

**TALLINN UNIVERSITY OF TECHNOLOGY**

SCHOOL OF ENGINEERING

Department’s title

**Smart Poker table**

**Tark pokkeri laud**

BACHELOR THESIS

|  |  |
| --- | --- |
| Student: | Magnus Vooder |
|  |  |
| Student code: | 201738MVEB |
| Supervisor: | Margus Müür |
|  | /name, position/ |

Tallinn 2024

(*On the reverse side of title page*)

**AUTHOR’S DECLARATION**

Hereby I declare, that I have written this thesis independently.

No academic degree has been applied for based on this material. All works, major viewpoints and data of the other authors used in this thesis have been referenced.

“.......” .................... 20…..

Author: ..............................

*/signature /*

Thesis is in accordance with terms and requirements

“.......” .................... 20….

Supervisor: ….........................

*/signature/*

Accepted for defence

“.......”....................20… .

Chairman of theses defence commission: .................................................

*/name and signature/*

|  |
| --- |
| **Non-exclusive licence for reproduction and publication of a graduation thesis[[1]](#footnote-1)** |
|  |

I \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (author’s name)

1. grant Tallinn University of Technology free licence (non-exclusive licence) for my thesis

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_,

(*title of the graduation thesis*)

supervised by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_,

(*supervisor’s name*)

* 1. to be reproduced for the purposes of preservation and electronic publication of the graduation thesis, incl. to be entered in the digital collection of the library of Tallinn University of Technology until expiry of the term of copyright;
  2. to be published via the web of Tallinn University of Technology, incl. to be entered in the digital collection of the library of Tallinn University of Technology until expiry of the term of copyright.

1. I am aware that the author also retains the rights specified in clause 1 of the non- exclusive licence.
2. I confirm that granting the non-exclusive licence does not infringe other persons' intellectual property rights, the rights arising from the Personal Data Protection Act or rights arising from other legislation.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (date)

**DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING**

**THESIS TASK**

**Student**: Magnus Vooder

Study programme, MVEB14/19 Integrated Engineering

main speciality: Integrated Engineering

Supervisor(s):…………………………………………………………….(position, name, phone)

Consultants: ……………………………………………………………..(name, position)

…………………………………………………………………………………… (company, phone, e-mail)

**Thesis topic**:

(in English)  *Smart poker table*

(in Estonian) Tark pokkeri laud

**Thesis main objectives**:

|  |
| --- |
| 1. Figure out a way to read in the card information(RFID, Machine Vision, etc) |
| 1. Choose electronic components(microcontrollers, central computer etc) |
| 1. Design a basic UI the spectators will see |

**Thesis tasks and time schedule:**

|  |  |  |
| --- | --- | --- |
| **No** | **Task description** | **Deadline** |
| 1. | Choose the best option to read in card information | 29.02.2024 |
| 2. | Pick out the best electronic components to use in the creation of the table, considering price, ease of use, my own skills. | 15.03.2024 |
| 3. | Program the micocontrollers that read in the cards. | 31.03.2024 |
| 4. | Read the data to a central computer. | 15.04.2024 |
| 5. | Program a basic UI that shows the information on a monitor that can be connected to the central computer using a HDMI cable. | 30.04.2024 |

**Language:** English **Deadline for submission of thesis:** 27.05.2024

**Student:** Magnus Vooder .......……........ “.......”………….....................20….a

*/signature/*

**Supervisor:** ………………… …………………….. “.......”......................20….a

*/signature/*

**Consultant:** ………………… …....................... “.......”......................20….a

*/signature/*

**Head of study programme:** …………… ..................... “.......”......................20…..a

*/signature/*

*Terms of thesis closed defence and/or restricted access conditions to be formulated on the reverse side*

**CONTENTS**

[PREFACE 7](#_Toc166431286)

[List of abbreviations and symbols 8](#_Toc166431287)

[INTRODUCTION 9](#_Toc166431288)

[1 Methodology 10](#_Toc166431289)

[1.1 Requirements 10](#_Toc166431290)

[1.2 Current existing products 11](#_Toc166431291)

[1.3 System build 12](#_Toc166431292)

[1.4 Reading in the amount of poker chips and the cards 13](#_Toc166431293)

[1.4.1 RFID 13](#_Toc166431294)

[1.4.2 Machine vision 14](#_Toc166431295)

[1.4.3 Weight sensor 15](#_Toc166431296)

[1.4.4 Chosen technology 15](#_Toc166431297)

[1.5 Showing players information 15](#_Toc166431298)

[1.6 Central computer and nodes 16](#_Toc166431299)

[1.6.1 Central computer 16](#_Toc166431300)

[1.6.2 Player and community nodes 16](#_Toc166431301)

[1.6.3 Communication between player node and central computer 17](#_Toc166431302)

[1.7 BDD diagram 18](#_Toc166431303)

[2 Components for system 19](#_Toc166431304)

[2.1 RFID reader 19](#_Toc166431305)

[2.2 Screen for players 20](#_Toc166431306)

[2.3 Player node microcontroller 20](#_Toc166431307)

[2.4 Central computer 22](#_Toc166431308)

[2.5 Playing cards and RFID tags 22](#_Toc166431309)

[2.6 Poker chips and RFID tags 23](#_Toc166431310)

[2.7 Power supply 24](#_Toc166431311)

[3 Prototype hardware and wiring 26](#_Toc166431312)

[3.1 Player node 26](#_Toc166431313)

[3.2 Player node to central computer 26](#_Toc166431314)

[4 Prototype code 27](#_Toc166431315)

[4.1 Player node 27](#_Toc166431316)

[4.1.1 RFID reader 27](#_Toc166431317)

[4.1.2 Screen communication 27](#_Toc166431318)

[4.1.3 I2C communication 27](#_Toc166431319)

[4.2 Central computer 27](#_Toc166431320)

[4.2.1 I2C communication 27](#_Toc166431321)

[4.2.2 Speaking with the server 27](#_Toc166431322)

[4.2.3 UI 27](#_Toc166431323)

[4.3 Server 27](#_Toc166431324)

[4.4 Webpage 27](#_Toc166431325)

[SUMMARY 28](#_Toc166431326)

[LIST OF REFERENCES 29](#_Toc166431327)

[APPENDICES 32](#_Toc166431328)

[GRAPHICAL MATERIAL 33](#_Toc166431329)

# PREFACE

The length of preface must not exceed of A4-format one page. Preface indicates, by whom (organisation, company, person) was initiated the thesis topic, where the major thesis work was done, who (names, positions) assisted author in data collecting, consulted, etc.

Student may, if wished, express gratitude to them, who assisted, supported or inspired him/her on the way to graduation.

The preface must contain a short summary of the thesis that could, even in case of thesis publishing embargo, be published, for example in TTÜ digital library. The end of preface must provide 4-5 keywords, the last of which’ must be bachelor thesis or master thesis respectively.

### List of abbreviations and symbols

UHF – Ultra high frequency

RFID - Radio-frequency identification

RAM - random access memory

INTRODUCTION

The aim of thesis introduction is to acquaint reader with the thesis subject area and integrate it with a larger context of society and economics. Thesis problem and objectives must be defined in the introduction. Also the thesis topic choice, together with actuality and importance aspects, is reasoned, thesis tasks are formulated and the short overview of the thesis subject area and object are given. If needed, known alternatives could be introduced and connection with similar works and projects may be indicated. Methods used in thesis, computer software etc. may also be named.

As a general rule, a short overview of thesis chapters and appendices (if they exist) content is also given in the introduction.

The length of introduction should be at least 1 page, but not more than 1/10 of the main body length.

# Methodology

## Requirements

The smart poker table is intended for home use and should make playing games at home more exiting and introduce possibilities that are available in online play. The smart poker table should also make the game more fun for players who have lost and are now spectators. They should be able to see the game on a monitor that is hooked up to the table or on their phones trough the internet.

The table should also allow for different amount of people to play from 2-10 players. It should also show players some information on the game state and allow for some customizability of the game. The specific reuirements for the table are listed in the (Table 1) below.

Table 1. Specific requirements for the poker table

|  |  |
| --- | --- |
| **Player** | * See big blind size * See ante * See in which position they are(big blind, small blind, etc.) * See time until increased big blind * View folded cards * View past game cards * See the chance to win in case of all in situation * See how many chips they have in their pot |
| **Dealer/Game statistics** | * Change the amount of starting big blind and its increase with each level. * Change the time between levels |
| **Spectators** | * See every players cards * See every players pot size * See the community cards * See every players chance to win |

## Current existing products

There are many solutions to a smart poker table and this chapter will discuss some of them and look at what systems they have and how they differ from the thesis requirements.

Videopokertable offers a RFID enabled poker table that automatically reads in the players cards and displays them with their custom pokerGFX software [z]. While they offer many of the same options as the requirements for this project, they do not automatically read in their poker chips. While the pokerGFX software does show players stack and their bids, it seems that these need to be manually entered in by a human operator. Their poker set is more focused on tournament tables, as their advertisements focus on their video streaming options. Videopokertable also does not give players any information about the game.

A group of people playing poker

Description automatically generated

Figure 1. Picture of videopokertable RFID poker table

RFpoker is another producer of smart poker tables, but they are more focused on creating tables for game rooms that host large scale tournaments[aa]. Their 1 table costs 20000 USD and it is also needed to buy their software subscription plan to use the table, which costs at a minimum 300 USD a month. They also do not have a screen for players to see some game information, but their overall idea is similar, just very expensive.

A black and red device with a red border

Description automatically generated

Figure 2. RFpoker RFID poker table render

PokerPro also produces poker tables for casinos, but they have an interesting twist [ab]. Their tables do not use physical cards or chips, it is all digital. Due to this their tables work pretty much like online poker games, which is not exactly this project is interested in. Otherwise they offer the same ideas this project has.

A hand touching a poker table

Description automatically generated

Figure 3. Pokertek poker table

## System build

The smart poker table should have a central computer and different nodes for each player, that will read in their cards and chips, sends that information to the central computer and show the players their relevant data. There would also have to be 1 node for reading the the community cards and pot. The initial set up idea is shown visually in (Figure 4) below.

A diagram of a computer network

Description automatically generated

Figure 4. Initial idea diagram

## Reading in the amount of poker chips and the cards

The hardest challange of building a smart poker table is getting the information about the cards and chips the players have. To solve this issue 2 technologies were considered.

### RFID

First idea to reading in the chips and the cards was using RFID technology. This would require a RFID reader that can read in multiple RFID tags simultaneosly. Currently the best option for that is UHF RFID, since its GEN2 or ISO 18000-6C communication protocol is designed for reading hundreds of RFID tags a second. This would require having a tag reader under the table and every poker chip and card would need to have a UHF RFID tag inside it. This option works well, since it can be totally invisible to the players, since the tag reader can be under the table and the chips would have the tags in them. The largest problem with this technology would be reading in every single tag. While there would not be any problem reading in the playing cards, the poker chips on the other hand are stacked together and their tag antennas might block each others signals. This would be hard to overcome, if it turns out to be a problem. The second problem would be the cost, since this technology costs alot, simulataneous UHF RFID readers cost around 200 euro or more.[d][e]

### Machine vision

The other option would be to use machine vision for detecting the playing cards and poker chips. While using RFID is quite straight forward, then there are many options for machine vision, since there are many algorithms and technologies to choose from.

Training and using object detection models would make sense here. There are 52 different cards and 5 different colors of poker chips. Training a object detection model and using it to read in the poker chips and playing cards would be possible. A study published in 2023, by Kuan-Huan Yu created a self-playing poker robot. They used YOLOv5 as their training model and were able to detect all 13 cards from a single image[y]. The idea is to have a microcontroller at each player node that could handle the detection of cards and poker chips. For this purpose, a large training model like YOLO might be too computationally expensive so other models should be considered.

FOMO (faster objects, more objects) by Edge impulse has shown many examples of their novel machine learning algorithm that uses object-detection [b]. In their gitbook page Edge impulse has shown multiple examples with different microcontrollers with different processing power. Their lowest processing power application had a 80 MHz processor with <100 KB of RAM, which is quite low considering it is doing objects detection. They used MobileNetV2 as their base model at had good results. Using FOMO, that is designed for microcontrollers would be a good option.

The second option would be to use object detection algorithms. A study from 2010 by J. Pimentel considered 3 object detection algorithms, 1 template matching algorithm and 2 edge based probabilistic algorithms [w]. While the study is old, the basic principles still apply. They found that the template matching algorithm worked well and was computationally time effective. Its problem was that it was not so effective in low lighting environments. The other 2 methods, while more robust, were computationally slower. The template matching algorithm detected the value and suit separately for each card and later combined them for the same card, this way they only had to have 17 templates instead of 52. The lighting issue can be solved with LEDs around the playing cards to always have similar lighting conditions.

A newer study from 2021 also used a template matching algorithms and a similar process [x]. Their paper further expanded on how their algorithms works. They first got the ROI of the suit and value of the card, then they gray scaled the image and from that they got a binary image. Having done this they used contour shape matching to match the ROI to the correct templates. While they did have recognition errors, they had a relatively fast recognition of the cards.

The problem with using machine vision, is that it is computationally very expensive and would require a camera on the outside of the table to read in the poker chips. This would also mean, that the players would have to place the stacks of poker chips in a way that every chip is visible to the camera, which is not ideal. The payers would also have to place their cards in a certain location.

### Weight sensor

Another idea was to use a weight sensor, but this would not be very useful. All it could tell the system is how many poker chips there are, but not what the values are. This could maybe be used with the RFID reader, to let it know how long it should scan for. It would also not allow the players to place anything else on the table where the poker chips are supposed to be located. This would make the game a bit more annoying and would take some fun away from the game.

### Chosen technology

Currently it seems, that using RFID would be the better option. Since it would have all of the technology hidden away inside the table. While it might be more expensive than compared to using a camera and machine vision options, it would make the whole table look nicer and would feel more like a regular game.

|  |  |  |
| --- | --- | --- |
| Technology | RFID | Machine vision |
| Visible to players | Not at all | Yes |
| Requires custom chips | Yes | Yes |
| Requires custom cards | Yes | No |
| Required space | Less | More due to cameras |

## Showing players information

The players should be able to see the information as planned in System requirements (Table 1). The information should be shown on a screen, on either a small screen inside the table or on the players phones trough an app.

Incase of a screen inside the table, each player should have their own small screen. The screen should be around 3’’, large enough to see the relevant information, but not large enough to take up too much space. Players should be able to see their folded cards on their screen, but it should not always be visible, only if the player wishes to see them. That means the screen should also be touchscreen to allow for enabling or disabling of some options.

Incase of an app, the phone should retrive the relevant information from the poker table trough bluetooth, which would mean the table should be able to support up to 10 bluetooth connections. It would make sense for each player node to have a seperate bluetooth module to facilitate this kind of communication.

While making an app would make more sense and would offer more options in regards to the graphics on the phone and leave more of the table open for other stuff, I feel that the screen in the table itself will be a better option for now, as it offers an easier solution. This way an app would not have to be developed.

## Central computer and nodes

### Central computer

The central computer will be managing all the player nodes and the flow of the game. It will ask the player nodes what cards the player has, how many poker chips they have in their stack and tell the player nodes what their position is (big blind, smll blind), how much time until the next level, what the current BB and ante is and the chance to win, if all remaining players are all in. The computer itself will show a UI to spectators where every players cards and stack is visible, it will log all of this data, so that people can rewatch games. The computer will calculate the winning chance based on every players cards and the community cards.

### Player and community nodes

Each player node will have to read in the players cards and stack using the RFID reader and display information to the player using the small 3’’ screen each player has. Each player node should be controlled by a microcontroller that speaks with the central computer. So in total the microcontroller has to communicate with 3 seperate devices.

### Communication between player node and central computer

While devices like the RFID reader and the screen will probably have set communication protocol, then communication betwwen the player nodes and central computer is free to decide.

There are 3 main communication protocols available to most microcontrollers: UART, I2C and SPI. UART, I2C and SPI are all serial communication protocols. These are the potential option when considering communication and the different options will be analyzed based on a 2023 study „Analysis and Comparison of UART, SPI and I2C“ by Shengqiu Huang and Jinrong Chen [r].

Since we need to have 1 master device, the central computer and up to 11 slave devices, the player nodes and 1 community node, then we need to consider that we have to have communication between several devices at once. This automatically rules out UART, since it is not a BUS communication line, it only works in one-to-one communication. That leaves I2C and SPI to choose from.

The central computer would have to co

|  |  |  |
| --- | --- | --- |
| Communication protocol | SPI | I2C |
| Max amount of slaves | Amount of slave select pins available | 120 with 7 bit adress |
| Data transfer speed | Limited by CPU frequency, up to 10 MHz | Normal mode: 100 kbps fast mode: 400 kpbs high-speed mode: 3.4 Mbps |
| Transmission distance | Short range | Shorter range |

While SPI would seem like the better option, I2C would be the better choice here. I2C is worse of in terms of Data transfer speed and transfer distance, but these attributes are not that important in terms of this project, since the data transfered between the 2 devices is not that large and the distance are not that big. I2C bus is easier to manage and set up since there are only 2 communications lines. If SPI were used, then that would be 14 wires used (MISO, MOSI, SCKL and 11 slave select lines). That is why I2C is chosen.

## BDD diagram

# Components for system

In this section I will list some possible choices for the components, then compare them and pick one. When choosing a components, it should match the criteria of the requirements table(table 1).

## RFID reader

Table 2. Possible RFID readers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Product** | ThingMagic MEGA (M7E-MEGA) [f] | CAEN RFID Lepton3 (Model R3100C) [g] | Chainway CM710-1 UHF RFID Module [h] | Technology solutions 3117 and 3417/3419 RAIN RFID Reader Modules [i] |
| **Read Speed** | 600 tags/sec | N/A | 950 + tags/sec | 1200 tags/sec |
| **RF power** | -10-30 dBm | 0-25 dBm | 1-30 dBm | 1-32 dBm |
| **Current draw at max RF power, 5V** | 1150 mA | 800 mA | 1500 mA | 1200 mA |
| **Control/Data Interfaces** | UART 3.3V logic level 9.6 - 921.6 kbps | UART 3.3V logic level 9.6 - 921.6 kbps | UART 3.3V logic level 115.2 kbps | UART 3.3V logic level, 5V tolerant 9.6 – 921.6 kbps |

While there are defenetly more compatible RFID readers out there, these seem to be some of the possible options to use, that would fit the project. Alot of them also use the IMPJ E710 series chip for their reader. While the Lepton3 would seem like the best option, they did not specify their read speed in their datasheet, so I would have to go with the ThingMagic M7E-MEGA. While the M7E-MEGA has lower read speed than the other options, it is really not that necessary to have over 600tags/sec, since we do not have that many tags to read. The ThingMagic series of RFID readers also have really good support and alot of documented materials to use.

## Screen for players

The screen should be around 3’’ and also have touchscreen capabilities and high enough of a resolution to maybe offer some fun customizability. It should also have a serial communication available, like SPI.

|  |  |  |  |
| --- | --- | --- | --- |
| **Product** | HiLetGo SPI TFT LCD Display [j] | Adafruit 3.5" TFT 320x480 with Capacitive Touch Breakout Board [k] | Display visions 3.5" TFT IPS SPI or RGB [l] |
| Size | 2.8’’ | 3.5’’ | 3.5’’ |
| Resolution | 240x320 | 320x480 | 320x480 |
| Control/Data Interfaces | SPI | 8-bit or SPI, I2C for touchscreen | SPI or 8-/16-bit data bus or 16-bit RGB interface |
| Current draw, mA | N/A | N/A | N/A |

Table 3. Table of screen options

While there are many screens out there that fit this project, these are some of them that were considered. While an OLED screen would have been more optimal, it seems that in the 3’’ screen size range there does not seem to be many full color OLED displays and the ones that do exists cost too much, so the better pick was the TFT LCD displays. HiLetGo board already has a built in driver with SPI pins, which makes it very easy to use and implement, it also costs 2x as less as the other options, which is why this one was picked. The resolution of the HiLetGo screen should also be enough. Its only downside is that it is 2.8’’, which may be too small.

## Player node microcontroller

The micocontroller will need atleast 1 UART interface for the RFID reader and SPI interface for the screen. The microcontroller will also speak with the central computer over I2C, which means an I2C interface is also needed. Other factors like clock speed is hard to determine, since calculating the clock speed is quite difficult. When considering a microcontroller, 3 microcontroller families were considered, Arduino, STM32 and ESP32. Out of those families 1 microcontroller was picked and compared, as seen in (Table 4).

Table 4. Microcontroller specification comparison

|  |  |  |  |
| --- | --- | --- | --- |
| Product | Arduino UNO [m] | STM32 NUCLEO-F030R8 [n] | ESP32-C3-DevKitC-02 [o] |
| GPIO pins | 20x | 55x | 15x |
| UART | 1x | 2x | 2x |
| SPI | 1x | 2x | 3x |
| I2C | 1x | 2x | 1x |
| Vin, V | 7 - 12 | 7 – 12 | 5, 3.3 |
| Current draw, mA | 50 – 100 | 50 | 40 |

Some of the most popular microcontrollers currently seem to be Arduino, STM32 and ESP32 microcontrollers. Both STM32 and ESP32 both offers a large variety of microcontrollers that all meet the specification and might even be overkill for this project, but STM32 seems to have better scalability with its IDE workspace. Arduino has the benefit of having a strong community and documentation which makes working with it easier. ESP32 microcontrollers also come with either bluetooth or wifi modules which are not required for this project. If the project was developed with having the players screens on their phones as an app, then the ESP32 would make alot of sense, since it could be used to create the bluetooth connection between the table and the phone.

It seems the better option would be to currently use the STM32 microcontrollers, since they seem to be the cheapest, most customizable when it comes to internal hardware thanks to its STMCUBE IDE workspace.

## Central computer

When considering a single board computer as the central computer, the most important factor was that it had the ability to communicate over I2C and had plenty of GPIO pins to use. The SBC should also have atleast 1 HDMI outlet, so spectators can watch the game over a monitor or TV set. The market for single board computers with GPIO pins is not that large as it is for microcontrollers, but some boards were considered as seen in (Table 5).

When considering producs, the first idea was to use the rasbberry pi, since the author has prior experiance with it, it is very popular and has been around for a long time, so it has a lot of support for it. Since the raspberry pi was the initial idea, other competitors were looked at aswell. First was the asus tinker board, it seems to be very similar to the raspberry pi, but lacks some of the functionality as the raspberry and seems to have less support than the raspberry. The technical specifications

Tabel 5. Possible products for central computer

|  |  |  |  |
| --- | --- | --- | --- |
| Products | Asus tinker board [p] | Raspberry pi 5 [q] | Orange Pi 5 |
| GPIO | 40x | 40x | 26x |
| UART | 4x | 5x | 4x |
| SPI | 2x | 6x | 1x |
| I2C | 2x | 4x | 3x |
| HDMI | 1x full-size HDMI | 2 × micro-HDMI ports | 2x full-size HDMI |
| Vin, V | micro-USB | USB-C 5 V GPIO header | USB-C 5 V GPIO header |
| Current draw, mA | 700 - 1000 | 600 - 2000 | 1000 - 2000 |

## Playing cards and RFID tags

For the poker table to work with RFID tags, then playing cards with UHF RFID tags need to be embedded in them. This means custom playing need to be ordered. The cards would have to have UHF RFID chips in them that are ISO 18000-6c compliant. Card material also matters, the main options are either paper cards or plastic cards. Casinos tend to pick plastic cards over paper cards since they are more durable, so they seem to be the better pick [s].

The market for these kinds of cards is not that huge, HF cards are mor popular but these are only in the 13.5 MHz range, UHF RFID tags that are ISO 1800-6c compliant are in the 860 to 960 MHZ range. It would also be nice, if the cards had the possibility to have custom textures on them, so they look nicer. Some products that match these specifications were found, but their reliability is not certain, they are listed in the (table 6) below.

|  |  |  |  |
| --- | --- | --- | --- |
| Manufacturer | TP-RFID[t] | Sunrise security [u] | IFAST [v] |
| Supported frequency range/ protocol | UHF 860 – 960 MHz HF 13.56 MHz | UHF 860 – 960 MHz HF 13.56 MHz | UHF 860 – 960 MHz HF 13.56 MHz |
| Card material | PVC or paper | PVC or paper | PVC |
| Possibility to order custom cards | Yes | Yes | No |

## Poker chips and RFID tags

The market for UHF RFID poker chips is even smaller, since casinos use HF poker chips for security reasons only. Some producers of chips will allow for UHF chips in the poker chips. Found producers are listed below in (table 6). TP-RFID also producers poker chips in addition to poker cards as mentioned in the above chapter, they have the option to add UHF RFID chips that are ISO 1800-6c compliant.

Table 2. Possible poker chip manufacturers

|  |  |
| --- | --- |
| Manufacturing | TP-RFID[t] |
| Supported frequency range/ protocol | UHF 860 – 960 MHz HF 13.56 MHz |
| Chip material | Clay |
| Possibility to order custom cards | Yes |

For UHF poker chips, only one producer who had listed custom poker chips with the possibility to add UHF chips in them was found. The same company also produces custom playing cards with UHF chips, so ordering from them would be most beneficial, since a single order for cards and poker chips can be made.

## Power supply

When considering a power supply, output voltage and max output current has to be considered. To decide on which power supply to use, the maximum power consumption of every component needs to be considered and the sum of all the components will determine what the power rating of the power supply should be.

First every components power consumption needs to be calculated and then multiplied by the amount of components and then all of those need to be added up to get the final power rating. The current draw for the HiLetGo screen is not listed, but during testing a current draw of 0.4 A was observed.

Table 3. Calculation of power supply power

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Amount of components, n** | **Voltage, V** | **Current draw, A** | **Total Power consumption, W** |
| RFID reader M7E MEGA | 11x | 5 V | 1.15 A | P = 5 \* 1.15 \* 11 = 63.25 W |
| Screen, HiLetGo | 10x | 5 V | 0.4 A | P = 5 \* 0.4 \* 10 = 20 W |
| STM32 NUCLEO-F030R8 | 11x | 7 V | 0.05 A | P = 7 \* 0.05 \* 11 = 3.85 W |
| Raspberry pi 5 | 1x | 5 V | 2 A | P = 5 \* 2 \* 1 = 10 W |
|  | | | | **Total:** P = 97.1 W |

Since the power supply has to be atleast 100 W, a power supply with a larger power rating will work as well.

# Prototype hardware and wiring

## Player node

## Player node to central computer

# Prototype code

## Player node

### RFID reader

### Screen communication

### I2C communication

## Central computer

### I2C communication

### Speaking with the server

### UI

## Server

## Webpage

# SUMMARY

Summary is a synthesis of introduction and most important results and conclusions. The length of summary is usually 1 ... 2 pages. Structure of the summary should follow that of main body divisions. Summary should contain the following:

* overview of thesis process and analysis in the light of initially specified objectives;
* concise summary of thesis results;
* student’s evaluation of thesis results and conclusions.

It is appropriate to mention problems in the summary, solving of which was left out of thesis scope, to be considered in the future.

One should follow a rule, that reading the summary (together with introduction) should be sufficient in order to understand thesis objectives, results and context (thesis main body, however, is intended to explain, how the results were obtained and to argue in detail the decisions made during the work).

Summary must be written both in English and Estonian. A thesis written in a foreign language shall include an Estonian summary, except in case of the graduation theses of degree curricula taught in English.

# LIST OF REFERENCES

[d] How to select a correct tag – frequency  
<https://rfid4u.com/rfid-frequency/>

[e] ISO 18000-6C  
https://www.iso.org/standard/46149.html

[a] Template matching  
<https://docs.adaptive-vision.com/4.7/studio/machine_vision_guide/TemplateMatching.html>

[b] Faster objects, more objects  
<https://edge-impulse.gitbook.io/docs/edge-impulse-studio/learning-blocks/object-detection/fomo-object-detection-for-constrained-devices>

[f] ThingMagic® M7e-Hecto UHF RAIN® RFID Module Spec Sheet  
<https://www.jadaktech.com/product/thingmagicm7e-uhf-rain-rfid-module-series/#specsheets>

[g] CAEN RFID Lepton3 (Model R3100C)  
<https://www.caenrfid.com/en/products/r3100-lepton3/>

[h] CM710-1 UHF RFID Module  
<https://www.chainway.net/Products/Info/124>

[i] Technology solutions 3117 and 3417/3419 RAIN RFID Reader Modules  
<https://www.tsl.com/products/rain-rfid-modules/>

[j] HiLetGo SPI TFT LCD Display  
<http://www.hiletgo.com/ProductDetail/2157216.html>

[k] Adafruit 3.5" TFT 320x480 with Capacitive Touch Breakout Board  
<https://www.adafruit.com/product/5846#description>

[l] Display visions 3.5" TFT IPS SPI or RGB  
<https://shop.lcd-module.com/3.5-320x480-IPS/TFT035-34AINN>

[m] Arduino UNO  
<https://store.arduino.cc/products/arduino-uno-rev3>

[n] STM32 Nucleo-F030R8  
<https://www.st.com/en/evaluation-tools/nucleo-f030r8.html#overview>

[o] ESP32-C3-DevKitC-02  
<https://docs.espressif.com/projects/esp-idf/en/stable/esp32c3/hw-reference/esp32c3/user-guide-devkitc-02.html>

[p] Asus tinker board  
<https://tinker-board.asus.com/series/tinker-board.html>

[q] Raspberry pi 5  
<https://www.raspberrypi.com/products/raspberry-pi-5/>

[c] Orange pi 5  
http://www.orangepi.org/html/hardWare/computerAndMicrocontrollers/details/Orange-Pi-5.html

[r] Analysis and Comparison of UART, SPI and I2C   
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=10090677

[s] Plastic Poker vs. Paper Poker, How Do I Choose  
<https://www.hopesgame.com/news/plastic-poker-vs-paper-poker-how-do-i-choose.html#:~:text=Plastic%20cards%20are%20mainly%20used,difficult%20to%20cheat%20with%20them>.

[t] RFID playing cards by TP-RFID  
<https://www.tp-rfid.com/product/rfid-playing-cards/>

[u] RFID playing cards by Sunrise security  
https://www.sunriserfid.com/hf-uhf-rfid-paper-playing-cards-for-casino-gaming-show\_p19.html

[v] RFID playing cards by IFAST  
<https://rfid-life.com/product/Manufacturer-RFID-chip-poker-ICODESLIX-poker-tag-NFC-plastic-poker-entertainment-magic-playing-cards.html>

[w]   
<https://www.semanticscholar.org/paper/Machine-Vision-in-Casino-Game-Monitoring-Pimentel/38b83ec996d350ce7e0a30cf0575441431c2015e#citing-papers>

[x]   
<https://www.semanticscholar.org/paper/Machine-Vision-in-Casino-Game-Monitoring-Pimentel/38b83ec996d350ce7e0a30cf0575441431c2015e#citing-papers>

[y] K.H Yu “Integration of Robotics, Computer Vision, and Algorithm Design: A Chinese Poker Self-Playing Robot” Cornell University, 2023  
10.48550/arXiv.2312.09455

[z] videopokertable.com  
<https://www.videopokertable.net/store.aspx>

[aa] RFpoker  
<https://rfpoker.com/>

[ab]

[ac]

# APPENDICES

Appendices complement the thesis main body. They may contain, in order to keep the main body concise, the following:

* all larger data volumes (tables of initial parameters, drawings of A3 and A4 size, specification, bills of materials, raw experimental data, etc.),
* repeatedly needed calculations of standard nature, computer programmes, their printouts or descriptions,
* text material of lower importance and/or supportive and/or illustrative nature,
* voluminous mathematical deriving’s, etc.

In the case of many appendices, it is allowed to position a page, titled **APPENDICES,** before the first appendix. Each appendix must start on a new page. The word Appendix together with is number and title should be written in upper right corner of each appendix’ first page, e.g.: Appendix 1 Form of title page. When an appendix is structured into divisions, their numbers should begin with letter A, in order to distinguish them from divisions of thesis main body, e.g. A3.2, A5.3.1, etc.

# GRAPHICAL MATERIAL

In the case, that thesis contains graphical materials, such as drawings, schemes, posters etc., that have size A3 or larger, it is allowed to:

* print it out as reduced, assuming that the texts remain readable, and bind them in thesis appendices or
* put together graphical part, place them (in original size and folded) into an envelop attached onto the inside of thesis back cover or into a separate folder, equipped with title sheet. Graphical material shall be folded after the thesis defence (see Appendix 4).

List of graphical materials shall be given in the end of thesis contents.

Formatting of all drawings must comply with valid standards (ISO etc).

1. *The non-exclusive licence is not valid during the validity of access restriction indicated in the student's application for restriction on access to the graduation thesis that has been signed by the school's dean, except in case of the university's right to reproduce the thesis for preservation purposes only. If a graduation thesis is based on the joint creative activity of two or more persons and the co-author(s) has/have not granted, by the set deadline, the student defending his/her graduation thesis consent to reproduce and publish the graduation thesis in compliance with clauses 1.1 and 1.2 of the non-exclusive licence, the non-exclusive license shall not be valid for the period.* [↑](#footnote-ref-1)