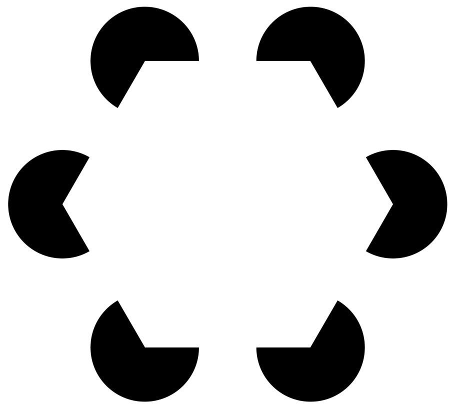
CBI ATTRACT 2024



TEAM HIPMED - FINAL REPORT

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Abstract

This report describes the process of team Hipfloyds during the CBI.ATTRACT program.
Team Hipfloyds was selected to design novel applications for HipMed, an advanced optical system based on hyperspectral imaging.
The process was based on design thinking: an iterative, non-linear, human-centered approach to innovation. As part of the program, the process was further structured into three phases: Discover, Design, and Develop.
Ultimately, team Hipfloyds proposed a device meant to support dermatologists in diagnosing Melanoma: the Hypscope.
The Hypscope uses the spectral signature of skin lesions to provide dermatologists with quantitative data on the likelihood of a lesion becoming cancerous.
The device is accompanied by a service meant to provide quality-of-life features to simplify dermatological visits.

Introduction

The team

Hipfloyds is composed of 6 people with varied backgrounds. This presented both opportunities and challenges.
On one hand, having complementary skills and different training was essential to developing the proposed solution. On the other hand, differences in communication style and expectations posed several challenges to the team, but this was very stimulating and useful for future group experiences.
The following is a list of the six members:
Andrea Corradetti, a brilliant computer science student at Unibo;
Tommaso Panebarco, an Advanced design student at Unibo gifted with excellent leadership skills;
Alessia Migliaccio, a management engineering student and a precious source of positive energy;
Mariagiovanna Zoccali, a photochemistry student at Unibo, with a special aptitude for public speaking;
Petra Marchesini, an explosive and amazing automotive engineering student at Unimore;
Athanas Kafia, an electronic engineering student at Unimore and a continuous well of ideas.

The technology

Hipmed, developed by Pentaomix, is a hyperspectral imaging (HSI) sensor.
Whereas the human eye sees the color of visible light in mostly three bands (long wavelengths, perceived as red; medium wavelengths, perceived as green; and short wavelengths, perceived as blue), spectral imaging divides the spectrum into many more bands. (Hagen & Kudenov, 2013)
The spectrum of a substance reflects its chemical, biological, and physical state. (Levenson & Mansfield, 2006)
At the time of writing, Hipmed is used for whole-slide imaging (WSI) of histological samples.
For each pixel in the captured image, Hipmed measures 40 points on the visible light spectrum between 450 and 800 nm.
In their paper, Brozgol et al. (2022) describe how Hipmed can be used for cancer diagnostics by analyzing the spectrum at each pixel of a histological sample.
Hipmed shows greater accuracy than WSI based only on the red-green-blue (RGB) ranges.
It also achieves shorter scanning times compared to methods like pushbroom scanning or filter-based scanning.
They propose two designs: one based on a Sagnac interferometer and one based on a linear variable filter.
Please refer to the original paper for a comprehensive explanation of the system.
For our purposes, we only need to remember that Hipmed can work with any type of optics at various magnification levels; different cameras can be used, though pixel size and frame rate

will affect performance; and while Hipmed has no moving parts, acquiring a complete spectral image requires relative movement at a (nearly) constant speed between the target and the objective lens.

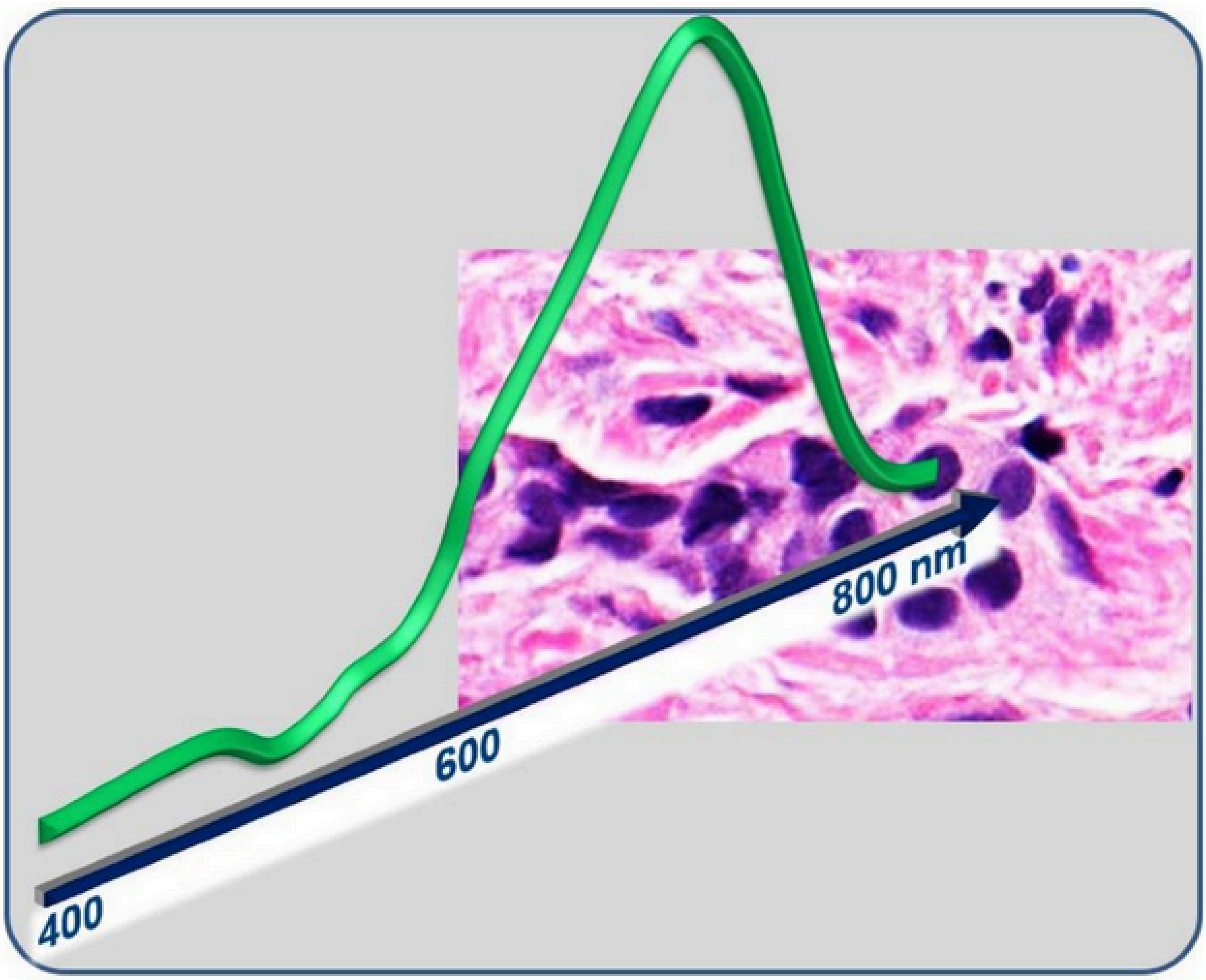


Illustration of tissue imaging

Discover

The first weeks

Initially, none of us members of team Hipfloyds were knowledgeable about the technology and we weren't familiar with hyperspectral imaging. So, the first few weeks were mostly exploratory.
It was immediately evident that the priorities were mapping out the domain of spectral imaging, understanding the inner workings of Hipmed, and placing it in the context of existing technologies.
We intended to understand better the capabilities of our assigned technology and to define what value it provided compared to the alternatives.
For this reason, the first task was researching scientific papers and informal sources.
This was conducted mostly independently by each member, and a summary of the findings was later shared with the team.

At this point in the process, our understanding was still fairly superficial; we knew that Hipmed could be used to detect cancerous cells in a controlled lab environment, but there was a lot more to discover, so we kept searching and started to interview with experts of the field to better understand hyperspectral imaging.
Our research showed us that hyperspectral imaging was already extensively used in many fields. This was a huge source of inspiration, and we started thinking of any improvement we could contribute to existing solutions.

We wouldn't meet our tech partner until sometime later, so we didn’t have a precise idea of the size of the device, its performance, cost, and technical details such as spectral resolution and pixel resolution. Therefore, at this early stage, we decided to base our early exploratory ideas on a few assumptions about the potential of Hipmed.
We knew that spectral data could be used to understand the composition of what is scanned, that the device was somewhat "fast," and could show an image enriched by spectral data.

Visiting Cern

Collision Week at CERN greatly influenced the team by exposing us to innovative ideas and deepening our understanding of emerging technologies. Collaborating closely with experts such as Pablo Garcia Tello, Ole Werner, Catarina Batista, and Roy Pennings provided invaluable insights into the genesis of new ideas and the intersection of values with technology.

Exploration Phase

During our visit to IdeaSquare at CERN, we engaged in a variety of activities designed to stimulate creativity and foster innovation. The experience included theoretical lectures, practical exercises, and group discussions to expand our understanding of emerging technologies and their potential applications.

Through the activities at IdeaSquare, we gained valuable skills and insights. Practical exercises facilitated by the IdeaSquare staff challenged us to apply divergent thinking methodologies. We explored unconventional ideas and approaches to technological advancement through brainstorming sessions and interactive workshops. Additionally, collaborating in these group activities with fellow participants allowed us to tackle real-world challenges and identify opportunities for technological innovation. These collaborative efforts fostered a dynamic exchange of ideas and perspectives, enhancing our ability to innovate and think creatively.

Throughout the process, we utilized methodologies such as the 6 Thinking Hats to strike a balance between creativity and realism. This approach ensured that our ideas remained grounded while exploring the boundaries of technological innovation.

During our time at CERN, we had the opportunity to meet Robert Cailliau, one of the founders of the World Wide Web. His insights into the evolution of digital technologies and their impact on society provided us with a profound perspective on innovation and the interconnectedness of technological advancement.

Mapping and selection of promising opportunities

During the intense week at Idea Square, we conducted interviews with researchers and professors to uncover the unexpressed potential of our technology. This led us to collaboratively draw up a map of the main features and functions of Hipmed.
The physicist Pablo Garcia Tello playfully described the technology as a camera that could "take colored pictures on steroids." We found the description fun and very fitting to convey the main idea of our technology, so this was immediately put on the map.
With this as our starting point, we outlined several plausible fields of application where we thought Hipmed could be used to positive effect. These choices were informed by our discussions with experts and the alignment of these opportunities with societal needs and the Sustainable Development Goals (SDGs).
The full map is shown below.

Five of the ten or so ideas that came out were selected to be presented to our peers and mentors at the end of our stay at IdeaSquare; they would become the starting point of our research focus for the next few weeks.
The selected fields were water monitoring, air quality monitoring, plant disease detection, waste sorting, and medicine.

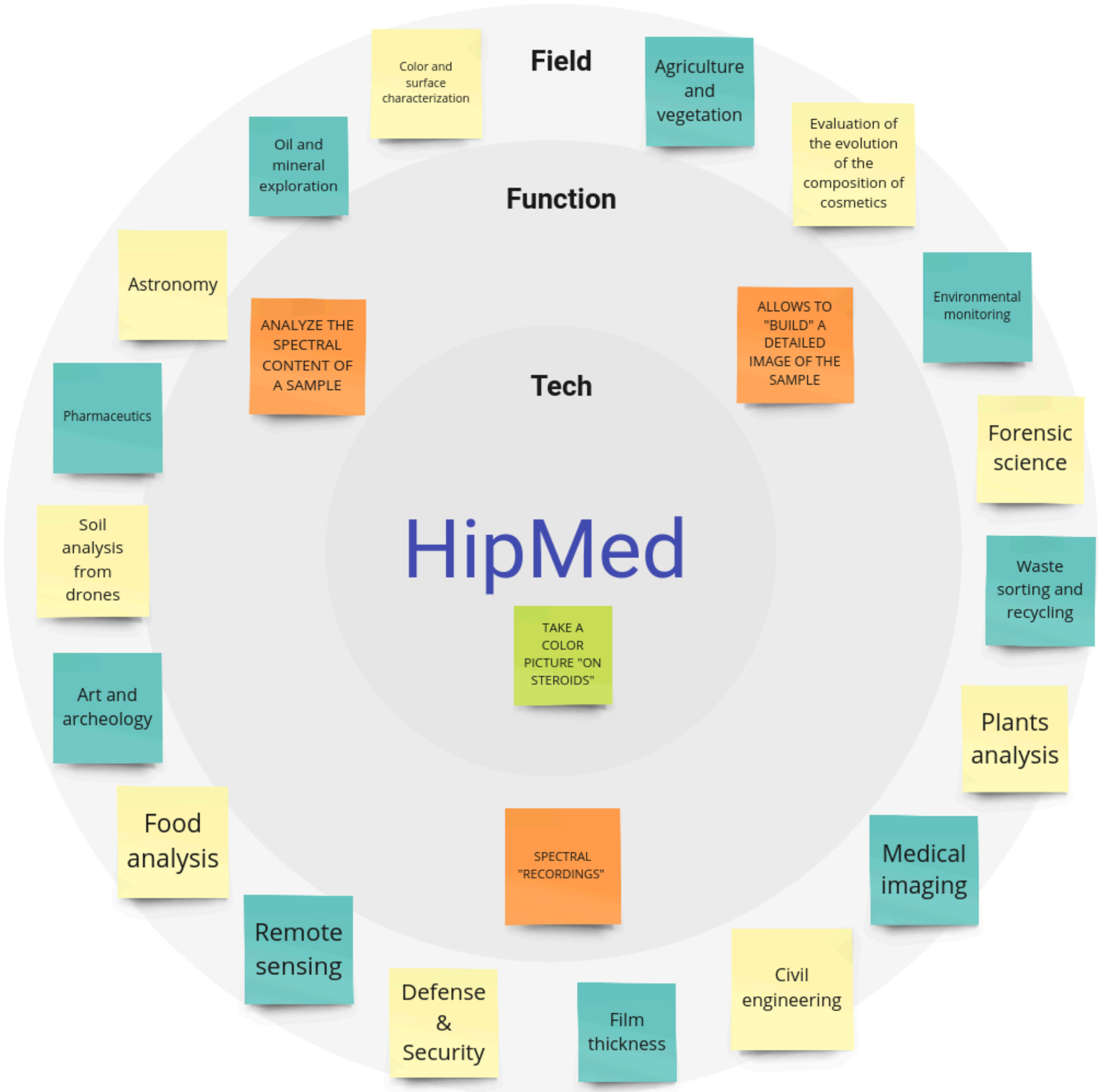
Interview with our tech partner Yuval Garini

During our visit to IdeaSquare, we interviewed for the first time our tech partner, Prof. Yuval Garini. In this online meeting, we discussed a general overview of the technology and its possible applications. We seized this chance to deepen our understanding of HipMed by asking numerous questions to explore its technical details, core functionalities, modes of use, and the flexibility of the technology to adapt to various scenarios. We then proceeded to discuss the fields of application we had identified, and Prof. Garini provided us with invaluable feedback. This feedback was crucial in helping us discard some opportunities in favor of more promising ones. The insights gained from this meeting were instrumental in refining our approach and focusing on the most viable applications of the technology.

Conclusion

Recognizing the dynamic nature of technological evolution, our experience at CERN emphasized the importance of anticipating challenges and seizing opportunities presented by exponential growth. This awareness will guide our efforts as we navigate the complexities of implementing our innovations in real-world contexts.

Our visit to IdeaSquare at CERN was instrumental in shaping our technological vision and refining our understanding of innovation. We are committed to leveraging these experiences, including our interaction with Robert Cailliau, to drive meaningful change and contribute positively to global challenges through our transformative technologies.



The field value map

The five fields and additional research

Keeping in mind Hipmeds strengths, we selected five initial fields of applications where we thought Hipmed could deliver a significant positive impact.
Research on them started immediately at IdeaSquare and continued in the following weeks; where we could, we organized interviews with experts.
The fields were refined through our findings and the results of these interviews; water monitoring was narrowed to marine microorganism monitoring and soil analysis, which now appeared more promising, replacing waste sorting.
The fields were analyzed using the Evidence-Problem-Opportunity framework and the resulting information would be the core of our first milestone presentation.

Water monitoring

We imagined using Hipmed to provide quick data about the presence of pollutants and pathogens in bodies of water. The usual process for water analysis consists of collecting samples and analyzing them in a laboratory. Hipmed could be mounted on aerial vehicles to provide rapid analysis of extensive areas without requiring numerous samples.
Discussions with our tech partner at IdeaSquare revealed that we could not be confident of Hipmed capabilities in detecting the presence of inorganic matter: whether or not Hipmed could detect the spectrum of each substance would have to be considered case by case, and it also depended on the context of use.
On the other hand, organic matter was generally much easier to identify.

With this information, we redirected our effort from detecting pollutants to monitoring marine organisms. We organized an interview with Marco Magnani, a marine biologist who explained how challenging it is to assess and map out the presence of very small but numerous organisms living in bodies of water.
Marco spurred us to investigate the possibility of using HSI to simplify this task.
Mills et al. (2023) document their use of a diver-operated hyperspectral imager to monitor and map benthic communities on tropical reefs.
At this point, we considered a few ways of proceeding: Hipmed might be used to scan a body of water superficially, possibly by installing it on a vehicle; it might be attached to a probe or some underwater device; or samples could be collected but quickly scanned in place thanks to Hipmed's compact size and rapid performance.
The former made very optimistic assumptions about the capability of Hipmed to detect microscopic organisms by way of remote sensing.

Air monitoring

Hipmed could be used alongside or in place of existing technologies to provide more complete data on air quality. This seemed promising in the context of work safety: Hipmed would guarantee a more controlled and safer environment for people working indoors.

Through research, we knew that a sensor like Hipmed would be suitable for detecting particulate matter (Mukundan et al., 2022); we wondered whether this could be extended to gases and other pollutants.
Many gases we wish to detect or monitor in our environment are infrared active (Crowder et al., 2006). Unfortunately, infrared bands are beyond Hipmed's range of detection.
We kept exploring the idea of air monitoring, focusing on particulate matter, but it seemed already that other existing technologies would be more suitable for the task.

To get a better picture, we organized an interview with the environmental engineer Prof. Giacomo Antonioni.
Prof. Antonioni felt that focusing on detecting particulate matter wasn't particularly interesting and that the existing technologies were already capable. He suggested we focus on detecting soil contamination which is an issue in need of a good solution.

Soil Analysis

Generally, cleansing contaminated soil requires expensive procedures guided by continuous sampling to ensure that enough contaminants have been removed.
The samples are sent to a lab and the waiting time to get results can slow down the process.
According to Prof. Antonioni, a mobile device that could monitor the presence of contaminants on the fly would make the remediation process more efficient.
This discussion pointed in the direction of a hand-held device with a screen that an operator could use to assess the condition of the soil in real-time.
Unfortunately, our tech partner Prof. Garini considered it unlikely that Hipmed could detect the features of inorganic contaminants caused by industrial processes. A quick literature review seemed to confirm this suspect: generally, these substances are reflective in the near-infrared range and beyond (e.g. the case of arsenic as illustrated by Wei et al. (2020))

Again, we took into consideration organic matter.
Comprehensive studies over the past decade showed that the VIS (400–700 nm), NIR (700–1100 nm), and SWIR (1100–2500 nm) spectral regions can serve as powerful tools for recognizing soils qualitatively and quantitatively (Ben-Dor et al., 2009)
We were mainly interested in the visible light spectrum and, in the conclusion to their paper, Viscarra et al. (2006) state that "the VIS range bands at 410, 570 and 660 nm showed good correlations with soil OC [soil organic carbon]".
We started considering a mobile device like a drone that could use Hipmed to cover the VIS range and other sensors to acquire data outside of Hipmed's range.
We imagined the drone would provide quick analysis of soil content for inaccessibly located areas, helping agricultural processes.

Plant disease detection

Standard methods for detecting plant disease often rely on crop agronomists manually checking the crop for indicator signs that are already visible. Depending on the type of crop and the size of the cultivated area, this process can be time-consuming and demanding.

In addition, manual detection relies on the disease or stress exhibiting clearly visible symptoms, which frequently manifest in the middle to late stages of infection. (Lowe et al., 2017).

In the conclusion of their literature review, Lowe et al. (2017) describe hyperspectral imaging as a non-invasive process to collect high-resolution data about plants. They state that this data can be analyzed using various techniques and the result of this analysis can be used to detect biotic and abiotic stress, with a focus on the classification of healthy and diseased plants, the severity of disease, and early detection of stress symptoms.

Nguyen et al. (2021) also describe how vegetation indexes and frequencies in the visible spectrum and near-infrared can be used to discriminate vines infected by the DNA virus grapevine vein-clearing virus at the early asymptomatic stages.

We considered an agile device that could use Hipmed to efficiently monitor the state of crops without damaging them. The device, possibly a drone, could be autonomous and periodically monitor large areas in a short time.
The device could provide raw data and also give estimates resulting from the analysis.
At this point, we still were not sure who would be the user of our solution. We envisioned a product that did not require special training and could be adopted by small and medium-sized cultivations.

Waste sorting

We imagined using Hipmed to help waste management companies better distinguish between the various materials, especially different types of plastics, which are particularly difficult to separate. These improvements in the waste sorting system would lead to an easier and more efficient recycling process.

Medicine

HipMed's advanced imaging capabilities could significantly enhance medical screenings, providing faster and more accurate diagnoses.

HSI has already proven its worth in the medical field for histological analysis, as demonstrated by Brozgol et al. (2022). The potential of extending HipMed's application to in-vivo analysis using hand-held scanners or endoscopes could further revolutionize medical diagnostics and treatment. Notably, hyperspectral imaging has been used to achieve more accurate tissue removal during surgeries for brain cancer, as reported by Fabelo et al. (2018).

Inspired by these advancements, we wanted to explore the development of a mounted sensor to guide surgeons in the precise removal of cancerous tissue. This approach aims to reduce the risk of leaving behind malignant cells, which is crucial in minimizing the chances of cancer recurrence.

In addition to this, we envisioned employing HipMed's hyperspectral imaging technology across various types of endoscopes, enhancing the detection and characterization of cancerous cells in different parts of the body. The ultimate goal was to develop a device that could detect cancerous cells during surgical interventions, significantly reducing the risk of repeated cancer cases and improving patient outcomes.

Lastly, we focused on dermatology and found that the most commonly used device in this field is the dermatoscope, which is essentially a magnifying glass. We realized that the lengthy and stressful procedures from initial diagnosis to final confirmation and potential removal of skin cancers, such as melanoma, could be greatly improved with a device capable of performing an in-vivo histological exam. Currently, this procedure is costly and painful, requiring surgical intervention to remove suspicious moles. Pathologists then analyze the sample to determine if it is cancerous.

First milestone

The presentation for the first milestone condensed the information gathered during the interviews and research phase. The focus was on the expected impact of Hipmed on each field and not on the details of each solution.

We were still missing the specifications and data that we needed for precise estimation and more concrete designs. After all, this phase was exploratory: we were still investigating interesting ideas.

At this point, we had a more informed view of hyperspectral imaging and its potential applications, a more intuitive understanding of what Hipmed could do and where it could be beneficial, and a few ideas worth investigating.

Design

After understanding the fundamentals of our technology and its potential applications, we entered the second phase: it was time to collect what we had found and start focusing.
Now we had a clearer idea of what information we were missing: we needed details on Hipmed's performance, size, and cost. After gathering this information we could conduct more effective interviews.
We were already narrowing down the fields we thought were most promising. At this time, however, we kept our options open by considering plant pathology, dermatology, and waste sorting; we would need more time to choose the two final fields.

More focused research, feedback from the interviews we would conduct, and the advice of our tech partner prof. Yuval Garini would lead to the selection of two fields of application out of the initial five and to the design of “prototype 0”.

Prototypes and interviews

Interview with Yuval Garini

Immediately after the first milestone we knew that we needed an exact view of what Hipmed could and could not do.
We sent a list of more informed questions to Prof. Yuval Garini, who helpfully answered them in detail. We learned that:

- Hipmed could acquire a spectral image with a pixel resolution of 1000x1000 in about one second, and the resulting image was 2Mb large.
- Due to the way it works, Hipmed requires relative movement and nearly constant speed between the objective lens and the target, although small velocity changes could be corrected during processing.
- Hipmed required stabilization and focusing to prevent smearing of the image, but this could be achieved easily with existing technology.
- Hipmed weighed about 500g
- Assembling a prototype with off-the-shelf components could cost about $2000

This meant that many of our exploratory ideas were feasible!
Hipmed would work on a flying drone, on a handheld device, and even underwater.
A device mounting Hipmed could have on-board computing for analysis of the images or it could send them to a remote location for processing and storage.
The resolution and speed of acquisition were high enough that scanning small organisms or large areas seemed doable.
Furthermore, the cost was contained.

Interview with Davide Ritorto - about plant pathology

Early in the second phase, we organized interviews to better understand the three remaining fields and, consequently, to choose the two most promising ones; we aimed to understand where our technology could be most useful when considering its specific strengths.
One of the first and most interesting meetings we had was with Davide Ritorto, an expert in the field of agricultural technology.

Davide emphasized the following key points:

- It's necessary to focus on a specific parasite/disease because it would be too complex, in terms of data interpretation, to consider a high number of pathogens. Therefore, we needed to choose a target culture with a target pathogen.
- Beyond the pathological state of the plants, we could probe their nutritional state, the turgidity of the leaf, and the percentage of A and B forms of chlorophyll. All of these parameters describe the overall health of the plant.
- To have a complete understanding of the plant's status, a bi-weekly analysis of the target is required.
- The user of the potential device for this kind of measurement would be an agronomist.
- Finally, the most important piece of information overall: a large portion of the harvest is lost due to the late detection of diseases. In other words, it is currently not possible to identify a diseased plant sufficiently in advance to treat it.

This interview helped us to identify the problem: the late detection of plant pathology leads to crop loss. Considering that it's not possible to detect these diseases early enough with the naked eye, it becomes clear that a device able to probe the health status of plants, long before it is evident, could be a solution to this issue.

Interview with Riccardo Rossi - about dermatology

Another crucial interview was with the dermatologist Riccardo Rossi. In this case, we wanted to learn about the tools that dermatologists use to examine skin health and diagnose skin conditions.

The doctor mentioned the following:

- A dermatoscope is a magnifier that can be aided by polarized light to have a more clear and defined image. It's used by dermatologists.
- Confocal microscopy is much more accurate than the dermatoscope but has a much higher cost and requires years of experience to use.
- A histological exam consists of the analysis of the removed mole in a dedicated laboratory. This step occurs after the dermatologist formulated a diagnosis; an anatomopathologist is also involved in this part of the process.

This and other interviews confirmed that the first diagnosis by dermatologists is based mainly on their personal experience. Confirmation of this first diagnosis occurs only after a histological exam, which means that a patient may undergo surgery unnecessarily in case of a false positive. Out of this problem came the need for a device, or better, a service, that could guarantee a fast, simple, and accurate process to monitor skin health.

Interview with the ENVAC company - Waste sorting

We interviewed the ENVAC company, which specializes in waste sorting systems. Mattias, their referent, was very interested in our technology. In this interview, we discussed how Hipmed could be integrated into their existing waste sorting system. Matias illustrated the functioning of a mechanical arm that selectively separates certain types of waste.
This arm is faster and more precise than a person, and, even more importantly, avoids the risks of picking waste manually.

Second visit to CERN

On this second trip to CERN, we met our tech partner, prof. Yuval Garini, in person. We intended to select together the two final fields of application, to build some early prototypes, and to test them. We split into three groups, one per area: the point was to convey the opportunity of each field and propose a prototype as a proof of concept. It was time to start envisioning our technology in action.
All the possibilities were promising, but we realized that the waste sorting field was too specific: we were just listening to the needs of a single company, which wasn’t our aim.
Besides, there were already several valid solutions for this issue, so we moved our focus to dermatology and plant pathology.
From now "plant pathology" would be renamed "agricultural technology" to better reflect our updated vision: the device we were designing would scan entire crops, and incorporate further analysis of soil conditions.

For the field of agricultural technology, we designed a drone with a hyperspectral camera that could perform continuous analysis of extended areas of soil and crops. This day-by-day monitoring of soil conditions, according to the experts we met, could save a lot of resources that would be wasted on unfruitful land.

For dermatology, we designed a portable device that included Hipmed and was supported by AI, to have a fast and more accurate analysis of moles, which were our main target.

Second milestone

At the end of the second phase, we identified two fields of applications that we intended to develop further: agricultural technology and dermatology.
At this point, we had exact details on the capability of Hipmed and we knew that there was interest for what it could do.

Development

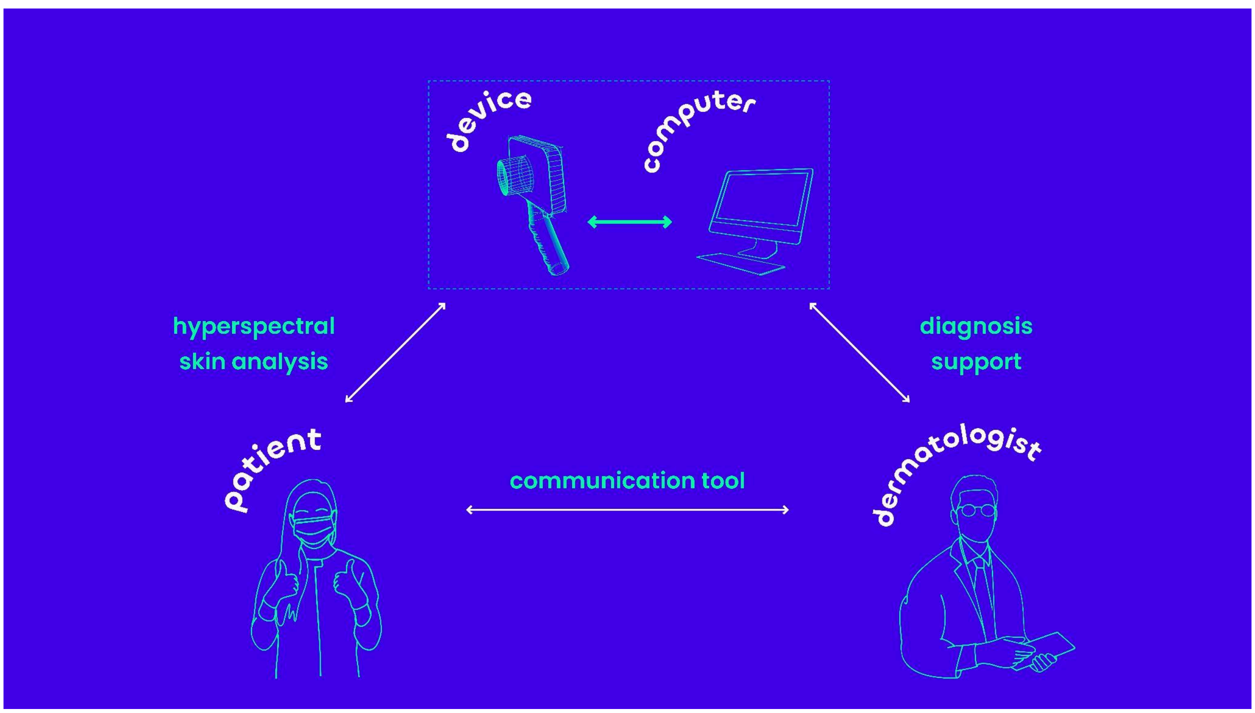
Focusing on dermatology

Fairly early in the third phase, we agreed to focus on dermatology.

Scientific literature from recent years is exploring the effectiveness of hyperspectral imaging and machine learning techniques for early and accurate diagnosis of skin cancer, and the results appear promising (Huang et al., 2023)
It seemed that Hipmed could provide doctors with the data for earlier and more confident diagnoses by exploiting the information in the spectral signature of skin lesions.

Our focus shifted to designing a device and an accompanying service that put usability and convenience first.
The device needed to be as simple as possible and not get in the way of a visit.
The service should provide convenient features for the doctor and a way for the patient to keep track of the health of their skin.

We named the device the Hypscope.



Prototyping the Hypscope

We soon had a clear direction for the physical appearance of Hypscope.
We had envisioned a handheld device, to be operated with one hand.
At the top of an ergonomic handle would be a case housing the main components and the screen.
The screen, with a diagonal of about 7 in., would face the user.
The objective lens would be placed on the side facing away from the user.
With this setup, the user could quickly see a preview of the image being captured, possibly complemented by real-time information.

Interview with Doc. Michelangelo La Placa

We interviewed dermatologist Michelangelo La Placa to gather insights into the clinical practices and the tools used in dermatological assessments.

Patients at the hospital are typically seen through scheduled appointments via referrals, though emergency consultations are also possible. Generally, the dermatologist has preliminary information about the patient's condition based on the referral.

Two primary tools are used in their practice: the dermatoscope and the video dermatoscope. While the dermatoscope is a standard device, the video dermatoscope, which is equipped with a camera, can take high-resolution images and zoom in on lesions. These images are stored in a database accessible to colleagues, facilitating collaborative review.

An expert dermatologist can often distinguish between benign and malignant moles, such as melanomas, by examining physical characteristics like color, shape, and patterns. If a mole appears suspicious, an appointment is scheduled for its removal. Typically, moles that are clearly tumorous or show suspicious characteristics are excised as a precaution. Histological examination of the excised tissue usually takes 4-8 weeks, although it can be expedited if urgent pathology is suspected.

Doc. La Placa noted that with experienced specialists, there are few unnecessary procedures. Even removing a benign mole as a precaution is considered prudent rather than wasteful.

Portable devices mainly benefit private practitioners and mobile doctors who travel between clinics. However, the current devices lack features for hair and nail assessments and are unnecessary for conditions like dermatitis, eczema, psoriasis, and acne. A wireless device would be more convenient, especially for examining difficult-to-reach areas.

Modern devices often feature automatic mapping, which the dermatologist believes would be more appropriate for histological examinations rather than initial diagnoses. Initially, they were skeptical about the device's utility for dermatologists but acknowledged its potential value in histological analysis.

For acne, Doc. La Placa finds using a smartphone to take photos more convenient and quicker than specialized devices. Currently, diagnoses rely on the dermatologist's informed opinion, with definitive conclusions only possible through histological examination.

He emphasized the importance of tracking changes in lesions, such as size and color, over time. However, they did not express any specific opinions on the device's form factor.

Overall, the interview provided valuable insights into the practical use of dermatological tools and the considerations for implementing new technologies in clinical practice.

Prototyping the interface

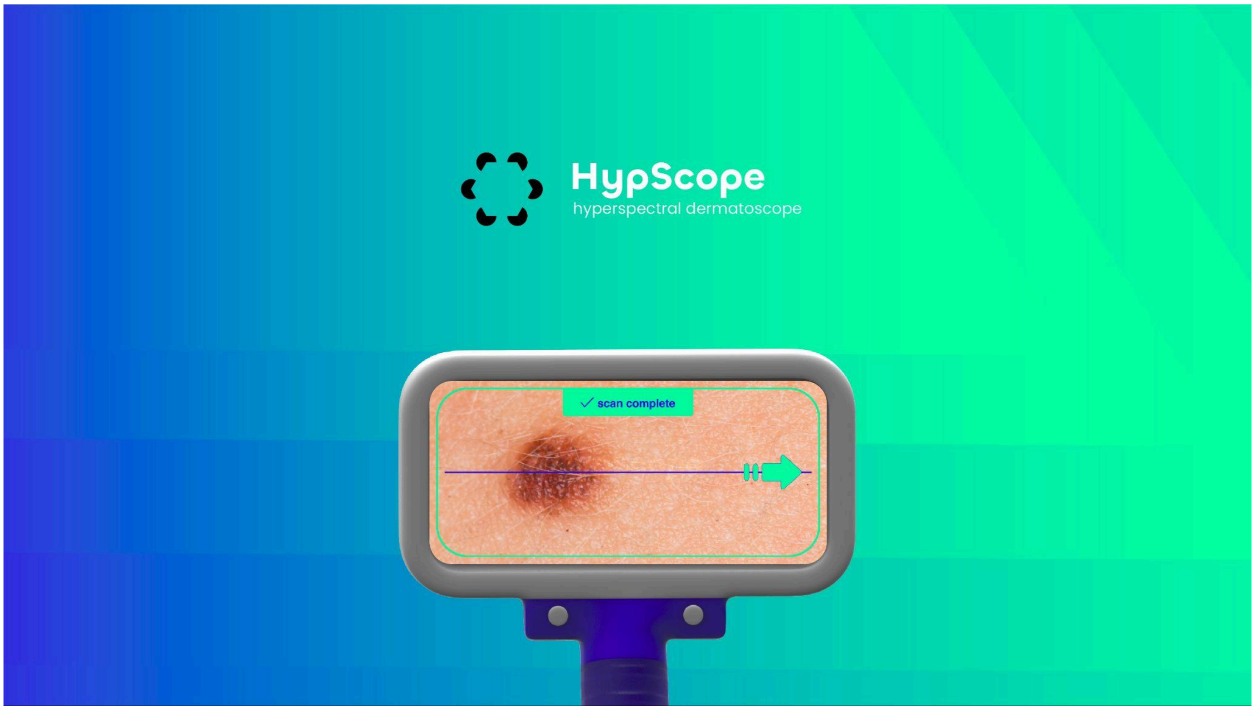
Many of the interactions with Hypscope would happen through the screen on the device itself, or through the doctor's computer screen. As such, we designed a few early concepts for the interface.

We kept in mind that dermatologists would conduct their visit wearing gloves, making interacting with a touchscreen uncomfortable or even impossible. Furthermore, Doctors expect their medical devices to not get in the way.

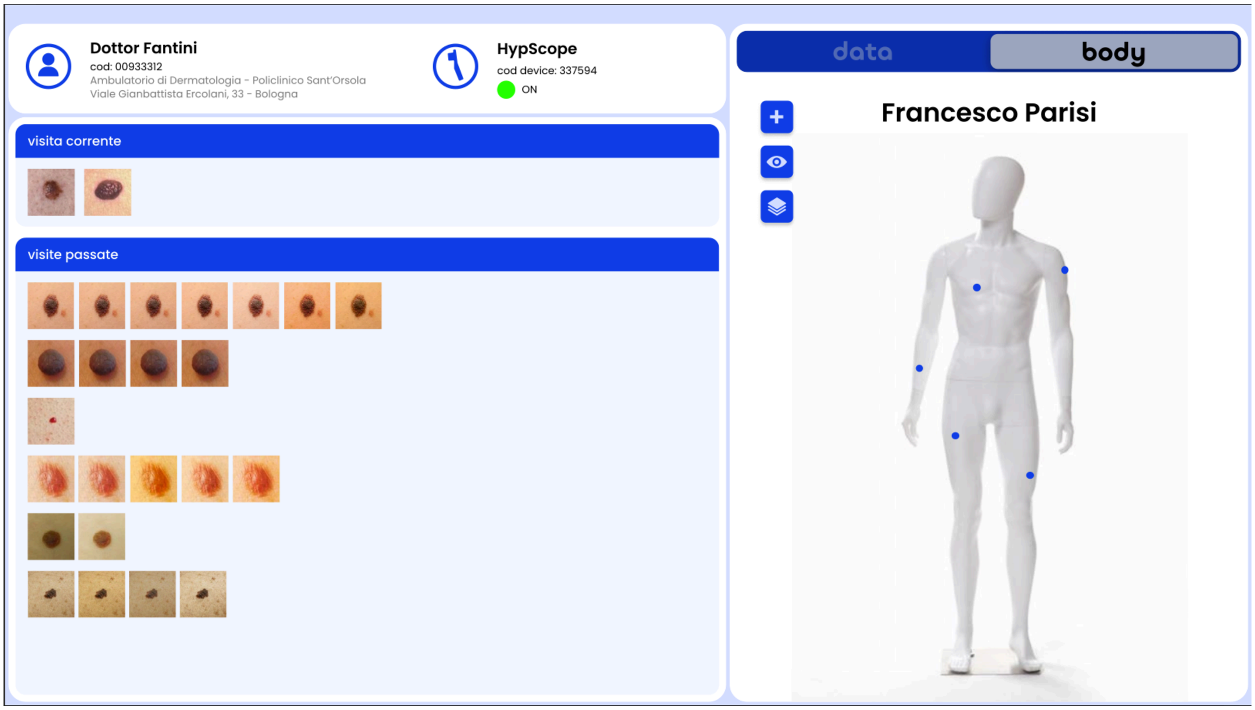
To make the interaction as straightforward as possible, during a usual visit, one physical button will control the Hypscope scanning function.

The touchscreen could still be used to set up the device and access its menus, although these functions were beyond the scope of the interface prototypes at this time.

The Hypscope's interface will guide the doctor in positioning the objective lens correctly and it will make clear that a horizontal motion is needed for the scan to occur.



The device will provide visual feedback after a scan and when the data is sent to the doctor's PC. On their PC, the doctors can map their scans on a model of the patient's body, quickly compare new and old scans, and get analytics aided by hyperspectral imaging about significant features of the mole.



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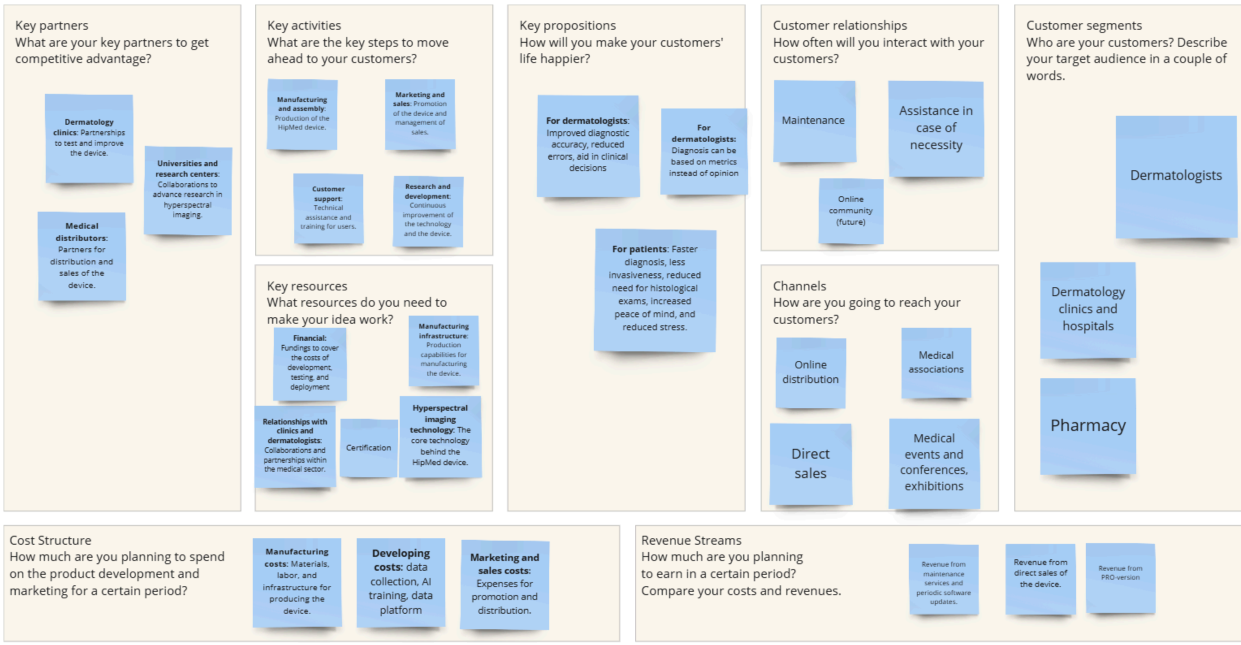
ON
data
body
Francesco Parisi
visita corrente
visite passate

Business Model Canvas



Using a Business Model Canvas (BMC) is crucial for structuring and visualizing the essential components of a business coherently and concisely. The BMC helps to understand and analyze how different elements of a business interact, ultimately contributing to its success. It provides a comprehensive view of the business model, highlighting areas that need attention and allowing for strategic planning and adjustments.

We first learned about the BMC during lectures by Prof. Bernardo Balboni, where we gained insights into its practical applications and benefits. For our project, we utilized the BMC to gain clarity on several aspects of our business strategy for the HipMed device. Here’s how we applied it:

1. **Key Partners**: We identified essential partners, including dermatology clinics for testing and improvement, universities and research centers for advancing hyperspectral imaging research, and medical distributors for device distribution and sales. These partnerships are vital for gaining a competitive advantage and ensuring the product's success in the market.

2. **Key Activities**: Our primary activities include manufacturing and assembly of the HypScope device, marketing and sales efforts, customer support through technical assistance and training, and continuous research and development to enhance the device's technology.

3. **Key Resources**: We determined the resources needed to make our idea work, such as financial investments for development, testing, and deployment, manufacturing infrastructure, relationships with clinics and dermatologists, and certification for compliance. Additionally, we emphasized the importance of hyperspectral imaging as the core of HypScope.

4. **Value Propositions**: We articulated clear value propositions for both dermatologists and patients. For dermatologists, HypScope offers improved diagnostic accuracy and reduced errors. For patients, it promises faster diagnoses, less invasiveness, reduced need for histological exams, and increased peace of mind.

5. **Customer Relationships**: We outlined how we will interact with our customers, including maintenance services, assistance in case of necessity, and the development of an online community in the future. This ensures that we provide continuous support and build lasting relationships with our customers.

6. **Channels**: We identified the channels through which we will reach our customers, such as online distribution, direct sales, medical associations, and participation in medical events and conferences. These channels will help us effectively market and distribute the HipMed device.

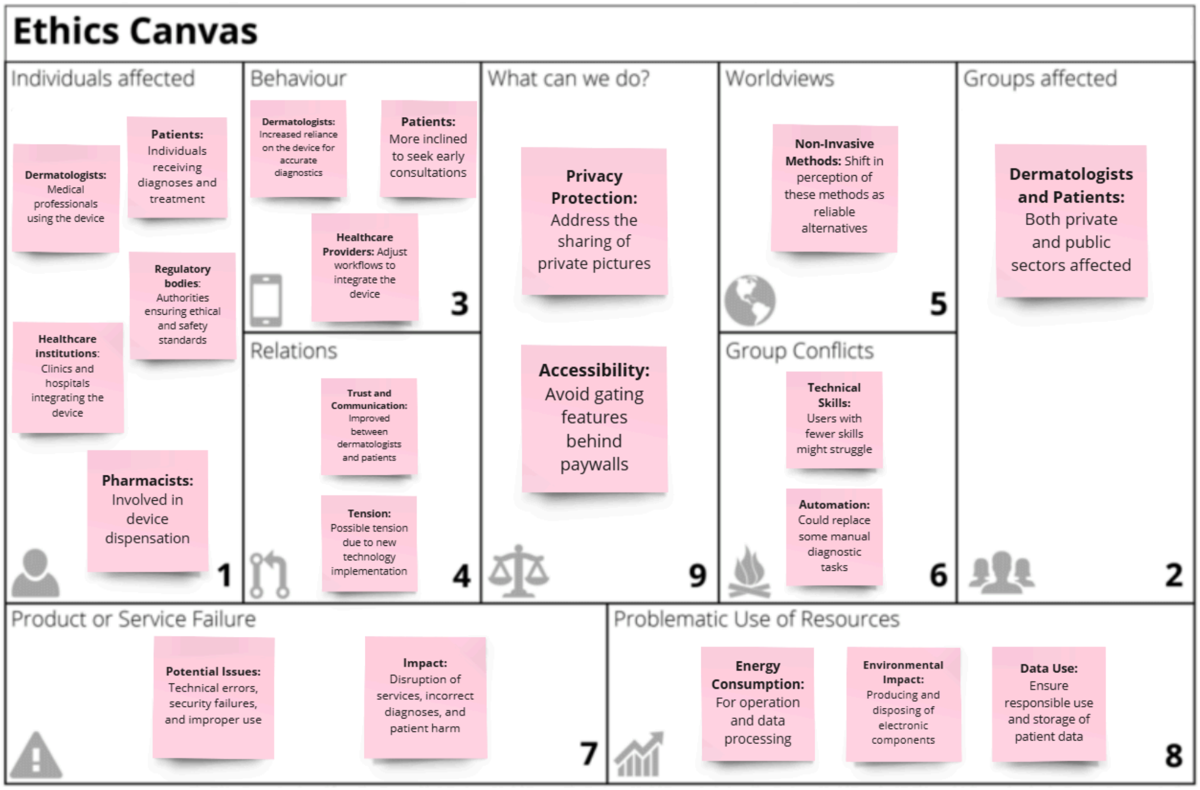
7. **Customer Segments**: We defined our target audience, which includes dermatologists, dermatology clinics and hospitals, and pharmacies. By understanding our customer segments, we can tailor our marketing and sales efforts to meet their specific needs.

8. **Cost Structure**: We planned our expenditures for product development and marketing, including manufacturing costs, developing costs for data collection and AI platform, and marketing and sales expenses. This helps in budgeting and financial planning to ensure sustainability.

9. **Revenue Streams**: We projected our earnings from various sources, such as maintenance services and periodic software updates, direct sales of the device, and revenue from a pro-version of the device. This allows us to compare our costs and revenues, ensuring profitability.

Using the BMC has been instrumental in organizing and refining our business strategy. It has enabled us to visualize the entire business model, identify critical areas, and make informed decisions to drive the success of the HipMed device. Learning about the BMC through Prof. Bernardo Balboni's lectures was invaluable in equipping us with the knowledge to effectively apply this tool in our project.

Ethics Canvas



Using an Ethics Canvas is vital for identifying and addressing ethical implications associated with our project. It allows us to consider the broader impacts on individuals, behaviors, worldviews, and resource usage, ensuring our solution is responsible and sustainable.

For our project, we applied the Ethics Canvas as follows:

1. **Individuals Affected**: We recognized the various stakeholders, including dermatologists, patients, healthcare institutions, regulatory bodies, and pharmacists, who will be impacted by the integration and use of the HypScope device.

2. **Behavior**: We anticipated behavioral changes, such as increased reliance on the device by dermatologists and early consultation by patients due to the device's capabilities. We also identified privacy concerns related to sharing patient images on mobile apps.

3. **What Can We Do?**: To address the ethical concerns, we plan to protect patient privacy and ensure essential diagnostic features are accessible without paywalls.

4. **Worldviews**: We considered how the adoption of non-invasive diagnostic methods might change perceptions of traditional diagnostic techniques.

5. **Groups Affected**: The main groups affected include both private and public sector dermatologists, as well as patients who need accurate and timely diagnosis.

6. **Relations**: The device is expected to improve trust and communication between dermatologists and patients, though it might also cause tension due to the introduction of new technology.

7. **Product or Service Failure**: Potential failures include technical errors, security breaches, and incorrect diagnoses, which could disrupt services and harm patients.

8. **Problematic Use of Resources**: We highlighted the need for responsible energy consumption, environmental considerations, and secure data usage.

9. **Group Conflicts:** We acknowledged that users with fewer technical skills might face challenges and that automation might replace some manual tasks, causing conflicts.

Using the Ethics Canvas has been instrumental in identifying ethical challenges and ensuring our project aligns with ethical standards and societal values. It complements our Business Model Canvas by providing a holistic view of the potential impacts and guiding us toward responsible innovation.

Third Milestone

For the third milestone of our project, we focused on presenting and refining our innovative solution, HypScope, an advanced optical system based on hyperspectral imaging designed to revolutionize melanoma diagnosis. The core aim of our presentation was to showcase the capabilities and potential impact of the HypScope, our hyperspectral dermatoscope, in the realm of dermatological diagnostics.

Key Highlights of the Presentation

1. **Importance of Early Melanoma Detection:** We emphasized the critical importance of early-stage melanoma detection. The survival rate drastically drops from 98.4% in stages 0-2 to 22.5% in stage 4, highlighting the need for timely and accurate diagnosis.

2. **Current Diagnostic Challenges:** The traditional diagnostic process involves multiple steps: initial diagnosis, surgical removal, histological testing, and final diagnosis, leading to long waiting times and patient stress. There also needs to be higher awareness among patients regarding skin health.

3. **HypScope Solution:**
    a. Device Features:
        i. Hyperspectral Skin Analysis: Provides detailed and accurate imaging by observing the full visible light spectrum.
        ii. AI-Based Image Analysis: Offers support for more accurate diagnostics by analyzing images using AI.
        iii. Communication Tool: Enhances communication between dermatologists and patients.
    b. Market Position:
        i. Compared to other diagnostic tools like dermatoscopes (€1500), Fotofinder systems (€70,000), and confocal microscopes (€200,000-300,000), HypScope is priced at €15,000, making it a cost-effective and superior alternative.

4. **Roadmap:**
    a. Short Term:
    Prototyping, medical certification, patent filing, and device/software development under EU regulation class 2a.
    b. Mid Term:
    Small-scale production, partnerships with research institutions, usability testing, and the creation of an open dataset for medical research.
    c. Long Term:
    Commercial production and widespread deployment.

Overall, the third milestone presentation was a significant step forward in demonstrating the value and potential of HypScope in transforming melanoma diagnosis. We aim to provide a faster, more accurate, and patient-friendly diagnostic solution by addressing current challenges and leveraging advanced technology.

Conclusion

We'd like to conclude with a brief reflection on this whole process, which has been a long one, and not without difficulties.
Each of us started this project with great determination, bringing their unique skills and ideas, but also their quirks and peculiarities.

We had a few disagreements along the way, showing how passionate and different we all are, but we faced these challenges. We grew not only as professionals but also as individuals, learning to appreciate our differences: we learned how to listen, compromise, and support each other.

Looking back, we are thankful for this opportunity; we take all those lessons in good spirit and move forward with great determination for future projects.

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