Smart Doorbell with Integrated Lock System

by

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DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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CERTIFICATE

It is certified that the work contained in the Continuous Assessment and Mini project(CAMP) titled "**Smart Doorbell with Integrated Lock System**" by "Thanga Sai Naga Anirudh bearing Roll No: 21BAI1871, Suggula Uday bearing Roll No: 21BAI1373, S. Lohith Krishna bearing Roll No: 21BAI1426, Adithya Vardhan bearing Roll No: 21BAI1471 has been carried out under my supervision and that this work has not been submitted elsewhere for a degree

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INTRODUCTION

In today's digital age, innovation is at the forefront, revolutionizing various aspects of our lives. One such advancement comes in the form of a state-of-the-art smart door lock system, seamlessly integrating convenience and security. Gone are the days of fumbling with keys; instead, facial recognition technology takes center stage, granting effortless access to registered individuals while ensuring unauthorized entry is a thing of the past. Real-time monitoring and detailed activity logs provide homeowners with peace of mind, offering swift responses to any security breaches.

This cutting-edge system not only enhances convenience but also sets new standards in security. By embracing facial recognition, it drastically reduces the risk of unauthorized access, transforming traditional lock and key systems into relics of the past. Meticulous testing ensures every aspect meets stringent standards, with scalability and compatibility woven into the blueprint to ensure longevity in a rapidly evolving digital landscape.

Meanwhile, in the realm of entertainment, the Autonomous Slot-car system emerges as a beacon of single-player enjoyment. Comprising a unique vehicle, track sensors, and computer control software, it enriches the experience of Scalextric products. With various features allowing competitive racing against different difficulty settings, it caters to the diverse preferences of enthusiasts, adding a touch of excitement to leisure time in the digital era.

LITERATURE REVIEW

In exploring the convergence of smart doorbells with integrated locking mechanisms, our investigation is structured across eight sections, each delving into distinct facets of this burgeoning field.

The introduction sets the stage, delineating the project's objectives and its significance within the context of evolving access control technologies. Following this, the literature review offers a comprehensive survey of existing research on smart doorbells and integrated lock systems. This review serves as a roadmap, guiding our understanding of the current landscape while identifying gaps and opportunities for further exploration.

Methodology, the subsequent section, outlines our research approach and design methodology, providing transparency into the methods employed to achieve our objectives. Moving forward, the system architecture section offers a visual representation of the proposed architecture, elucidating the interconnectedness of key components.

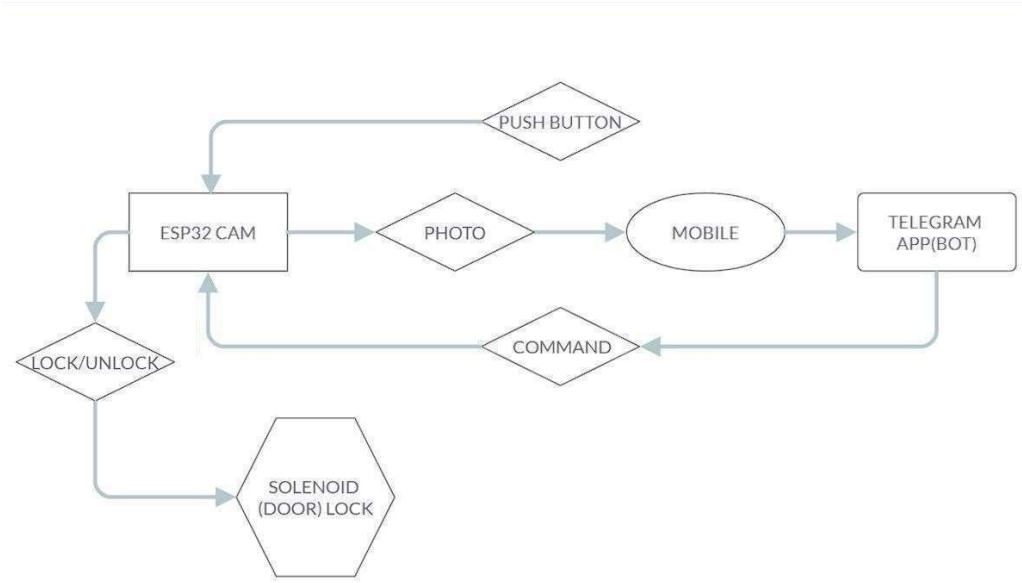
Implementation and evaluation detail the practical realization of our system, documenting the implementation process and the evaluations conducted to assess its functionality and performance. Results and analysis present the findings gleaned from these evaluations, offering insights into the system's efficacy and potential areas for improvement.

Discussion follows, where we engage in critical reflection on the implications of our findings, considering both technical and ethical dimensions. Finally, the conclusion and future work section encapsulate our reflections, summarizing key takeaways and proposing avenues for future research and development. Through this structured approach, we aim to contribute meaningfully to the advancement of smart doorbell systems, navigating the complexities of technology and human interaction in the digital age.

Table 1: Design Specifications

S.No.	**Component name**	**Specification**	
1.	ESP32 Camera ModuleMicrocontroller.	Overall Operating Voltage for controller:5V	Current rating:6mA – 310mA
2.	NPN transistor [TIP122]	Operating voltage: 5V	
3.	PN junction diode [1N4007]	Operating Reverse Voltage (Vr) : 1000V	
4.	7805 Regulator	Output Voltage: 5V	
5.	Solenoid lock	Operating Voltage: 12V	

ARCHITECTURE AND DESIGN



To ensure the development of a robust and compliant smart doorbell with an integrated lock system, a systematic design strategy is imperative. This strategy entails a series of key steps aimed at defining the system architecture, implementing advanced face detection and recognition algorithms, integrating seamlessly with the door lock mechanism, designing an intuitive user interface, and prioritizing security and privacy considerations.

Central to this strategy is the establishment of a well-defined system architecture, delineating the integration of modules such as face detection, face recognition, and automatic door access control. The synergy between these modules and the door lock mechanism facilitates smooth and secure access control based on facial recognition.

Moreover, the design process emphasizes the creation of a user-friendly interface, essential for effective management of the smart doorbell system. This interface is engineered to be intuitive and straightforward, enabling users to configure and control the system with ease.

Critical to the success of the project is the stringent adherence to privacy and security measures. Robust protocols are implemented to safeguard sensitive facial data and address privacy concerns, while stringent security measures are integrated to mitigate risks associated with unauthorized access and cyber threats.

Furthermore, the development process mandates adherence to relevant codes and standards to ensure quality, compliance, and safety. This includes upholding privacy standards to protect user data, implementing security standards to fortify against cyber threats, and ensuring interoperability with existing smart home ecosystems.

Realistic constraints, such as hardware limitations and compatibility with existing systems, are carefully considered throughout the design process. Trade-offs between factors like wired versus wireless systems, facial recognition versus alternative authentication methods, and privacy versus convenience are evaluated to strike a balance between functionality, usability, and compliance.

By adhering to this systematic design strategy and considering the myriad factors at play, the development of a smart doorbell with an integrated lock system can effectively address the needs and preferences of users while prioritizing security, privacy, and compliance.

FUNCTIONALITY

The smart doorbell with an integrated lock system offers an array of functionalities designed to enhance home security and convenience for homeowners. Through its connected design, it empowers users with the ability to remotely monitor and manage access to their homes, ensuring peace of mind and effortless control.

At the core of the project lies the development of a smart doorbell equipped with an integrated lock system, which incorporates sophisticated face detection and recognition algorithms to facilitate secure and reliable access control. Throughout the design phase, meticulous attention is devoted to addressing privacy concerns, implementing robust security measures, navigating hardware limitations, ensuring interoperability, optimizing usability, and adhering to regulatory compliance.

The thesis is structured to comprehensively explore the project's objectives, processes, and outcomes, spanning various sections including the introduction, literature review, methodology, system architecture, implementation and evaluation, results and analysis, discussion, and conclusion and future work.

Drawing insights from research papers and articles, the functionality of smart doorbells with integrated lock systems is elucidated. Acting as internet-connected devices, these smart doorbells notify homeowners when visitors approach the door, either through manual activation via a doorbell button or through motion sensors detecting movement. Utilizing a smartphone app, homeowners gain the ability to view and communicate with visitors via the integrated high-definition infrared camera and microphone. Additionally, certain models offer remote unlocking capabilities, allowing homeowners to grant access to their homes from anywhere using a smart lock.

The design process for such systems necessitates a meticulous approach, particularly in addressing privacy concerns and implementing robust security measures. Emphasizing the importance of comprehensive security management, the research underscores the need for safeguarding data transmission between devices and securing access within the product technology stack and other corporate systems.

EXPERIMENTAL PROCEDURE

Hardware Setup:

1. Smart doorbell unit with an integrated camera, microphone, and speaker for communication with visitors.
2. Facial recognition module for secure access control.
3. Smart lock mechanism to facilitate remote unlocking.
4. Motion sensors for detecting movement and activating the system.
5. Connectivity components such as Wi-Fi or Bluetooth for communication with smartphones and other devices.
6. Power source, typically via wired connection or battery pack.

This setup enables seamless operation and integration of the smart doorbell system within the home environment.

Software Installation for images:

1. Install the dedicated mobile app for remote access.
2. Enable notifications and camera access within the app settings.
3. Connect the smart doorbell to your home Wi-Fi network.
4. Integrate with Telegram using a compatible bot or API.
5. Configure the Telegram bot to send notifications with images upon doorbell activation.
6. Test the setup to ensure seamless notification delivery with images to your Telegram account.

Deployment:

The deployment of the smart doorbell with integrated lock system involves installation, configuration, and testing to ensure seamless integration with existing home security systems. This process is carried out by trained technicians to guarantee optimal performance and user satisfaction.

Configuration:

The configuration of the smart doorbell with integrated lock system involves setting customizable security and privacy options, integrating with IoT devices, ensuring affordability, enhancing user experience, and integrating with smart locks while maintaining stringent privacy measures.

Integration for Internet Accessibility:

Incorporating Cloudflare enables remote accessibility for the smart doorbell with

integrated lock system, ensuring seamless connectivity and control via the internet.

Testing and Validation:

Testing and validation for the smart doorbell with an integrated lock system ensures its reliability and effectiveness. Through rigorous testing, including functionality, performance, and security assessments, the system's features are evaluated to ensure they meet quality standards. Validation confirms that the system operates as intended and provides users with seamless security and convenience.

Documentation and Reporting:

The documentation and reporting for the smart doorbell with integrated lock system entail concise summaries of its features, design process, implementation, evaluation results, and conclusions. This documentation ensures clear communication of the system's capabilities, benefits, and outcomes for stakeholders and future reference.

RESULT AND DISCUSSION

The development of the smart doorbell with an integrated lock system has yielded significant advancements in home security and convenience. Through meticulous design and implementation, various critical aspects have been addressed, leading to a comprehensive solution that meets the needs of modern homeowners.
One of the key outcomes of the project is the incorporation of customizable security and privacy settings. By allowing users to tailor these settings according to their preferences, the system ensures a heightened sense of control and reassurance regarding the protection of their personal space.

Innovative interaction designs have also been implemented, enhancing the user experience and making the system intuitive and easy to use. Through thoughtful design choices, such as simplified navigation and intuitive controls, users can seamlessly interact with the smart doorbell and integrated lock system.
Integration with IoT smart home systems further expands the functionality and versatility of the system. By seamlessly connecting with other smart devices within the home ecosystem, users can enjoy enhanced automation and convenience, adding value to their overall smart home experience.

Affordability has been a crucial consideration throughout the project, ensuring that the smart doorbell with integrated lock system remains accessible to a wide range of users. By optimizing cost-effective solutions without compromising on quality or functionality, the system offers exceptional value for homeowners.
The enhanced user experience is a result of careful attention to usability and user interface design. By prioritizing simplicity and intuitiveness, the system provides a seamless and enjoyable experience for users, making home security management effortless and efficient.

Seamless integration with smart lock systems further enhances the functionality and security of the system. By synchronizing with existing smart lock technologies, the smart doorbell system offers a holistic approach to home security, ensuring a cohesive and robust solution for homeowners.

Through comprehensive testing and evaluation, the system has been validated for its performance, reliability, and effectiveness in enhancing home security and convenience. The results of these evaluations provide valuable insights into the system's strengths and areas for improvement, informing future iterations and enhancements.

In conclusion, the smart doorbell with an integrated lock system represents a significant advancement in home security technology. By addressing critical aspects such as security, privacy, usability, and integration, the system offers a comprehensive solution that meets the needs of modern homeowners, providing peace of mind and convenience in managing home security.

CONCLUSION AND FUTURE SCOPE

Summary of Findings:

The smart doorbell with an integrated lock system offers customizable security and privacy settings, innovative interaction designs, integration with IoT smart home systems, affordability, enhanced user experience, and seamless integration with smart lock systems. Through meticulous design and implementation, it provides a comprehensive solution that enhances home security and convenience while addressing critical aspects such as security, privacy, usability, and affordability.

Achievements and Contributions:

1. Enhanced home security through innovative face detection and recognition technology.
2. Streamlined access control with seamless integration of smart lock systems.
3. Customizable security and privacy settings for personalized user experience.
4. Integration with IoT smart home systems for enhanced automation and convenience.
5. Affordable solution without compromising on quality or functionality.

1. Advancement in home security technology, offering peace of mind to homeowners.
2. Simplified user experience through intuitive interaction designs.
3. Expansion of smart home ecosystem with seamless integration capabilities.
4. Accessibility to a wider range of users through affordability.
5. Setting new standards in privacy protection and data security for connected devices.

Implications and Significance:

The implications and significance of the smart doorbell with an integrated lock system lie in its ability to elevate home security and convenience. By seamlessly integrating advanced technology with customizable features, it offers users greater control over access to their homes while ensuring privacy and peace of mind. This innovation represents a significant step forward in modernizing home security systems, enhancing both safety and user experience in residential settings.

Lessons Learned:

1. Prioritize user privacy and security from the outset.
2. Focus on seamless integration with existing smart home ecosystems.
3. Invest in intuitive user interface design for enhanced usability.

4. Ensure affordability without compromising on quality.
5. Conduct thorough testing and evaluation to validate performance and reliability.

Future Scope and Recommendations:

Expansion of Integration: Further integrate with emerging IoT technologies to enhance functionality and interoperability.

Enhanced Security Features: Invest in research and development to strengthen security measures, including encryption protocols and biometric authentication methods.

User Experience Optimization: Refine user interface design and interaction patterns to improve usability and enhance user satisfaction.

Cost Reduction Strategies: Optimize manufacturing processes and component sourcing to reduce production costs and improve affordability.

Accessibility Improvements: Incorporate accessibility features to cater to users with diverse needs and abilities.

Continuous Evaluation and Feedback: Establish mechanisms for ongoing user feedback and system evaluation to drive continuous improvement and innovation.

Conclusion:

In conclusion, the smart doorbell with an integrated lock system combines security and convenience for homeowners. It offers customizable settings, innovative design, IoT integration, affordability, and enhanced user experience. With seamless integration with smart locks and strong privacy measures, it advances home security, providing peace of mind and effortless control.

REFERENCES

1. CHALLENGING THE CONCEPT OF SMART DOORBELLS BY DESIGNING NEW INTERACTIONS BASED ON PRIVACY - Responsible Sensing Lab

2. CHALLENGING THE CONCEPT OF SMART DOORBELLS BY DESIGNING NEW INTERACTIONS BASED ON PRIVACY - TU Delft Repositories

3.A STUDY ON IOT SMART DOORBELLS - ResearchGate

4. Dashbell: A Low-cost Smart Doorbell System for Home Use – escholarship.
youtube links

APPENDIX

Appendix 1: CODING

```
#include <WiFi.h>
#include <WiFiClientSecure.h>
#include "soc/soc.h"
#include "soc/rtc_cntl_reg.h"
#include "esp_camera.h"
#include
<UniversalTelegramBot.h>
#include <ArduinoJson.h>

// Replace with your network credentials
const char* ssid = " "; //WiFi Name const
char* password = " "; //WiFi Password

// Use @myidbot to find out the chat ID of an individual or a group
// You need to click "start" on a bot before it can message you
// Initialize Telegram BOT
String chatId =
"XXXXXXXXXX";String
BOTtoken =
"XXXXXXXXXX:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX";

bool sendPhoto = false;

WiFiClientSecure clientTCP;

UniversalTelegramBot bot(BOTtoken, clientTCP);

// Define GPIOs
#define BUTTON
13
#define LOCK 12
#define FLASH_LED 4

//CAMERA_MODEL_AI_THINKER
#define PWDN_GPIO_NUM 32
#define RESET_GPIO_NUM -1
#define XCLK_GPIO_NUM  0
#define SIOD_GPIO_NUM 26
#define SIOC_GPIO_NUM 27
```

```
#define Y9_GPIO_NUM       35
#define Y8_GPIO_NUM       34
#define Y7_GPIO_NUM       39
#define Y6_GPIO_NUM       36
#define Y5_GPIO_NUM       21
#define Y4_GPIO_NUM       19

#define Y3_GPIO_NUM    18
#define Y2_GPIO_NUM     5
#define VSYNC_GPIO_NUM25
#define HREF_GPIO_NUM 23 #define
PCLK_GPIO_NUM 22

      int lockState = 0; String
r_msg = "";


const unsigned long BOT_MTBS = 1000; // mean time between scan
messagesunsigned long bot_lasttime; // last time messages' scan has been done

void handleNewMessages(int numNewMessages);
String sendPhotoTelegram();

String
unlockDoor(){if
(lockState == 0) {
  digitalWrite(LOCK,
  HIGH);lockState = 1;
  delay(100); return "Door
  Unlocked.
  /lock";
} else{
 return "Door Already Unlocked. /lock"; }
}
String
lockDoor(){ if
(lockState == 1) {
  digitalWrite(LOCK, LOW);
  lockState = 0; delay(100);
  return "Door Locked.
  /unlock";
} else{
 return "Door Already Locked. /unlock"; }
}

String sendPhotoTelegram(){ const
  char*myDomain =
```

```
"api.telegram.org";
 String getAll = "";
 String getBody =
 "";

 camera_fb_t  *  fb  =
 NULL;        fb     =
 esp_camera_fb_get();
 if(!fb) {
  Serial.println("Camera capture
  failed"); delay(1000);
  ESP.restart();return "Camera
  capture failed";
 }

 Serial.println("Connect to " + String(myDomain));
 if (clientTCP.connect(myDomain, 443)) {
  Serial.println("Connectionsuccessful");

  Serial.println("Connected to " + String(myDomain));

  String head = "--IotCircuitHub\r\nContent-Disposition: form-data;
name=\"chat_id\"; \r\n\r\n" + chatId + "\r\n--IotCircuitHub\r\nContent-
Disposition:form-data; name=\"photo\"; filename=\"esp32-
cam.jpg\"\r\nContent-Type: image/jpeg\r\n\r\n";
  String tail = "\r\n--IotCircuitHub--\r\n";

  uint16_t imageLen = fb->len; uint16_t extraLen
  = head.length() + tail.length(); uint16_t totalLen
  = imageLen + extraLen;

  clientTCP.println("POST /bot"+BOTtoken+"/sendPhoto HTTP/1.1");
  clientTCP.println("Host: " + String(myDomain));
  clientTCP.println("Content-Length: " + String(totalLen));
  clientTCP.println("Content-Type: multipart/form-data;
  boundary=IotCircuitHub");clientTCP.println();
  clientTCP.print(head);

  uint8_t *fbBuf = fb->buf;
  size_tfbLen = fb->len; for
  (size_t
  n=0;n<fbLen;n=n+1024) {
   if (n+1024<fbLen) {
   clientTCP.write(fbBuf,1024);
    fbBuf += 1024;
```

```
      }
      else if (fbLen%1024>0) {
        size_t remainder = fbLen%1024;
        clientTCP.write(fbBuf,remainder);
      }
    }

    clientTCP.print(tail); esp_camera_fb_return(fb);

    int waitTime = 10000; // timeout 10
    secondslong startTimer = millis();
    boolean state = false;

    while ((startTimer + waitTime) >
     millis()){Serial.print(".");
     delay(100); while
     (clientTCP.available()){
        char c =
        clientTCP.read();
        if (c == '\n'){ if
        (getAll.length()==0) state=true;
        getAll = ""; } else if (c != '\r'){
        getAll += String(c);
        } if
        (state==true){
          getBody += String(c);
        }
        startTimer = millis();
      } if (getBody.length()>0)
      break;
    }
    clientTCP.stop(); Serial.println(getBody);
  }
  else
  {
    getBody="Connected to api.telegram.org failed.";
    Serial.println("Connectedto api.telegram.org failed.");
  } return
  getBody;
}

void handleNewMessages(int numNewMessages){
  Serial.print("Handle New Messages: ");
  Serial.println(numNewMessages);
```

```
  for (int i = 0; i < numNewMessages; i++){
   // Chat id of the requester
   String chat_id = String(bot.messages[i].chat_id);
   if(chat_id != chatId){
    bot.sendMessage(chat_id, "Unauthorized user", "");
    continue;
   }

   // Print the received message
   String text =
   bot.messages[i].text;
   Serial.println(text);

   String fromName =
   bot.messages[i].from_name;if (text ==
   "/photo") {
    sendPhoto = true;
    Serial.println("New photo
    request");
   }
   if (text == "/lock"){ String
    r_msg =lockDoor();
    bot.sendMessage(chatId, r_msg,
    "");
   } if (text == "/unlock"){ String r_msg
   =                          unlockDoor();
   bot.sendMessage(chatId, r_msg, "");
   } if (text ==
   "/start"){
     String welcome = "Welcome to the ESP32-CAM Telegram Smart
    Lock.\n";welcome += "/photo : Takes a new photo\n"; welcome
    += "/unlock : Unlock the Door\n\n"; welcome +=
    "/lock : Lock the Door\n"; welcome += "To get
    the photo please tap on /photo.\n";
    bot.sendMessage(chatId, welcome,
    "Markdown"); }
  }
}

void setup(){
 WRITE_PERI_REG(RTC_CNTL_BROWN_OUT_REG,
 0);
 Serial.begin(115200);
 delay(1000);
```

```
pinMode(LOCK,OUTPUT);
pinMode(FLASH_LED,OUTPUT);
pinMode(BUTTON,INPUT_PULLUP);

digitalWrite(LOCK,  LOW);

WiFi.mode(WIFI_STA);
Serial.println();
Serial.print("Connecting to
");Serial.println(ssid);
WiFi.begin(ssid, password);
clientTCP.setCACert(TELEGRAM_CERTIFICATE_ROOT);
while (WiFi.status() !=
  WL_CONNECTED) {Serial.print(".");
  delay(500);
}
Serial.println();
Serial.print("ESP32-CAM IP Address: ");
Serial.println(WiFi.localIP());

camera_config_t config;
config.ledc_channel =
LEDC_CHANNEL_0;config.ledc_timer =
LEDC_TIMER_0; config.pin_d0 =
Y2_GPIO_NUM; config.pin_d1 =
Y3_GPIO_NUM; config.pin_d2 =
Y4_GPIO_NUM; config.pin_d3 =
Y5_GPIO_NUM; config.pin_d4 =
Y6_GPIO_NUM; config.pin_d5 =
Y7_GPIO_NUM; config.pin_d6 =
Y8_GPIO_NUM; config.pin_d7 =
Y9_GPIO_NUM; config.pin_xclk =
XCLK_GPIO_NUM;
config.pin_pclk = PCLK_GPIO_NUM;
config.pin_vsync =
VSYNC_GPIO_NUM; config.pin_href =
HREF_GPIO_NUM;
config.pin_sscb_sda =
SIOD_GPIO_NUM;config.pin_sscb_scl
= SIOC_GPIO_NUM; config.pin_pwdn
= PWDN_GPIO_NUM; config.pin_reset
= RESET_GPIO_NUM;
config.xclk_freq_hz = 20000000;
config.pixel_format =
PIXFORMAT_JPEG;
```

```
  //init with high specs to pre-allocate larger buffers if(psramFound()){
    config.frame_size = FRAMESIZE_UXGA;
    config.jpeg_quality = 10; //0-63 lower number means higher
    qualityconfig.fb_count = 2;
  } else {
    config.frame_size = FRAMESIZE_SVGA;
    config.jpeg_quality = 12; //0-63 lower number means higher
    qualityconfig.fb_count = 1;
  }

  // camera init
  esp_err_t err =
  esp_camera_init(&config);if (err !=
  ESP_OK) {
    Serial.printf("Camera init failed with error
    0x%x",err); delay(1000); ESP.restart();
  }

  // Drop down frame size for higher initial frame
  ratesensor_t * s = esp_camera_sensor_get();
  s->set_framesize(s, FRAMESIZE_CIF); //
UXGA|SXGA|XGA|SVGA|VGA|CIF|QVGA|HQVGA|QQ
VGA
}

void loop(){

  if (sendPhoto){
    Serial.println("Preparing photo");
    digitalWrite(FLASH_LED,HIGH);
    delay(200);
    sendPhotoTelegram();
    digitalWrite(FLASH_LED,
    LOW);
    sendPhoto = false;
  }
  if(digitalRead(BUTTON) == LOW){
    Serial.println("Preparing photo");
    digitalWrite(FLASH_LED, HIGH);
    delay(200); sendPhotoTelegram();
    digitalWrite(FLASH_LED,
    LOW);
```

```
 sendPhoto = false;
}

if (millis() - bot_lasttime > BOT_MTBS)
{ int numNewMessages = bot.getUpdates(bot.last_message_received +1);

 while (numNewMessages)
 {
  Serial.println("got response"); handleNewMessages(numNewMessages);
  numNewMessages =bot.getUpdates(bot.last_message_received + 1);
 }
 bot_lasttime = millis();
```

Appendix 2: Simulation Images