Prototyping and evaluating a camera redesign

Capita selecta - Master programme Industrial Design Engineering
UNIVERSITY OF TWENTE

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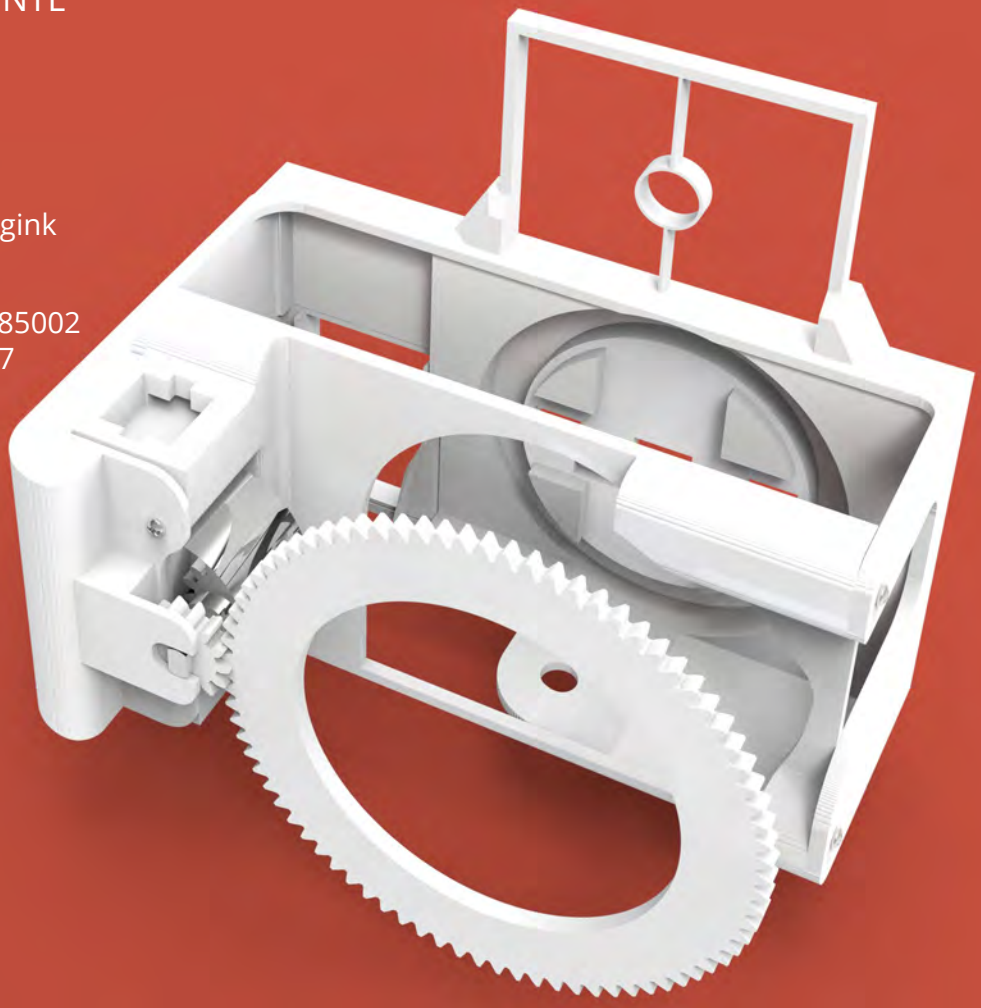

Capita Selecta report

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Content

Introduction

This report contains the process and developments regarding a redesign of a traditional photo camera. The origins of the design originate from a project executed at the University of Twente as a minor project (Deinum & Feij, 2017). The purpose of this project is to further develop the existing design into a semi-functional prototype and evaluate the design through interviews involving the prototype.

Furthermore, the design was featured on the Mind the Step exhibition during Dutch Design Week 2018. This exhibition showcases student projects from three engineering universities in the Netherlands. This report also includes various audience responses gathered from the crowd passing by the exhibition setup.

The prototyping process and results are also explained and provided with recommendations for future work, as well as conclusions from interviews with potential users.

Previous Work

In the project described in Deinum & Feij (2017), the goal of the redesigned camera is to make people more aware of their surroundings when they are taking photographs and make sure that people's attention is not constantly aimed at the camera they are using. This means that the camera design is not aimed at professional or enthusiastic amateur photographers as these people have the intention to create nice photographs and thus need to focus on their camera's to make sure all settings are perfect. At the same time they are already looking at their surroundings to define how they want to frame it to capture the surrounding effectively in their photographs.

The projected target group of the Camera.reframed are primarily people who like to use photos as a way of making memories and documenting life events and holidays. This can be a wide range of different people but the primary group will consist of people who are looking for ease of use and an unobtrusive way of creating memories and photographs.

Prototype and process

The prototype to demonstrate the functionality of the product has had multiple iterations. The purpose of the prototype is not to give a realistic image of the final product in all its aspects, but to provide an idea of what the interaction will look like. I can then be used to guide conversations with potential users of the product to evaluate the design. Therefore the demonstrator must be able to at least carry out its intuitive framing functionality in line with the following requirements:

- The input of the prototype is the distance between the frame on top of the camera and the face of the user.
- The input should be translated into a physical degree of zoom that the camera should adjust to.
- The camera should be able to automatically carry out the above requirements.

The prototype should be similar to the concept on the following aspects:

- The screen does not show a live view of the camera's image.
- The prototype should communicate feedback of what it is doing to the user

Furthermore, additional requirements were determined to make sure the prototype was able to function on the Mind the Step exhibition of the Dutch Design Week. These included:

- The prototype should be able to function without supervision.
- The prototype should be able to be secured to the exhibition tables.

The physical appearance of the demonstrator developed through three iterations. The first experiments were focused around altering an existing compact camera to achieve that it zooms automatically. The idea was to connect the actuators for zooming directly to an electric current from an Arduino microcontroller board. However, after the one of the first attempts, the capacitor of the built-in flash of the camera was short circuited. This rendered that camera unusable.

The next approach consisted of a small stepper motor that was mounted to the top of a 3D printed casing. The motor turning left or right resulted in physical rotation of the zoom button on top of the camera. The advantage of this prototype is that it was extremely mobile due to the built-in powerbank and the compact size of the camera. However, the delay between the measurement of an infrared distance sensor, the duration of the movement of the motor and the physical movement of zooming which is not a homogenous movement. Its velocity profile does not follow a linear trajectory and therefore it was difficult to estimate an exact enough way to connect the zoom amount with the amount of time that the motor holds down the zoom button. A way that this was tried to achieve is by zooming out completely after every interaction. However, this took an extra second or two for every time an interaction took place.

Due to this problem, this approach was discarded almost completely. Only the learned knowledge remained. The third and final approach was built around a larger camera with a zoom lens. In this type of camera, the user rotates a ring on the lens a certain amount of degrees in either direction to zoom in or out. This proved very useful since the motors could be set to rotate an amount of steps quite precisely. Because of the low quality of the motor however, it would be just slightly off every time, resulting in a larger error after a few subsequent interactions. This could however be solved by resetting the motor position every so often.

Built around the camera was a 3D printed case that had all the necessary mounting possibilities for the motor, the button and the interface made out of a LED ring, including all the wiring. The design of the casing went through various iterations as well, making small adjustments in every one. These adjustments included: changing the position of the LEDs from the outside to inside the case, adding a cavity for the button and varying the position of the motor. The final casing consists of three different parts that are screwed together. The motor is mounted with the same screws and clamped between two of the 3D printed parts. Furthermore, on the shaft of the motor, a small 3D printed gear

Figure 1: overview of casing parts

was placed as well as a larger gear that was glued around the lens. These allowed for the motor to control the rotation of the lens. However, the hole in the small gear often wore out due to the large torque of the motor and had to be replaced more than once. 3D printed parts are not expensive and very easy to manufacture, but it would be better to replace it with a steel laser cut gear to ensure a more precise approximation of the right degree of rotation.

The distance sensor used is an infrared gesture sensor. It was more precise and provided a larger range than both the ordinary infrared distance sensor and the ultrasonic distance sensor that were tested as well. The sensor was also mounted on the inside of the casing in the middle of the LED ring.

With this final approach came one big problem: the camera was to large to incorporate both a power source and the Arduino microcontroller into the case as well as keep it manageable size-wise. Therefore the final prototype was place on a tripod and had a thick bundle of wires coming out of it and into a small wooden box that contained the Arduino and other necessary electronic components such as a motor driver and the wiring for the sensor and the LED ring. The Arduino was then connected to an electrical outlet by an ordinary 12 Volts cable adapter. Because of the needed space for the components to work, the final demonstrator is not mobile at all and has to be placed on a table for use.

Dutch Design Week exhibition

To present the working prototype and concept on the Dutch Design Week was somewhat of a challenge because of limited space and the fact that the prototype was not completely mobile. With the limited space available the aim was to present the concept in an interesting way as well as present people with a little bit of context about where the project was created from.

How this was achieved was by creating a showcase containing a small timeline of the history of cameras, as well as creating a mirror with a monitor included. This monitor live streamed what the camera was seeing and because of the mirror glass people could take selfies with the camera. This created an interesting and fun way of experiencing the concept while the prototype was fixed to the stand. On a secondary display the presentation video of the concept was playing on a loop.

The combination of the animated LED lighting on the camera and the mirror display created a exhibit that spiked the interest of people passing by and made it tempting to get closer to see what the exhibit was about.

Audience responses

At the Dutch Design Week a lot of people have seen and tried the Camera.Reframed. This gave an opportunity to see how the audience reacts to the issue the camera tries to solve, as well as responding to the proposed solution with trying the created working prototype.

Almost all the responses to the presented issue area categorizable in two categories. Either people recognize the issue and are excited that the project tries to solve it, or people do not recognize the issue and find it hard to see how the design could help them or others.

A lot of people that recognized the issue primarily with other people, they stated that they see a lot of people who are only looking at their screens when on holiday. Only a few people said that they experience this issue themselves. Also a lot of couples came by the presentation and the interesting thing with some couples was that one of them said that the other has the issue while the other denied this. This could potentially mean that the issue is more frustrating to the person who is not taking photographs than the person who is.

Responses on the working prototype were very varying. Most of the people did not directly understood how it worked and what they should do with it. The project needed explanation. After this most of the people understood what the prototype does and how they should use it. Overall people were surprised by what it does and how it worked. It could however not represent a real life use scenario because the camera needed to be fixed to the table to function, and there were limited possibilities on framing a picture at the Dutch Design Week stand. This meant that people could not fully experience what it does and cerate a valuable opinion. Also because it is a first and basic working prototype it does not function as quickly and fluently as it should.

The presentation and the LED interface was however interesting enough for people to get excited for the idea.

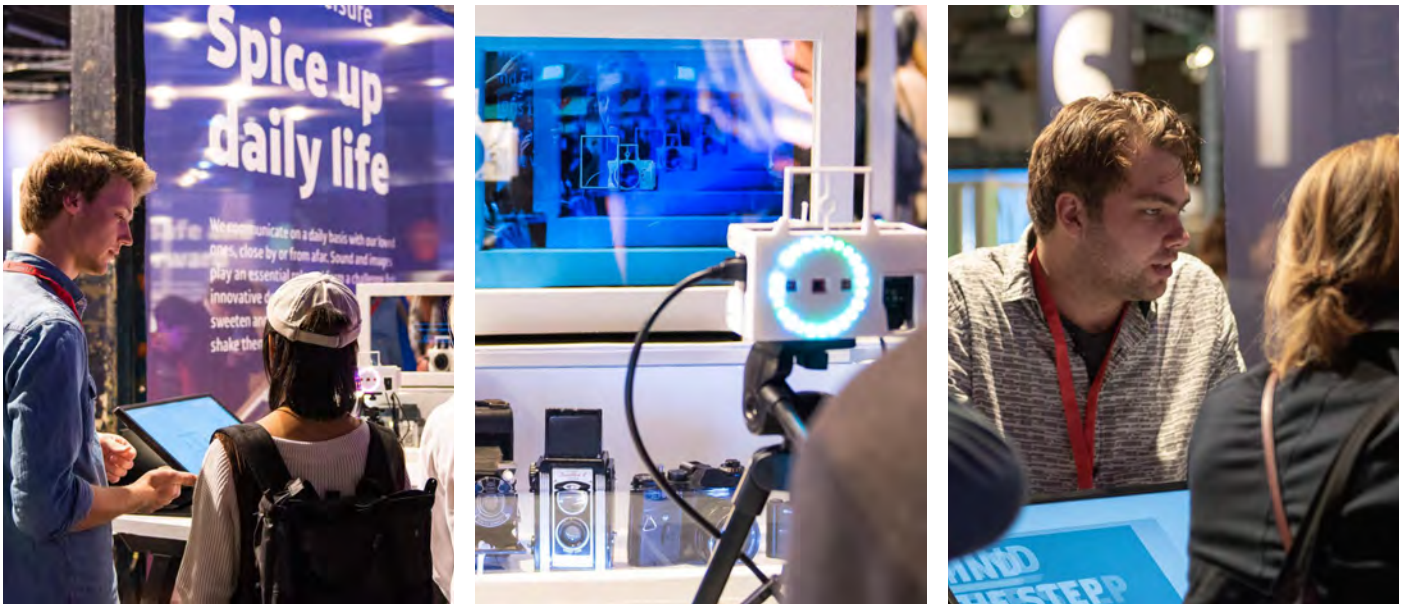

Figure 2: The prototype at Mind the Step during Dutch Design Week 2018. Photos by Peter Feij.

Evaluation of the design

The evaluation of the prototype and the concept behind it consists of informal, but slightly structured conversations about the design. The product attempts to solve a very psychological problem that might be larger for some people than for others and the interaction depends very much on what the user experiences. Furthermore, the product is still in the early stages of testing. The prototype does not embody a holistic representation of the final product, both regarding its looks as well as some functionalities. This renders performing a reliable qualitative method of evaluation almost undoable. However, evaluating in another way can still prove very valuable for the design process. The prototype being as rough as it is allows for easy adaptation, the design is still very flexible and not cast in stone and suggestions of insights from people outside the process of designing this product could easily be incorporated into a next iteration.

During the interviews, the potential user is able to see, and experiment with, both the functional prototype and the foam model of a possible final design that was created in an earlier stage of the design process. The following points of attention will be brought to the table by the interviewer to guide the conversation and hopefully get valuable insights into the design:

- The current situation with regard to photography
- The intuitiveness of the interaction. Can be tested by giving the user the task to take a photo
- Impressions by the user and answer to the question whether the user thinks the concept could work and why (not)?
- The position in which the user would place the design in the novelty-typicality graph as shown in the design process by Deinum & Feij (2017).

Seven people participated in the interviews. One of them had some prior knowledge of the design. Two others had seen it during the Dutch Design Week but did not know much about it. The other four had no prior knowledge about the product.

All seven respondents were students of Industrial Design, but in various stages of their studies and with different fields of interest. One was in his third year of the bachelor, one was a masterstudent following the Human Technology Relations track of the Industrial Design Engineering master programme, three were second year bachelor students, one of which had currently paused her studies to perform extracurricular activities, that was also the case for another participant, who is currently in the third year of the bachelor, another was a masterstudent following the Emerging Technology Design track of the Industrial Design Engineering master programme and the final one was following courses in the third year of the bachelor.

The notes taken during the interview can be found in appendix B of this report.

Evaluation conclusions

The slightly structured nature of the interviews allows for well comparable data. Most of the participants gave similar responses and their input could lead to valuable insights into the design.

The participants all had some experience with photography, although to different degrees. Their experiences ranged from ‘only with my phone every once in a while’ to ‘photography is my hobby’ and ‘I want to capture the invisible’. However, all of them could imagine using photography as a memory-making tool and most even said that that would be their primary goal for the medium.

While testing the intuitiveness of the interaction, almost all participants achieved the same results. Most of them first moved the camera closer to their face when asked make the camera zoom in on a particular detail.Which is the motion to zoom out. However, when asked why they chose this specific movement, most of them re-evaluated their choice and corrected it almost immediately after. One person had it right at the first try.

When asked for their thoughts on the matter, most of them said that the interaction would be counter-intuitive, not with their own intuition, but with the interaction that modern cameras provide: if you want to zoom in, you get closer. It is not about framing what you see, it is about getting closer or farther away from a subject. They almost all mentioned that it would simply be a mental switch that they would have to toggle. One person said that after three times of using the product he would be used to the different perspective that the concept takes. The fact that the camera was on a tripod during the tests might also be of influence on these results since moving your head to control a product is less intuitive than moving the product itself to control it. One person had the interesting notion that, instinctively, the interaction of moving away to zoom in feels wrong, but when actually seeing the product in front of him, that it felt more natural than he would have expected.

Figure 3: Participants testing the prototype

All of the people found the idea very interesting and could see it work for the targeted audience, casual photographers. This was confirmed by the one hobby photographer that was interviewed and said that the concept would not particularly be a solution for her but she could see it being for other people. Another participant stated that the target group would be either low-end amateurs or conceptual artists.

A few other statements that people noted during the interview included that focussing on both the frame and the framed environment is generally found very difficult. If the frame is in focus, the environment is not and vice versa. However, it was also stated by someone that this fact could also cause that less attention of the user would be diverted towards the product and more of it would be with the environment. Which is somewhat the

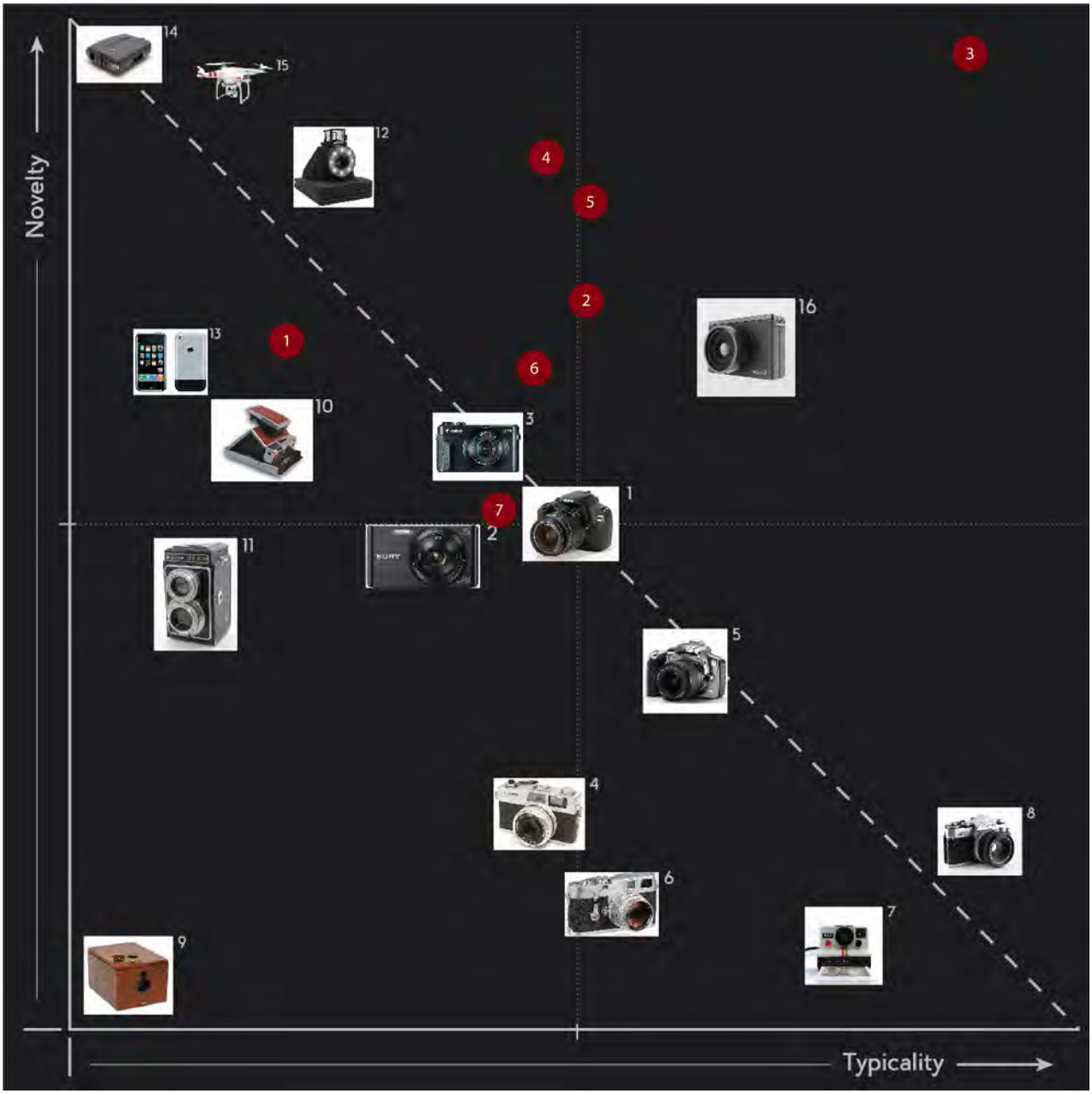

Figure 4: The novelty-typicality graph with the participants' input

general purpose of the product. Most people were most enthusiastic about the fact that they were able to see everything around them while using the product and agreed that this would help achieve the goal of the design.

Many people said they were confused by both the setup of the prototype (its lights were generally found to be distracting) and the shape of the prototype itself. It might have looked too much like a camera to signal to people that it is not expected to work exactly like the photocameras they know and instead deliver a whole other interaction. Many of the participants therefore experienced the camera not as a tool to frame their environment, but expected something more in the sense of traditional photocameras, that bring the world to the device. However, after toggling their mental perspective switch, they almost all adjusted to the idea and would have no difficulties whatsoever in understanding the interaction. Therefore, it could be concluded that this interaction has a clear mental model, for it is easily understandable without much else than a foundational explanation of the concept or the mentioning of a metaphor, for example comparing it to a photo frame around the world.

Lastly, at the end of every interview, the participants were asked to place the holistic design (design of foam model with interaction of the prototype and designed concept) in the novelty-typicality graph as proposed by Deinum & Feij (2017). The results can be seen in figure 4. On average, the design is placed above and to the right of the middle, which is the placement that was aimed towards in the design process. One participant mentally separated the aesthetics of the foam model and the interaction of the prototype and therefore ended up in the far top-right of the graph. However this was the reasoning behind the design, this separate view of the concept would probably not be adapted by consumers in general and therefore, this result possibly is not representative. The rest of the dots, however, do represent the participants' perspective on the design as a whole.

Conclusion and further development

In conclusion, the design was received well. Its archetypical shape is both a typicality virtue, but also communicates the message that this might as well be a camera like any other. Therefore it would be wise to re-evaluate the aesthetics of the design and consider aiming at sliding it slightly towards a less typical, but more novel design. The mental model of the design could be exploited and communicated more in the design, resulting in an even more intuitive way of interacting with the product.

In the process described in this report, many result were logically influenced by the way that the product was presented. A more objective research with a more representative and extensive prototype could benefit the design greatly. Testing the design in the real world would also be a possibility in that case. The next step would therefore be a redesign of the camera, taking into account the input of the participants of the interviews, after which the design could be transformed into a prototype that is more mobile and that takes aesthetics into account.

Reference

Deinum, S., & Feij, T. (2017). Learning from the past in a photo camera redesign project. Scientific Challenges project. Engineering Technology. University of Twente. Enschede.

Appendix A - Arduino code

```
[code]
#include <Wire.h>
#include <ZX_Sensor.h>
#include <FastLED.h>
#include <Stepper.h>

#define LEDPIN 6
#define LEDNUM 24
#define BUTTONPIN 4
#define BUTTONLED 2

const int ZX_ADDR = 0x10;

Stepper stepper(64, 8, 10, 9, 11);
CRGB leds[LEDNUM];
ZX_Sensor sensor = ZX_Sensor(ZX_
ADDR);
uint8_t zPos;
uint8_t gHue = 0;
int nrStable = 0;
int stableCount = 0;

int LDmin1 = -1;
int LDmin2 = -5;
int LDmin3 = -9;
int lightDistance = 0;

int turn = 0;
int orangeCount = 0;
int target = -1;
int cO;
bool firstTime = true;

int zoomStep = 0;
int zoomGoal = 0;
int focal = 15;
int resetCounter = 0;

int standbyTimer = 0;

bool buttonAvailable = true;

void setup() {
  // set up serial
  Serial.begin(9600);

  // set up leds
  FastLED.addLeds<NEOPIXEL,
LEDPIN>(leds, LEDNUM);
  FastLED.setBrightness(35);

  // set up sensor
  sensor.init();

  // set up motor
  stepper.setSpeed(500);

  //set up button
  pinMode(BUTTONLED, OUTPUT);
  pinMode(BUTTONPIN, INPUT);
  digitalWrite(BUTTONLED, LOW)
}

void loop(){
  EVERY_N_MILLISECONDS( 20 ) { gHue++; }

  if(standbyTimer == 1800){
    if(zoomStep <= 1100){
      stepper.step(300);
      stepper.step(-300);
    }else{
      stepper.step(-300);
      stepper.step(300);
    }
    standbyTimer = 0;
  }
// checken of er iemand voor de camera staat, anders confetti
  if(userInRange()){
    delay(70);
// wél iemand in beeld, is die situatie dan stabiel?
    if(isStable()){
      // is de hoeveelheid oranje lichtjes al evenveel als de blauwe lichtjes?
Zoja, dan is b true.
      if(orangeIsBlue()){
        turn = 0;
        target = -1;
        zoomGoal = map(zPos, 5, 47, 0, 2200);
        zoomAdjust(zoomGoal);
      }else{
      // de eerste keer dat hij hierlangs komt terwijl hij stabiel is?
        if(firstTime){
        turn = 1;
        measureLightDistance();
        target = lightDistance;
        firstTime = false;
        }

        // niet de eerste keer, dan gewoon door met de code, verder met tellen
van oranje lichtjes

        FastLED.clear();
        measureLightDistance();
        showLightDistance();
        countOrange(turn);
      }
    }else{
```

```
    // niet stabiel (meer)? Dan de target resetten, net als het aantal oranje lampjes dat aanstaat.
    target = -1;
    orangeCount = 0;
    turn = 1;
    firstTime = true;

// en ook de blauwe lampjes weer meten
    measureLightDistance();
    showLightDistance();
  }
 }else{
  confetti();
 }
standbyTimer = standbyTimer +1;
}
bool buttonPressed(){
 return digitalRead(BUTTONPIN) == HIGH;
}

void zoomAdjust(int d) {
 buttonAvailable = true;
 digitalWrite(BUTTONLED, HIGH);

    if( resetCounter >= 10){
  zoomReset(zoomStep);
 }

 stepper.step(-(d-zoomStep));
 resetCounter = resetCounter +1;
 zoomStep = d;
 delay(1000);
}

void zoomReset(int s) {
 stepper.step( s+30 );
 zoomStep = 0;
 zoomGoal = 0;
 resetCounter = 0;
for(int c = 0; c < 150; c++){
 EVERY_N_MILLISECONDS( 20 ) { gHue++; }
 uint8_t BeatsPerMinute = 62;
 CRGBPalette16 palette = PartyColors_p;
 uint8_t beat = beatsin8( BeatsPerMinute, 64, 255);
 for( int i = 0; i < LEDNUM; i++) { //9948
  leds[i] = ColorFromPalette(palette, gHue+(i*2), beat-gHue+(i*10));
 }
 FastLED.show();
 FastLED.delay(20);
 }
}

void countOrange(int u){
 if( u > target){
  orangeIsBlue();
 }else{
 for(int led = 0; led <= u; led++){
  leds[led]=CRGB::Orange;
 }
 FastLED.show();
 turn = turn + 1;
 }
}
int measureLightDistance() {
 LDmin3 = LDmin2;
 LDmin2 = LDmin1;
 LDmin1 = lightDistance;
 lightDistance = map(zPos, 5, 47, 0, LEDNUM - 1);
}

void showLightDistance(){
 FastLED.clear();
 for (int led = 0; led <= lightDistance; led++) {
 leds[led] = CRGB::Blue;
 }
 FastLED.show();
}

bool userInRange(){
 zPos = sensor.readZ();
 return zPos < 48;
}

bool isStable(){
 if( abs (lightDistance - LDmin1) <= 1 && abs (lightDistance - LDmin2) <= 1 && abs (lightDistance - LDmin3) <= 2){
    if(stableCount == 3){
     return true;
    }else{
     stableCount = stableCount + 1;
    }
 }else
  stableCount = 0;
  return false;
}

bool orangeIsBlue(){
  return turn == target;
 }

void confetti(){
 //gHue = gHue + 100;

  fadeToBlackBy( leds, LEDNUM, 8);
  int pos = random16(LEDNUM);
  leds[pos] += CHSV( gHue + random8(64), 200, 255);

  FastLED.show();
  delay(25);
}

[/code]
```

Appendix B - Interview Notes

Respondent #1

- Does not take photos for beauty, takes them for remembering and collecting memories.

- Does not take photos herself often, because other people do that, but when she does she wants to capture the atmosphere.

- When asked to use the prototype, she misunderstands the interaction and tries to zoom in by moving closer to the product. Which is the wrong way around.

- When asked if she thinks the product could work she says that the idea is clear and a fun way to think about photograhpy. But she also notes that the prototype with its lights might be a distraction to test subjects.

Respondent #2

- Takes photos quite regularly because it is her hobby. She almost always uses a higher tier camera, but uses her phone when necessary. The goal is to take a picture that is beautiful.

-When she uses her phone, it often is to capture something that needs remembering.

- When asked to use the prototype, she carries it out the wrong way around at first. But later realizes , after asking after her rationale behind the movement, that she should be moving away from the camera.

- She does not think that it would work for her, because the prototype still requires that the user looks through a frame. It is not completely free.

- When asked what she would see as a fitting target group, she names casual holiday-goers.

Respondent #3

- Does not take photos very often. In his own words: ‘half of the time that I take photos, I have had a few drinks’. He then concluded that his goal would be to capture something to share with other people. So they would also have an image of his memory. He also takes pictures to remember technical installations at work.

- He almost exclusively uses his phone for photograhy.

- Sometimes on vacation he wants to photograph landscapes. But wants to do it quick.

- After thinking for a short while, he carries the interaction out perfectly. But states that it requires a mindset to be switched.

- He thinks it could work for certain people.

- The interaction is very novel but the aesthetics are very typical, according to this respondent.

Respondent #4

- Is an all-round photographer. Uses it for posting on Instagram, but also as a memory capturing-tool.

- Carries out the interaction perfectly.

- Thinks it can work because the user does not lose vision of the environment around the camera frame. Sees this as the biggest improvement with regard to other cameras.

- The aesthetics are not perceived to be very novel.

Respondent #5

- Only uses his phone for photography and only to capture moments of emotion, mostly positive emotions.

- Captures things that stand out, but very spontaneously. He decides to photograph on the spot, not beforehand.

- At first, he fails to carry out the interaction, but as he is performing that wrong interaction, he notes that the frame is becoming bigger and continues to correct the movement all by himself. This results eventually in the right movement without any interuption from the researchers.

- He thinks that the concept offerst a good alternative for photography through screens. However, by using such a rigid frame, the user might be busy already 'editing' the photo while taking it and therefore the concept might surpass its goal because the user is still busy with the picture-taking process.

Respondent #6

- Takes photos with his phone often to capture fun moments.

- He carries out the interaction well. However, he states that it felt counter-intuitive. Notes that it is more logic than intuition.

- Seeing a picture change live before your eyes without a screen in between is what makes it work for him.

- Difficult to focus on both the frame and the subject to photograph at the same time. Eyes have a hard time adjusting.

Respondent #7

- Sees photography as a casual hobby. Likes to spot things that other people do not see.

- Has a difficult time focussing on the frame.

- Logically, she thinks that she should move the camera closer to zoom in, but gets the concept almost immediately.

- Thinks it is good that things that happen outside the camera can be noticed even while taking pictures. More connection to the environment.