Automatic Tracking of Actors with Intelligent Theatrical Lighting System

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CLIENT: STORY THEATER COMPANY

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Project Vision

Overview
Track a specific actor across the stage autonomously during an act regardless of other lights.

Approach
integrating control theater spotlight software with a programmable microcontroller hardware .

Goal
Tracking actor with intelligent lighting system.

Conceptual

Main Design Parts:

- Spotlight Control system.

- Programmable Microcontroller.

Story Theater Company Benefits.

- Increasing operational efficiency.

- Decreasing the cost.

- Help the director to get audience attention to specific area.

http://m.golocalworcester.com/lifestyle/holy-name-high-school-starts-fundraising-campaign-for-new-theater-seating

Requirements

- **Functional:**
  - System supports automatic tracking with at least one light.
  - System supports automatic tracking with at least one actor.
  - System supports tracking an actor assuming a fixed starting location for the actor.
  - Delay between actor movement and light movement is less than one second.
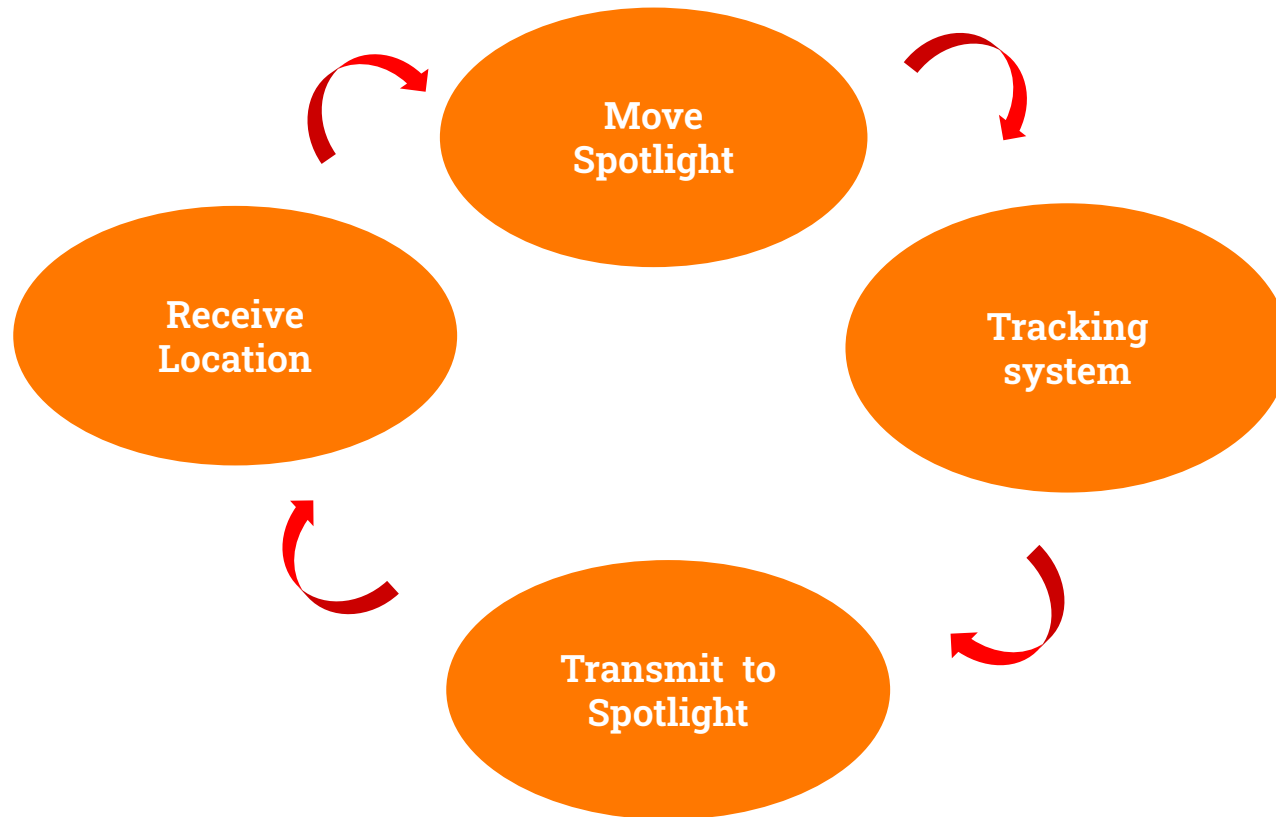 - System supports a rectangular, two dimensional playing space.

Requirements

- **Nonfunctional:**
  - **System must be designed as an add-on to existing hardware.**
  - **System should be low cost(less than $500 fixed cost).**
  - **System should be designed such that it could be integrated with typical theatrical lighting software in the future.**

Project Plan - Market Survey

- Jayanth, S Narasimha & Teja, N & Bhagyasri, Y & Shahapur, Kiran. (2016). RF based Remote Stage Lighting Controller. 10.13140/RG.2.1.4553.8165. https://www.researchgate.net/publication/302590662_RF_based_Remote_Stage_Lighting_Controller

- Pozyx that uses wireless communication but it is ridiculously expensive, priced at 1050 euros per kit. https://www.pozyx.io/shop/product/creator-kit-65

Conceptual Design Diagram

Why We Chose localino?

Method	Accuracy (%)	Cost	advantage	Disadvantage
Antennas & transmitter	%99	High	Have a choice to either track manually or automatically	Too expensive
infrared camera		Low	Potential to easily switch targets without multiple tracker devices.	Hard to work with, inconsistent tracking when objects change orientation
Localino	They are are able to locate a person or moving object down to a few centimeters, using a time-delay based measurement method. This way, an accuracy of about 10 cm can be achieved.	$159	They have scalability, user-friendly, and high quality design, and open source software.	
Indoor GPS	Precise (±2cm)	Low - Moderate	Precision is exact and performs well for indoor	Beacons, which come along with the package, must be mounted on the walls around the corners of the

Design

- **We have chosen Localino positioning system because of its:**
  - **Accuracy: +/- 2 cm from the actor.**
  - **Price ($200) is efficient.**
- **Components of the positioning system are:**
- **A transmitting microcontroller to be held by the actor over stage.**
- **Three beacons are mounted around the stage to receive the location signal (x,y, z) of the fourth localino on the actor.**
- **The DMX spotlight receives the location signal from the beacons and follows the actor according to this signal.**
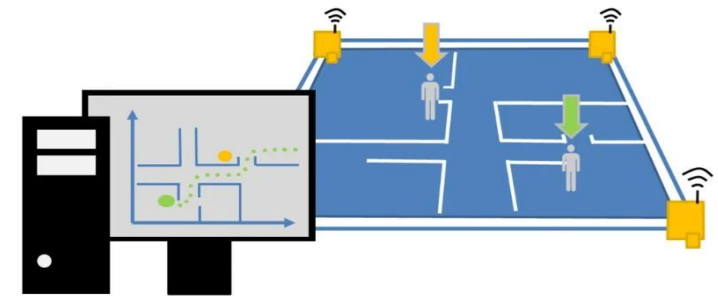
Localino Beacon

Design

- **Obstacles**
  - **The positioning system might encounter some delay while tracking an actor.**
  - **The location accuracy could be slightly off because of object distractions.**
- **Skills desired**
  - **A soldering hand is needed.**
  - **Programmer in C++ or Python.**

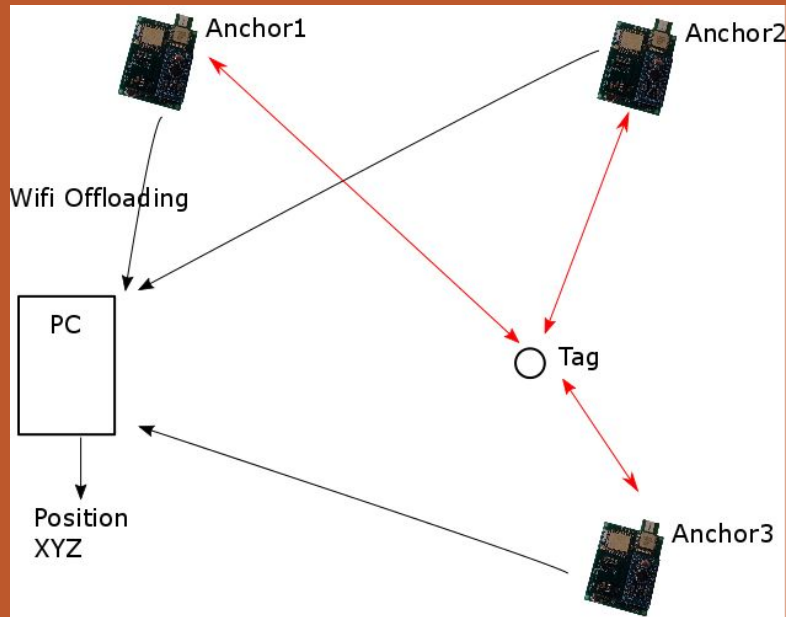Localino
do it yourself localization system

www.localino.net

System Parts

- **Localino tracking system.**
- **Python Software Controller.**
- **Open Lighting Architecture Framework.**
- **DMX Spotlight.**

Localino tracking system

- The localino tracking system is a custom PCB with a microprocessor that communicates with other 3 localino that will be mounted around the room.

- The system uses a DWM1000 Module which is a UWB transceiver for measuring object location.

- The system tracks the position of the actor/actress is the room.

- The positioning data in the form of coordinates will be sent to the python controller.

Python Software Controller

- **The spotlight will be controlled through a python controller using Open Lighting Architecture python API.**
- **The python controller will take actor positioning data from the localino system and calculate the turn and tilt angle the spotlight need to move to.**
- **The angles will be translated into DMX values and send to the spotlight with OLA.**

- **Inputs:**
  - **3D Coordinates from the tracking system.**
- **Outputs:**
  - **A DMX value that will be sent to the spotlight.**

Open Lighting Architecture Framework

- OLA is a open source framework.

- OLA uses a USB to DMX device to convert OLA commands to DMX signals.

- We are using the DMXKing ultraDMX Micro device for our project.

- The spotlight is controlled by DMX signals send by the USB device.

DMX Spotlight/DMX

- **DMX Stands for Digital Multiplex Signal**
- **DMX is a protocol made for lighting systems**
- **DMX512 is a commonly used standard for lighting systems today**
- **DMX512 is divided into "universes" and "channels"**
- **Each universe has 512 channels**
- **Each Channel have a value of 0-255**

DMX Spotlight

- A DMX Spotlight is a spotlight that is controlled by DMX signals.

- Our spotlight will be controlled through 14 channels.

- Each channel will controll a different function of the spotlight.

14-Channel Mode

Channel	Function
1	Pan Control (coarse)
2	16-bit Pan Control (fine)
3	Tilt Control (coarse)
4	16-bit Tilt Control (fine)
5	Pan/Tilt Speed (slow to fast)
6	Master Dimmer (0-100%) and Strobe (slow to fast)
7	Red Dimmer (0-100%)
8	Green Dimmer (0-100%)
9	Blue Dimmer (0-100%)
10	White Dimmer (0-100%)
11	RGBW Color Mixing (0-231) and Random Color Mixing (232-255)
12	Color Mixing Speed (slow to fast)
13	Function Combination (Auto and Sound Activated)
14	Reset

Demo Prototype

Project Plan : Tracking

- **Figure out a way to track an actor on stage using some external device.** ✓

- **Have alternatives to that tracking mechanism.** ✓

- **Start Testing tracking mechanism.**

- **Calibrate tracking.**

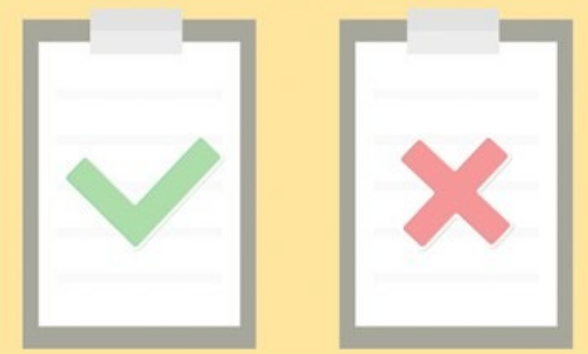- **Integrate into control system.**
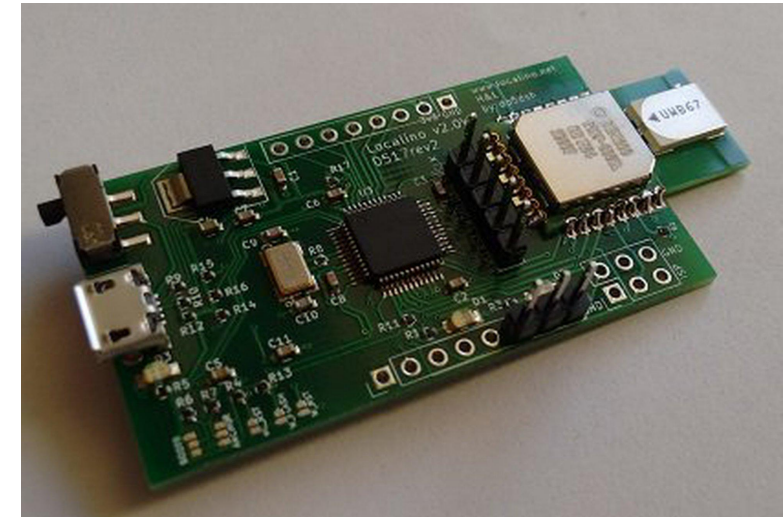
Localino PCB

Project Plan : Control System

- **Explore DMX lights inputs and outputs.** ✓

- **Start looking for open source libraries.** ✓

- **test out library to control DMX lighting.** ✓

- **Integrate DMX custom control with tracking.**

- **Calibrate whole system to stage.**

Test Plan - Individual Components

Tracking:
- figure out Localino kit and see its range of tracking.
- Make an estimate actual accuracy of location of actor on stage.
- Record delay of actor coordinates & find an acceptable delay range.
- Does any material affect location accuracy?

Control System:

- Calibrate angle of how much the light turns with the respective DMX channels.
- Use DMX light in a sample space to coordinate it's movements with the size of the room
- Record delay of actor coordinates to DMX lighting moving & find an acceptable delay range.

Test Plan - A whole system

- Once The Control and Tracking Systems are linked together, use theater space to test measurements of room.
- Calibrate an acceptable delay to get the Location Data from Tracking Unit to Control Unit.
- Test on rehearsal session and from there calibrate system based on results.

TEST
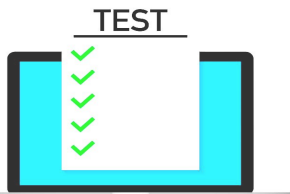
Challenges

- Finding an indoor tracking system.
- Figuring out how DMX protocol works and understanding DMX channels.
- Fitting our system into a larger lighting system that our client currently uses.

Conclusions

- The parts for the tracking device (localino) has been ordered ✓

- The software tracking system is ready to control the spotlight ✓

- Next Semester:
  - building the tracking system from the parts ordered.
  - connecting the tracking system with the control system.
  - testing the design.

Team Members Contribution

- **Tracking Team**
  - **Hassan Alhaddad**
  - **Mouez Zayed**

- **Spotlight Control Team**
  - **Raed Albloushy**
  - **Joel Ohge**

- **Synthesis**
  - **Hasssan Almohammedsaleh**

Questions

Thank You