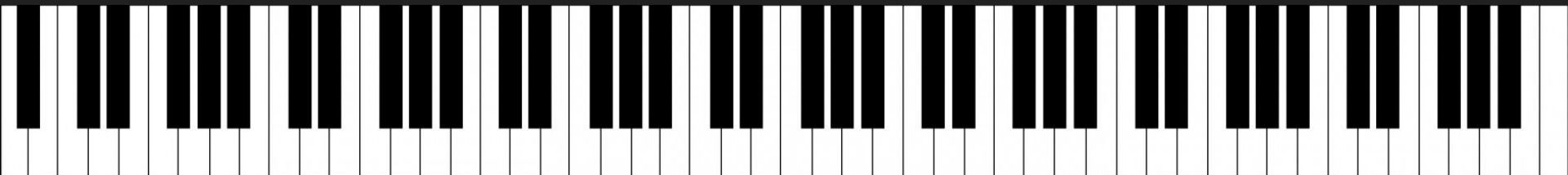


P21363: Automated Player Piano

Problem Definition Review
September 9, 2020



Team *(look how cohesive!)*



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The Design and Implementation Process

MSD 1

Problem Definition

Systems Design

Preliminary Detailed Design

Detailed Design

MSD 2

Build & Test Prep

Subsystem Build & Test

Integrated System Build & Test

Verification and Validation

Agenda

- Introductions
- States of the Piano & Constraints
- Goals and Deliverables
- Stakeholders
- Use Scenarios
- Customer Requirements
- Engineering Requirements
- Project Plan/Sample Scheduling

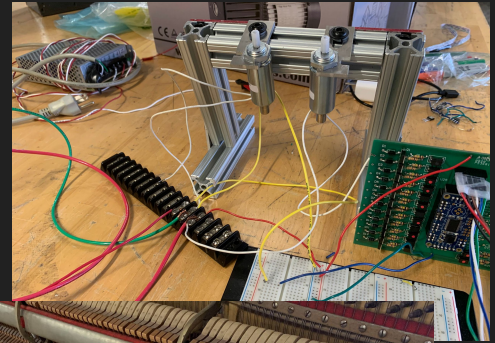


What is the Player Piano?

The project is a custom built player device that is custom built onto a upright piano that allows for automated play

This particular device is driven by accessibility for those who have difficulty playing with both hands.

The current iteration is the finalization of the 2019-2020 work process by the 20363 team that had to be stopped due to the COVID pandemic.



States of the Piano & Constraints

Current State:

- Piano has been playable in the past
- Device frame exists and fits in the piano
- Many components purchased but only partially assembled because of COVID



Desired State

- Piano can play completely autonomously and with a human pianist
- Implement a feedback system
- Easy to use UI & User manual

Constraints

- Piano must not be permanently modified or damaged
- Must fit within the existing piano and allow for the cover to close
- Device must use standard wall power
- Device must be easily used by persons undergoing physical or mental rehabilitation
- Unknown budget



Goals & Deliverables

Goals

- Finishing the construction of the device
- Create a device to operate the sustain pedal autonomously
- Further develop a feedback system
- Increase the amount and type of songs available to play

MSD Prescribed Deliverables

- Fully Functional Prototype
- Exhibit at Imagine RIT
- Technical Paper
- Design Poster

Customer Prescribed Deliverables

- Fully Functioning Prototype
- User Manual
- Find The Piano a Home

Stakeholders

Ron Dufort, Customer

MECE Department

RIT Campus

Physical Therapy Clinic

Piano Instructor

Rehabilitation Clinics



Jerry Adamski, Guide

Assisting Professors

User/Amputee

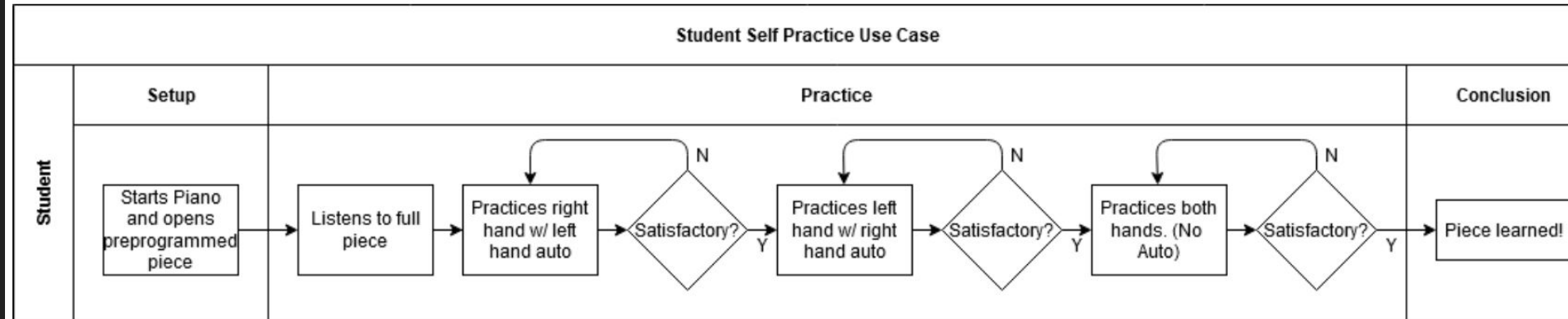
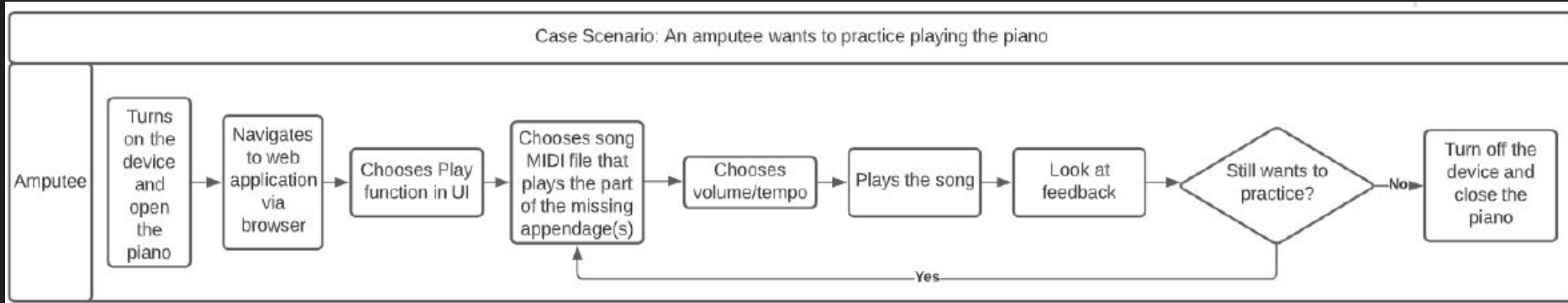
Beginner Piano Students

Hospitals

Possible Use Scenarios

1. Student/Teacher Case : This use case considers the scenario of a Piano Teacher Providing a Student with complete or supplemental lessons/exercises. These would likely be performed by the piano and include the student playing along with the MIDI performance.
2. Amputee Use Case : This use case considers the scenario of an amputee wanting to practice playing the piano. Whichever appendage is missing, there will be MIDI files to choose from that can play that part.
3. Student Self Practice Use Case : This use case considers the scenario of a student who wishes to practice a piece.
4. Physical Therapy Use Case : The use case explores the potential of using the piano player device as a physical therapy device within a hospital setting. Automated accompaniment can help facilitate piano play for any tempo/skill level.
5. Duet Use Case : This use case considers members of a duet who are unable to rehearse together ahead of a performance. One member of the duet (Pianist 1) will practice and record themselves playing, then send the recording to the other member (Pianist 2). Pianist 2 can then play along with the recording, practice, and return a recording to Pianist 1. This process can be further iterated if needed.

Sample Use Scenario Diagrams



Customer Requirements

Customer Rqmt. #	Importance	Description
1	High	Must play any standard MIDI arrangement completely autonomously
2	High	Piano still can be played normally, with no obstruction, all panels close fully
3	High	Ability to record performance as MIDI file
4	High	Piano cannot be permanently altered
5	High	Components must not pose any safety risk
6	Med	Should sound as much like a human player as possible
7	Med	Should be completely stable/stationary within the piano
8	Med	Device supports sustain pedal
9	Med	Include support for a count-in with a metronome.
10	Med	Piano can play full 88-key range
11	Med	Create a user manual
12	Med	Improve/consolidate all electronic/mechanical systems
13	Low	Volume/tempo controls within UI
14	Low	Master shutoff switch/volume
15	Low	Improve playing/training/practice interface

Engineering Requirements

Source	Function	Engr. Requirement (metric)	Unit of Measure	Marginal Value	Ideal Value
CR 3	Feedback system function	Time from key press to recorded feedback	Seconds	0.25	0
CR 13, 14, 15	Intuitive UI	Satisfaction	User Feedback Scale of 1-5	3	5
CR6	Mechanical noise from solenoids	How loud the device is	Decibels	15	45
CR9	Lead in/metronome	Time between 'Play' and part of song selected	Seconds	5	20
CR4	Visual Defects with piano	Our work does not hurt the piano	Number	1	0
CR1, 6	Ability to play any song like a human and autonomously	Time between key presses	Seconds	0.01	0.03125
CR11	User Manual	Satisfaction	User Feedback Scale 1-5	3	5
CR15	One Hand Operable	Satisfaction	User Feedback Scale 1-5	3	5
CR1	MIDI Compatibility	MIDI Conversion	Key Played/Notes in MIDI	10	88
CR5	Safety	Follows Health and Safety Protocol	Passes EHS or related health entity review	Pass/Fail	Pass
CR7	Device Stability	How far can it move once installed	Millimeters	10	0
CR10	All 88 Keys are usable	Number of keys playable	Number	86	88
CR8	Sustain Pedal Support	Time from pedal press, to feedback signal reaching computer	Seconds	0.1	0
CR8	Sustain Pedal Support	Time from signal sent to pedal, to pedal being pressed	Seconds	0.1	0
CR2, CR4, CR12	Component Enclosures	Number of system components that are not enclosed/are visible when functioning	Number	1	0

House of Quality

Issues and Solutions

- *Limited exposure to entire team due to pandemic safety protocols*
 - Following protocol/staggering in-person workloads to minimize exposure and maximize productivity (e.g. Computer Systems don't have to be in the same time as Mechanical)
- *First stage of the project revolves solely on completion of previous team's work*
 - Extra care will be taken to review documentation and more time will be spent understanding the scope and meaning of the previous team's intention and work
- *Team is behind schedule by a few days of work (e.g. PDR review was meant to occur earlier)*
 - Plans to recover workload between a Wednesday to Monday meeting by focusing on Friday/Weekend work to catch up in the beginning of the Systems Design Phase
- *Difficult to gauge time and resources for stages of design and development*
 - Team will remain in step with the coursework and continue estimating where unsure and await further information to readjust previous assumptions

Gantt Chart



The Design and Implementation Process - Next Steps

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MSD 2

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Thank you!



Questions?