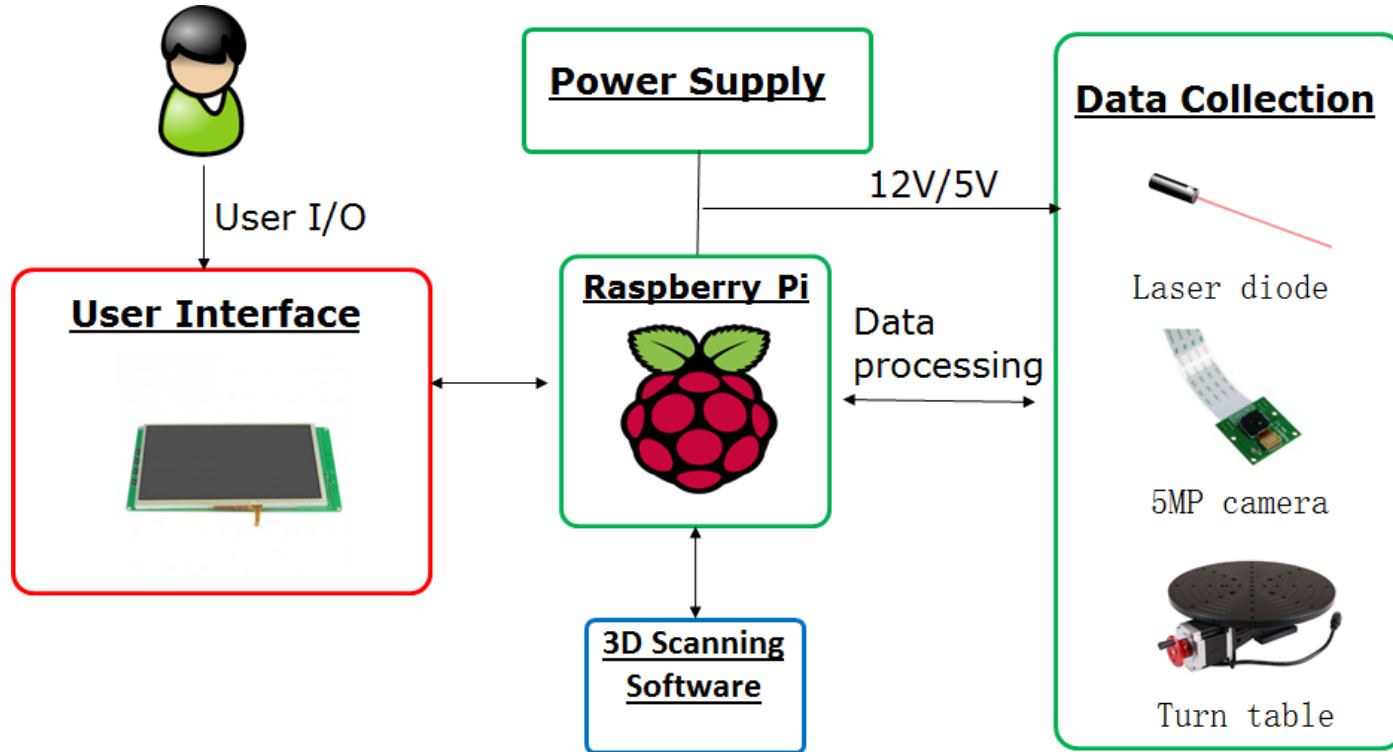
## 1. Photogrammetry

- Take multiple images of objects manually
- Reference common points in each photograph in order to create 3d measurement

<http://www.rapidform.com/3d-scanners/>



# Overview Block diagram



# Power Supply Requirements

- 5-12V
- Drive the stepper motors(12V input)
  - Stepper Motor driver
- Power the laser
  - Forward voltage for a red laser is 1.7V-2.5V
  - Operation current: 45mA(typ.)
- Power the microprocessor (5V input)
- Safe, reliable and uninterruptible



# Power Supply Implementation

- 12V/5V AC to DC power adapter

- Input voltage 100-240VAC @ 50-60Hz
- Output voltage 12V/5V
- Output current: 2A
- Output power:  $12V \cdot 2A = 24W$ ,  $5V \cdot 2A = 10W$ ,  $24W + 10W = 34W$  (Maximum)



- Alternatives: LM317 (Adjustable positive voltage regulator)

- Range: 1.25 V to 37V

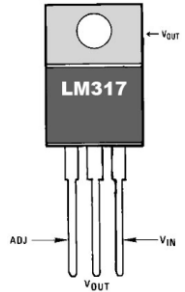
- A4988 Stepper motor driver

- Supply voltage: 3-5.5V
- Full speed, max: 2A



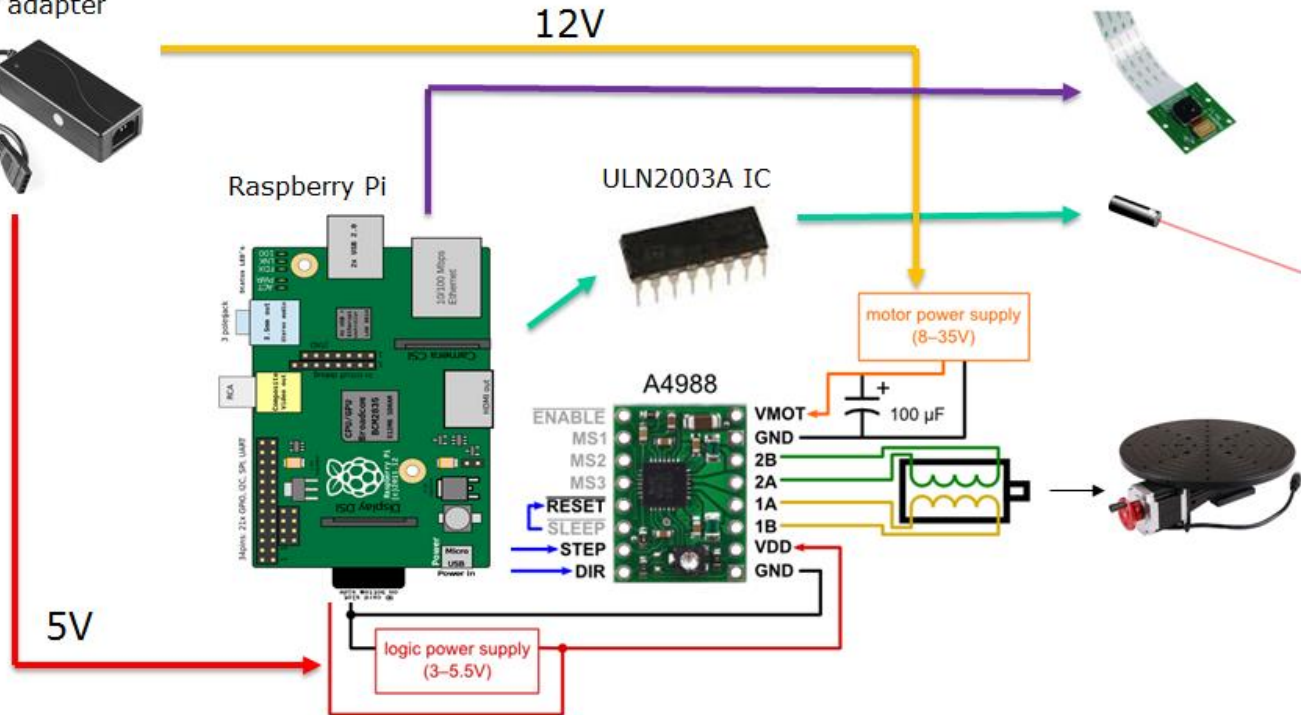
- High-Current Darlington Transistor Arra

- ULN2003A IC (Relay Driver)
- Ability to control laser



# Power Supply Implementation

Power adapter





# Power Consumption

- If raspberry pi is power by 5V USB

Product	Recommended current capacity	Maximum total USB peripheral current draw	idle state current consumption
Raspberry Pi Model B+ and Pi 2	1.8A	1.2A	330mA

The GPIO pins can draw 50mA safely

the camera module requires 250mA and keyboards and mouse takes 100mA

- Power consumption roughly:
  - $1.8A * 5V(\text{raspberry pi}) + 1A * 12V(\text{table}) + 250mA * 5V(\text{Camera}) = 22.25W$
  - fit our power supply of max. 34W



# Microprocessor Requirements

- Embedded 3D scanning softwares
- General Purpose Input/Output
- Data storage
- Data processing and algorithms
- Turntable table, camera and lasers at the same time
- Reasonable power consumption



# Microprocessor- Raspberry Pi 2

## Why -

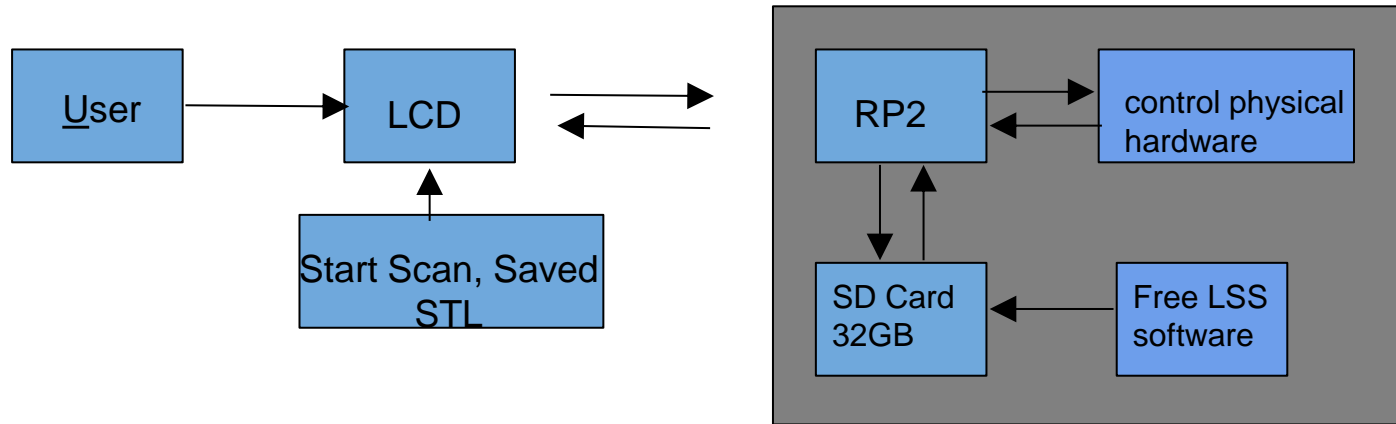
- Inexpensive and reliable
  - \$45
- Powerful performance
  - 900MHz quad-core ARM Cortex-A7 CPU
  - 1GB RAM
  - 20 GPIO pin
- Relative small size
  - 85mm x 56mm x 21mm
- Strong interface and multiple programming language support
  - Python, C, C++, Java, Scratch and Ruby
- Flexible storage
  - SD card: 8GB-32GB

## Alternatives

1. Arduino - Can't support embedded softwares
2. Intel Edison - Too expensive(\$100-\$200)



# More detailed block of Software



Numbers to consider:

Software needs < 512MB RAM

SD card minimum 16GB

STL output files: up to 100MB



# Data Collection Requirements

- Turntable table
  - 200 steps/rev
  - Roughly area:  $\pi(10 \text{ cm})^2 = 314 \text{ cm}^2$
- laser
  - Line laser
  - Red (wavelength 520-635 nm)
- Camera
  - Camera data processing(time-lapse ect.)
  - Capable of capturing images or video recordings
  - 5MP (2592x1944 pixels)
  - Video resolution 1080p30



# ***Possible Alternatives We Considered***



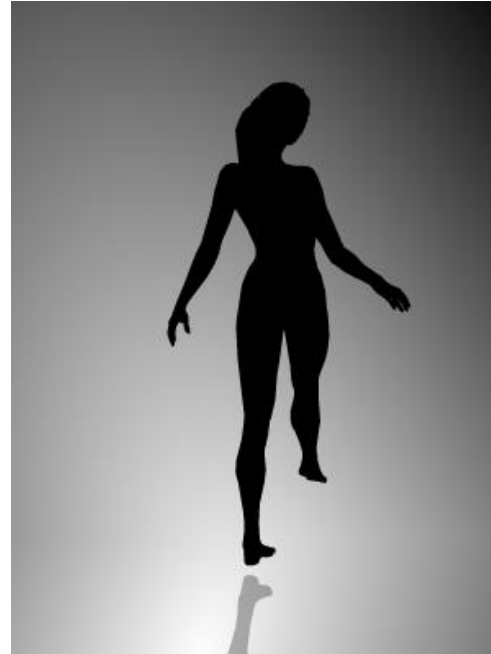
# Video output (preview functionality)

Preview mode

A clip of video showing scanned  
file rotating

Or

A software that lets user zoom in,  
zoom out and rotate at their will



# Video output (preview functionality)

## Traditional Monitor

- +sophisticated
- +plug in and use
- price (~\$100)
- output only
- relatively big





# Video output (preview functionality)

## Mini-Projector

- +super mini size
- +versatile
- expensive (~\$80)
- output only
- lamp life

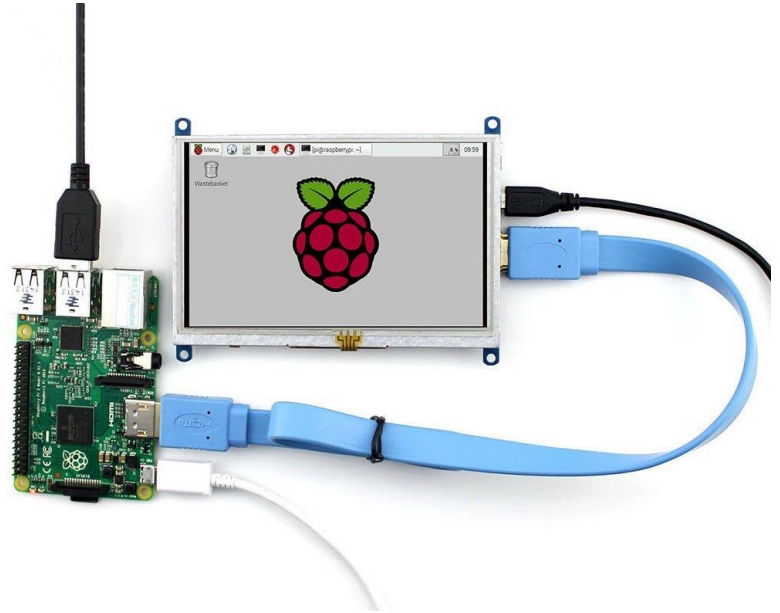


# Video output (preview functionality)

LCD solution

- +highly adjustable
- +affordable (~\$60)
- +I/O device

Resistive or Capacitive

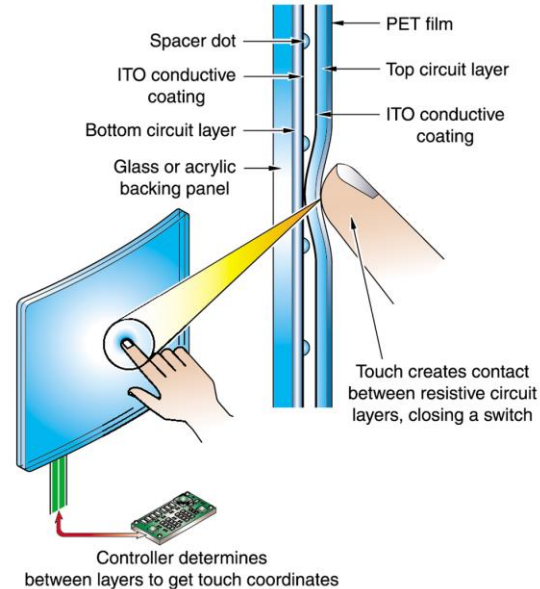


# Video output (preview function)

## Resistive touch screen LED

+cheap

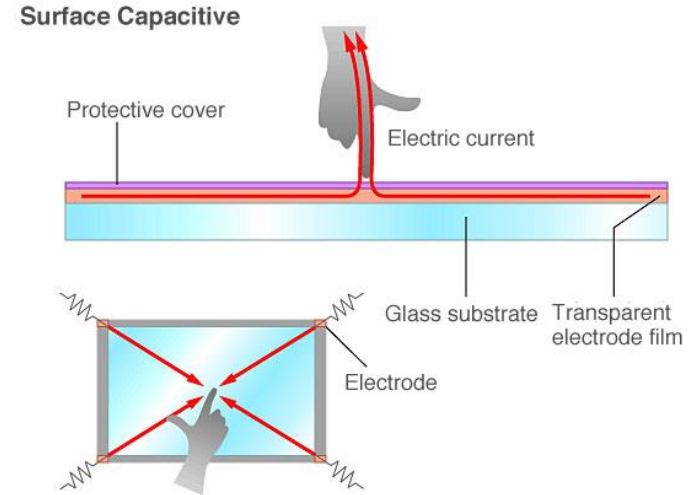
- dedicated gui to interact
- potential messier gui
- outdated



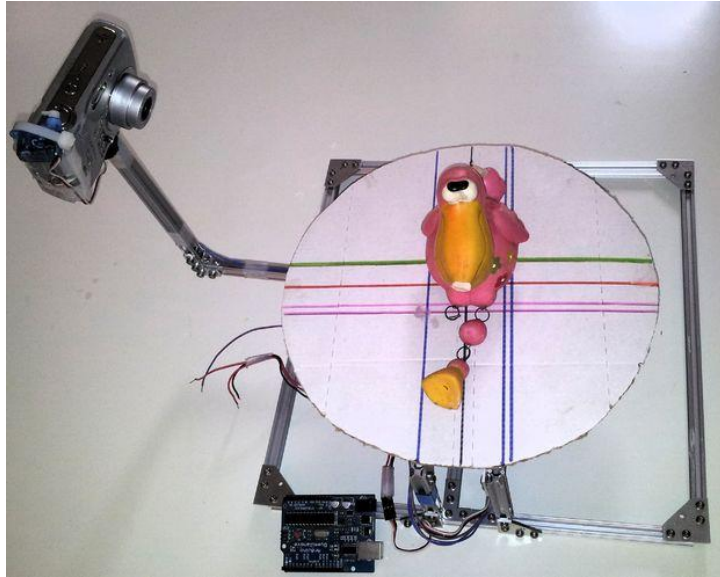
# Video output (preview function)

## Capacitive touch screen LCD

- +Multi-point touch-> more gesture
- +Intuitive pinch to zoom in and out
- +cleaner gui -> focus on content
- expensive (comparing to resistive)



# Camera vs Lss



VS



## Part list

Raspberry pi 2		(~\$40)
Step-Motor( a4988)	(~\$10)	
Laser sensor	(~\$10)	
Camera sensor		(~\$30)
Sd card		
	(~\$10)	
Power supply		(~\$10)
Capacitive touch screen lcd	(~\$70)	
ULN200x(Relay Driver)	(~\$10)	
miscellaneous		(~\$20)
Turntable		

**Overall budget**

**\$300**

**under**



# MDR Deliverables

- Purchase part and prototype of hardware working on breadboard
  - GUI interface which can connected to the hardware
  - demonstrate data collection from sensors and as well as ability of basic communication
  - A prototype 3D laser scanner which able to roughly output stl file of scanning objects
- 
- Siyan - Reliable power supply which able to power raspberry Pi, turntable, camera and laser
  - Vangjel - Software data processing and able to output stl file from the input data collection
  - Chenkai - Create GUI on LCD to display connectivity between GUI and raspberry pi



# Timeline

- November 16th: Build the physical scanner
- MDR day: fully connected Scanner able to output stl files to a computer or laptop
- Mid February: Get the LCD screen displaying the visual image of the scanned object
- Mid March: LCD will be full functional: able to view STL files, save the files on the SD card, start the scan, force stop the scan, directory to all the saved STL files with the ability to open and display previously saved files.





# Questions??