Book Wonk

An Automated Book Reader with Voice Assistance

Capstone Project Proposal

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BE Third Year – COE

CPG No. 54

Under the mentorship of

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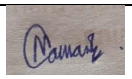
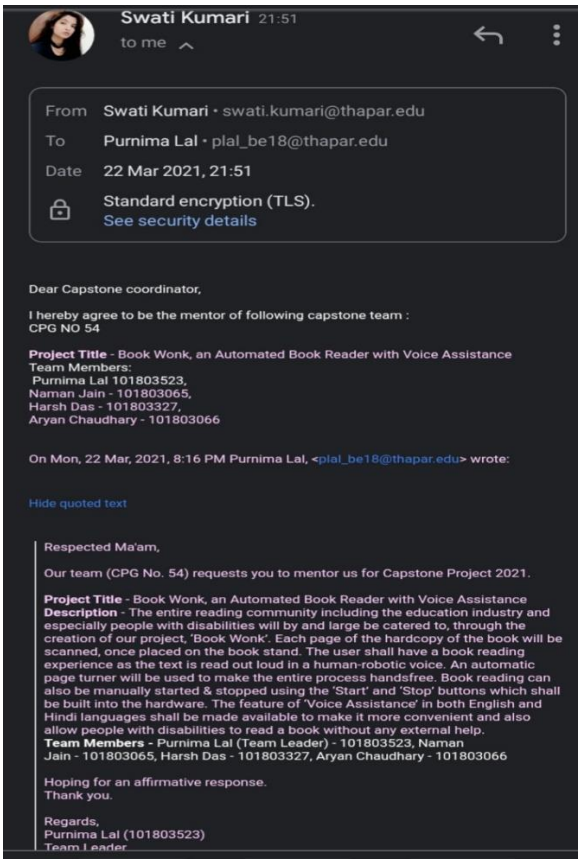
Mentor Consent Form

I hereby agree to be the mentor of the following Capstone Project Team

Project Title: Book Wonk, an Automated Book Reader with Voice Assistance		
Roll No	**Name**	**Signatures**
101803523	Purnima Lal	
101803065	Naman Jain	
101803327	Harsh Das	
101803066	Aryan Chaudhary	

NAME of Mentor: Dr. Swati Kumari

SIGNATURE of Mentor: 



Swati Kumari 21:51
to me

From Swati Kumari • swati.kumari@thapar.edu
To Purnima Lal • plal_be18@thapar.edu
Date 22 Mar 2021, 21:51
Standard encryption (TLS).
See security details

Dear Capstone coordinator,

I hereby agree to be the mentor of following capstone team :
CPG NO 54

Project Title - Book Wonk, an Automated Book Reader with Voice Assistance
Team Members:
Purnima Lal 101803523,
Naman Jain - 101803065,
Harsh Das - 101803327,
Aryan Chaudhary - 101803066

On Mon, 22 Mar, 2021, 8:16 PM Purnima Lal, <plal_be18@thapar.edu> wrote:

Hide quoted text

Respected Ma'am,

Our team (CPG No. 54) requests you to mentor us for Capstone Project 2021.

Project Title - Book Wonk, an Automated Book Reader with Voice Assistance
Description - The entire reading community including the education industry and especially people with disabilities will by and large be catered to, through the creation of our project, 'Book Wonk'. Each page of the hardcopy of the book will be scanned, once placed on the book stand. The user shall have a book reading experience as the text is read out loud in a human-robotic voice. An automatic page turner will be used to make the entire process handsfree. Book reading can also be manually started & stopped using the 'Start' and 'Stop' buttons which shall be built into the hardware. The feature of 'Voice Assistance' in both English and Hindi languages shall be made available to make it more convenient and also allow people with disabilities to read a book without any external help.
Team Members - Purnima Lal (Team Leader) - 101803523, Naman Jain - 101803065, Harsh Das - 101803327, Aryan Chaudhary - 101803066

Hoping for an affirmative response.
Thank you.

Regards,
Purnima Lal (101803523)
Team Leader

Project Overview

Book Wonk – A Book Reader with an Automatic Page Turner and Voice Assistance

The entire reading community including the education industry and especially people with disabilities will by and large be catered to, through the creation of our project, ‘Book Wonk’. Book Wonk is being designed intelligently & simply. Each page of the hardcopy of the book will be scanned, once placed on the book stand. The user shall have a book reading experience as the text is read out loud in a human-robotic voice. An automatic page turner will be used to make the entire process handsfree. Book reading can also be manually started & stopped using the ‘Start’ and ‘Stop’ buttons which shall be built into the hardware. The feature of ‘Voice Assistance’ in both English and Hindi languages shall be made available to make it more convenient and also allow people with disabilities to read a book without any external help.

Voice Assistance functionalities include –

- Reading of a book that can be commenced with a pre-defined voice command.
- Turning to a specific page number with a pre-defined voice command.
- Turning to a specific chapter in accordance with the index.
- Support of a voice enabled google search and meanings of words can be looked for or a thesaurus be used.
- Reading of a book that can be halted or paused.
- Production of a soft copy of the book using a pre-defined voice command. This shall result in each page of the book being scanned using the automated page turner and the overhead camera, thereby converting the scanned images to a single pdf file. A custom designed web application software with an interactive user interface will also be developed. The pdf can be viewed on the web application interface and the above stated voice commands in both English and Hindi languages will also be supported for the pdf version. Written notes (.txt file) can also be made by the user using the ‘speech to text’ tool offered by the Book Wonk’s web application.

Problem Statement

Using the knowledge of our course subjects, devise a working product for the general reading populace, especially people with disabilities, that makes book reading (hardcopy as well as a softcopy) an easy hassle free, handsfree and enjoyable experience with the use of features such as voice recognition, image recognition & speech to text conversion and vice-versa, supporting English and Hindi languages, all accessible through an interactive web application and a physical book reading stand.

Need Analysis

Reading books, magazines & printed material is a part of the daily routine for many of us. Turning pages of a bulky book or a lengthy document can be cumbersome or really difficult especially for people with limited upper-body functioning.

The responses to the Learning Resource Survey 2019-20 in the UK showed that 76 per cent of respondents said they preferred printed textbooks, compared with 18.5 per cent who chose eBooks and 5.5 per cent who said digital courseware [1]. 54,856 public libraries (Survey Report ORG-MARG) are there in India [2]. Therefore, a physical book reader will be a much-used tool as physical books are still the preferred way of reading. A revolutionized method of handsfree reading to varied generations of avid readers will be Book Wonk.

Hours spent reading per person per week in India has been 10 hours & 42 minutes while in Korea it has been as low as 3 hours & 6 minutes as shown by studies, in 2016 [3]. With a helpful & handsfree product such as Book Wonk these hours are expected to shoot up resulting in a knowledgeable, well-read & well-informed populace.

Energy, resources & time can be saved making reading easier & quicker for professionals such as the teaching community, learners, journalists, lawyers – all for whom our project is the need of the hour. Work can be made a lot easier while also making notes using the 'Speech to text' tool offered by Book Wonk.

Paper that becomes brittle or crumbly causes serious loss and expense to libraries, archives, and public offices. Due to insufficient physical storage and lots of maintenance most of the documents and books are discarded. Hence, digitization of documents has become a much needed technology. Preservation of the content of historical and legal records, important books, and scientific publications as well as books and papers can be accomplished by Book Wonk by converting them into a digital format.

285 million people are estimated to be visually impaired of whom 39 million are blind according to WHO in 2010 [4]. Books in Braille are sparsely available. Or better still, having someone or a voice assistant read out loud is the need of the hour. With audiobooks not accessible to all, an automatic page turner & reader along with the needed technology, can be of immense value & help.

Literature Survey

Research papers were read in order to comprehend and identify the already existing systems. The team went through the research and work done so far in the area of automated book reading and handsfree page turning to come up with a more robust, affordable and efficient book reader with an automated page turner offering voice assistance, Book Wonk.

Mechanism to turn the page

The mechanism to turn the page in the paper [5] by Shubham Sachdeva et al. titled Development of Voice Controlled Automatic Page Turning System (IJRET 2018) depicted the proposed idea as closely related to the actual motion of the hand while turning the pages as shown in the figure1 and figure2.

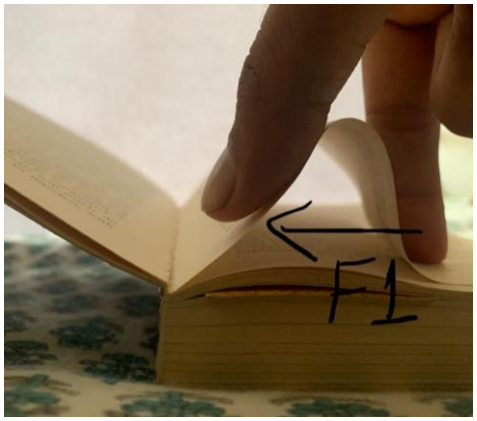


Figure1

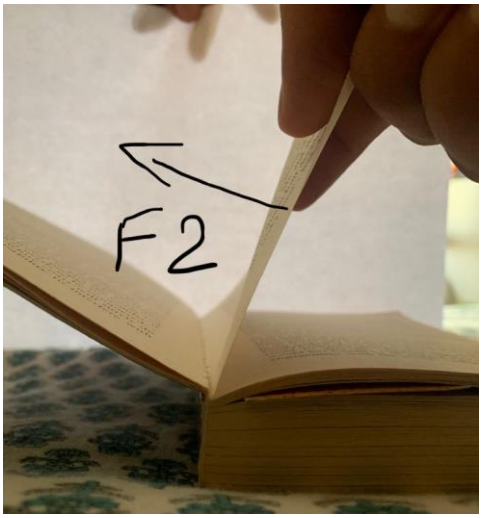


Figure2

The idea was to use a roller connected to a servo motor to recreate the motion resulting in the frictional force f1 and use a turning arm attached to a servo motor to create a resultant pushing force f2. These fluent motions combined resulted in the page being turned.

In the paper [6] by Ellaine Abueg et al. titled A New Approach to Automated Page-Turner Design Implementing a Re-usable Adhesive (RESNA 2004), the proposed idea was to use a reusable adhesive to lift the page up and a sliding arm to apply a force which would result in the page being turned. The major issue observed in the approach was the use of an adhesive which needed to be reapplied after certain intervals to ensure its persistent functionality. Another drawback observed was the inability to use this system independently by people with disabilities.

Based on the adhesive design there also exists a product [7] that uses magnets to turn the pages on which metallic paper clips are attached. The issue with this approach was the time spent as also the effort in adding the paper clips on the pages. People with disabilities could also not use this system independently.

In the paper [8] by Yoshihiro Watanabe et al., titled Automatic Page Turner Machine for High-speed Book Digitization (IEEE/RSJ IROS 2013) the mechanism used relied on expensive and complicated hardware. A page turner manipulator was used & the proposed technique did not work well on old manuscripts/ books.

Expensive or non-user-friendly hardware and designs have been used for the existing prototypes of a basic page turner.

Scanning the pages

In a video [9] demonstrating an automated book scanner developed by Ethiopian students on the YouTube channel of Karsten Fuhst, the approach used to scan the pages of the book relied on extensive hardware and required the book to be kept upside down which made it impossible to read while the scanning took place. This methodology only converted the hard copy into a soft copy.

In the paper [10] by N Bano et al. titled Automatic Book Scanner (ICMMR 2018), the proposed technique was to keep a capture device right on top of the book and to use a robotic arm with a suction pipe installed to lift and turn the pages in order to scan them. In this technique even though the book was being scanned, it wasn't read out.
The Methodology section states our manner of building an effective book reader.

The Voice control feature

The Voice control feature in the paper [11] by Balachandra HN et al. titled Voice Controlled Smart Page Turner for the Differently Abled (IJERT/NCESC 2018), proposed a method to implement the voice control feature such as start (to begin the page turning) using some libraries like pip3, PyTesseract, eSpeak, ALSA, url. retrieve, PyAudio 2.11, PocketSphinx, Google API Client Library for Python. However, only basics commands such as 'start', 'stop', 'pause' and 'repeat' were made available.
We endeavour to build a more user friendly, feature embedded, accurate, reliable, affordable working system, details of which find mention in the methodology section of this proposal.

Conclusion

Thus far an all-in-one system that offers an automated book reading experience along with voice assistance and the feature to digitize hard copies hasn't been proposed or built.
The literature we reviewed gave us a broad perspective, ticking our minds towards a pragmatic solution which is showcased in our project, Book Wonk.
Since the project is an ongoing one, modifications, if any, shall be reflected in the final report to be submitted along with the completed project.

Objectives

- To use the knowledge obtained in our course subjects and design a hardware tool named Book Wonk meant to read books/printed materials out loud including an automatic page turner and a camera powered by servo motors and Arduino.
- To offer voice assistance for the hardcopy in both English and Hindi languages.
- To provide ‘Search by voice’ feature powered by Google.
- To allow the conversion of the hard copy (actual book) to a soft copy in a readable pdf file.
- To offer viewing of the pdf file supporting voice assistance, search by voice and notes by voice through Book Wonk’s web application.

Methodology

A step-by-step methodology to achieve the objectives of Book Wonk, the Book Reader with Automatic Page Turner and Voice Assistance –

Step 1 – The book stand along with a camera overhead shall have a hard copy of a book placed on it. Activation of Book Wonk is accomplished by either pressing the physical 'Start' button or by giving a pre-defined voice command in the English or Hindi language which will commence a microcontroller-controlled sequence.

Step 2 – The required clamp shall be enabled by the servo motor which will then disengage the book for the automated page turner to turn the page.

Step 3 – Depending on which side the user wants to turn a page to (left or right), the rotating wheel connected to a servo motor can be rotated in both clockwise & anti-clockwise direction, controlled by Arduino. The page shall get folded in an upward direction & be held there by the wheel.

Step 4 – The fold of the page shall be caught & turned by the arm equipped with the ability to rotate clockwise or anti-clockwise, as the case may be.

Step 5 – To avoid a turn of the page back & forth due to external forces such as a blowing wind, fan etcetera, either ends of the book shall have clamps placed on them automatically.

Step 6 – The left & right pages of the book will then be scanned by the overhead camera & captured in an image format. Edges shall be detected by Book Wonk using the OpenCV Python library. The edges in the image shall then be used to locate/ find the contour (outline) representing the page of the book being scanned. A top-down view of the book page shall be obtained by applying a perspective transformation. The images scanned will be stored in a database at the back end of the Book Wonk's web application.

Step 7 – Through Optical Character Recognition (OCR), the text and graphic elements in the scanned image will be converted into a bitmap, which is essentially a matrix of black and white dots. The image will then be pre-processed where the brightness and contrast will be adjusted to increase the accuracy of the process. The image will now be split into zones to identify the areas of interest such as where the images or text are

and this will help kick-off the extraction process. The areas containing text will be broken down further into lines and words and characters. The software will now be able to match the characters through comparison and various detection algorithms. The result is the text in the image that the camera had captured. All of the above will be achieved using the OpenCv and PyTesseract libraries.

Step 8 – Using pyttsx3 (text-to-speech library), PIL (Python imaging library) and Googletrans (Google Translate API), the text extracted as the result of Step 7 will be read out loud through the audio output of the laptop / device.

Steps 2 to 8 will be repeated until the user gives another voice command or presses the 'Stop' button.

Voice commands will be implemented using PyAudio and Google-Cloud-Speech / Google-Web-Speech (speech recognition API). A Python script will be written which will enable the use of microphone, recognize the speech, transcribe it to text and run the voice command. The script will run on the backend of the web application.

Voice Search will be accomplished by integrating Google Voice Actions or Google-Web-Search API with the Book Wonk's web application. Speech to text for 'notes by voice' will be accomplished using the Google-Cloud-Speech package.

Upon giving the voice command, pdf version of the hardcopy will be created following Steps 1 to 6 for all pages of the book and compiling all the images scanned by Book Wonk. The pdf will be stored in a database on the backend of the Book Wonk's web application.

Django web framework will be used to develop the backend of the web application which will include a database to store the soft copies generated. The front end will be developed on Visual Studio Code using HTML, CSS, Java Script, ReactJs and Bootstrap. The web application will either be hosted on Google Cloud Platform, Digital Ocean or on Heroku.

The hardware will be designed using an adjustable book stand, 5 servo motors, 3 motor driver circuits, 1 Arduino UNO board, a distance measuring ultrasonic sensor, 2 clamps, 2 switches, 1 camera, 1 rubber wheel, 1 ice cream/plastic stick to construct the arm.

Work Plan

A work plan to achieve the set objectives -

Sr. No.	Activity	Month	March		April				May			June				July				September				November				December			
		Week No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	Identification, Formulation and Planning of Project	Plan																													
		Actual																													
2	Hardware Design	Plan																													
		Actual																													
3	Frontend and Authentication	Plan																													
		Actual																													
4	Hardware Implementation	Plan																													
		Actual																													
5	Image and Voice Recognition Module	Plan																													
		Actual																													
6	Integrating the Hardware and Software	Plan																													
		Actual																													
7	Design Optimization and Performance Modifications	Plan																													
		Actual																													
8	Testing and Results Evaluation	Plan																													
		Actual																													
9	Final Report	Plan																													
		Actual																													

Project Outcomes & Individual Roles

Project Outcomes

A fully functional and automated book reader, Book Wonk, that supports voice assistance in both Hindi and English languages to be ready as a deliverable.

The project, Book Wonk shall have –

- An automatic page turner powered by Arduino and servo motors and an overhead camera acting as a scanner.
- A physical ‘Start’ and ‘Stop’ button to start/stop reading aloud printed materials/books.
- Voice Assistance for both the hardware and software components supporting both English and Hindi languages and Voice Search powered by Google.
- Hard copy to soft copy (pdf) conversion of any printed material/book (intended only for personal use and not for distribution).
- A web application to view any document that offers voice assistance and voice search in both English and Hindi languages and also offers the speech to text tool to make notes (.txt files).

Book Wonk shall certainly change the quality of life of readers in a really short span of time. They shall save energy, time & resources leading to efficiency in the workspace by leaps and bounds. The differently abled section of our society will be served.

Individual Roles

Purnima Lal (101803523) – Backend development of Book Wonk's web application that includes development of algorithms and Python scripts for image recognition, speech recognition, text to speech and speech to text. Front end development of the web application. Software testing. Software and hardware integration. Report curation.

Naman Jain (101803065) – Design and hardware implementation by use of servo motors, motor circuits, Arduino, a camera and an ultrasonic sensor. Arduino configuration and coding as well as hardware testing. Software and hardware integration. Report curation.

Harsh Das (101803327) – Design and hardware implementation by use of servo motors, motor circuits, Arduino and an ultrasonic sensor. Arduino configuration and coding as well as hardware testing. Front end development of the web application. Software and hardware integration. Report curation.

Aryan Chaudhary (101803066) – Backend development of Book Wonk's web application that includes development of algorithms and Python scripts for image recognition, speech recognition, text to speech and speech to text. Front end development of the web application. Software and hardware integration. Report curation.

Course Subjects

- **Design and Analysis of Algorithm (UCS415)**

  Considering the importance of algorithms to solve different problems, the team sets forth to implement the learnings of this course subject for development of efficient algorithms for accurate and systematic functioning of the hardware using Arduino. The Python scripts which are essentially the backbone of the project will also be efficiently and accurately coded using the concepts of UCS415.

- **Software Engineering (UCS503)**

  The idea curation, designing, documentation, implementation and testing plan will all follow the methodologies and concepts taught in UCS503 making the entire capstone project period robust, efficient and optimal.

- **Database Management System (UCS310)**

  User login credentials, user's soft copies of printed materials/books and notes made will all require a database structured by the developer. Here, the concepts learnt in database management system will be applied.

- **Data Science Fundamentals (UCS538)**

  Building on the basics of Python programming language and Python libraries taught in UCS538, the team will write the Python scripts used for image recognition and speech recognition.

- **Machine Learning (UML501)**

- **Artificial Intelligence Applications (UCS665)**

References

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[6] J. C. N. H. O. K. A. T. a. T. M. Ellaine Abueg, “A New Approach to Automated Page-Turner Design Implementing a Re-usable Adhesive,” in *RESNA 27th International Annual Conference*, 2004.

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[9] “mäqädat Bookscanner - Maker Faire 2015 Hannover,” 2015. [Online]. Available: https://www.youtube.com/watch?v=MOcewCUU3WY.

[10] N. B. e. al, “Automatic Book Scanner,” in *IOP Conference Series: Materials Science and Engineering*, 2018.

[11] J. S. K. S. N. K. S. S. T. Balachandra H N, “Voice Controlled Smart Page Turner for Differently Abled,” *International Journal of Engineering Research & Technology (IJER),* p. 5, 2018.