Cognitive Human Robot Interaction
Goal Statement

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1 Introduction

Collaborative human robot interaction is an emerging field. Especially in industrial setting where total automation will not lead to optimum profit, since some tasks can be very easily performed by human compared to a robot. Therefore, human has to be involved and thus the need for collaboration between human and robot increases. We are aiming at proposing and implementing a robot model for effective collaboration between a human and robot in an industrial setting.

2 Goal Statement

Formulating and Implementing a **Behaviour Dependant** and **Collaborative** robot model for robots in industrial settings. Behavior dependence refers to the adaptation of the robot to the human co-worker whereas Collaborative model refers to the robot models that consist of collaboration skills needed for effective team work as mentioned in [2].

3 Gap Analysis

Currently there are no industrial collaborative robots which adapt to the behavioral changes of the co-worker.

ABB proclaims that YuMi is the world's first truly collaborative robot, able to work side-by-side on the same tasks as humans while still ensuring the safety of those around it [1]. It does not adapt to behavioural changes of the co-worker.

There are works on behavioural adaptation robots in the service area. These robots have already been used for taking care of elderly people like in [4].Another example of human robot interaction in social settings is proposed in [3] called

CAIO architecture. It is capable of reacting based on the human emotions.

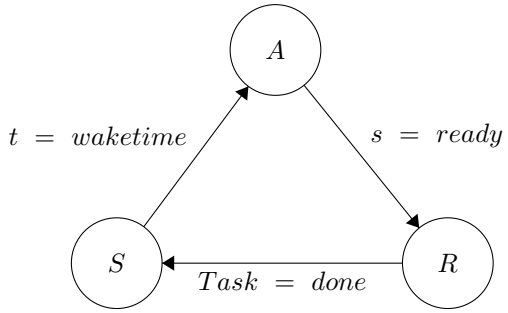
It is explained in [2] on how to modify a robot model to include collaborative skills in it.

4 Technology and Architecture

Collaborative Task:
Robot has to pick up a raw material from Location A and drop it in Location B. The robot hibernates until the human completes his/her task and ask for the next raw material.
Human will be waiting for the raw material in Location B and when he gets the raw material, Human performs his analysis on the object and after he is done with the task, he will ask for the raw material.
Our goal is to reduce idle time of human, we do this by predicting his *task* time so that the robot can complete its part without any delay for the human side.

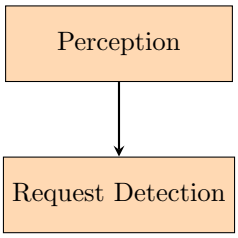
State diagram for the robot:
States = {S,A,R}
Variables = {t, s, task}

S is the *sleep* state where the robot hibernates and updates the *waketime* variable to a certain time, mentioning the time at which it has to wakeup. If human request occurs s is changed to ready.
A is the *awake* state in which robot will monitor the need of human. Whenever the human needs the robot (In this case, s=*ready*), then the robot will go to *running* state. If the human requests for the raw material s is changed to ready.
R is the *running* state in which the robot performs the collaborative task mentioned above, and updates the *task* variable to *done*. After the task is done, s is updated to *null*.



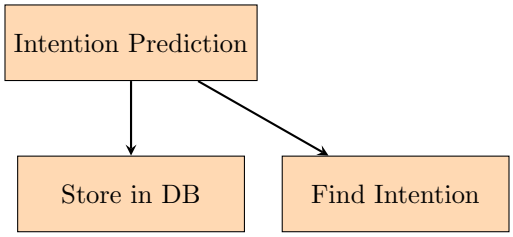
4.1 Structure of Architecture

4.1.1 Perception



Request Detection uses python libraries, mainly OpenCV, to detect hand gesture from the videofeed, the timestamp is send as the output.

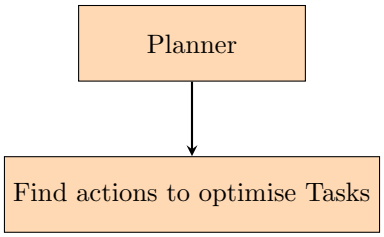
4.1.2 Intention Prediction



Store in DB, stores the timestamps in a MySQL database for further calculation.

Find Intentions retrieves a series of timestamps from the MySQL database and calculates the next predicted timestamp using a regression algorithm.

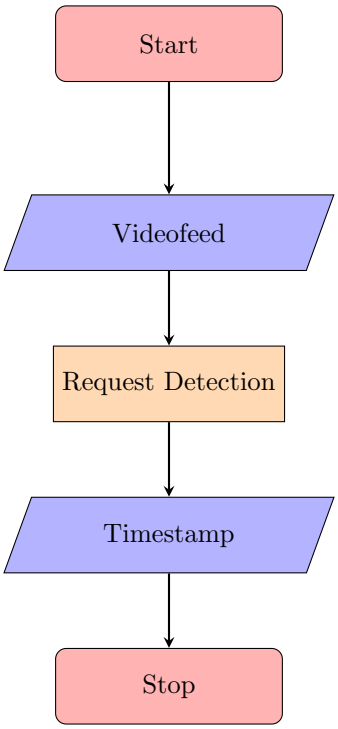
4.1.3 Planner



Find Actions to optimise Tasks uses knowledge of tasks and object location as well as the predicted timestamp to determine actions. Python can be used to implement this.

4.2 Functionality

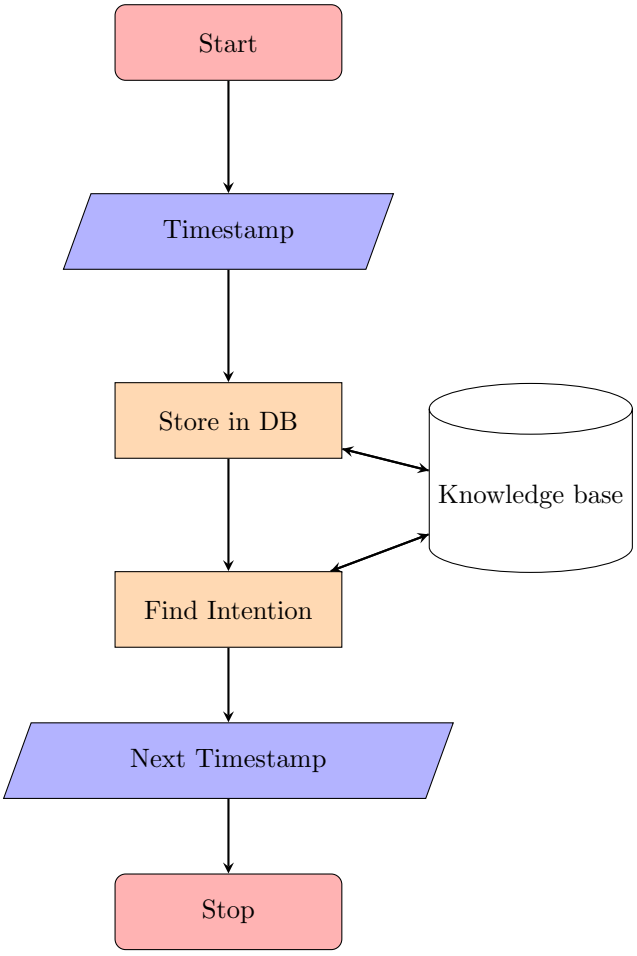
4.2.1 Perception



The objective of this module is to perceive when the human requests for robot's involvement.

The input is the videofeed, it is passed to *Request Detection* where it recognises the gesture for request and outputs the timestamp.

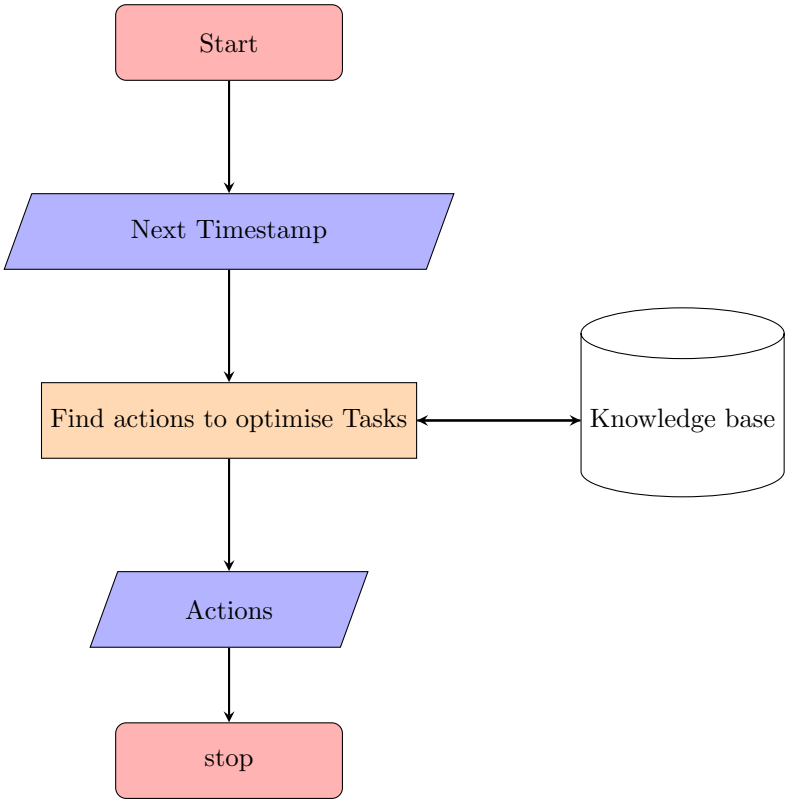
4.2.2 Intention Prediction



The objective of this module is to predict when the human is going to request robot's involvement based on previous data.

The input is the current timestamp, it is stored to a DB using *Store in DB*, then using a regression algortihm based on previous timestamps a new timestamp is generated, this is done in *Find Intention*.

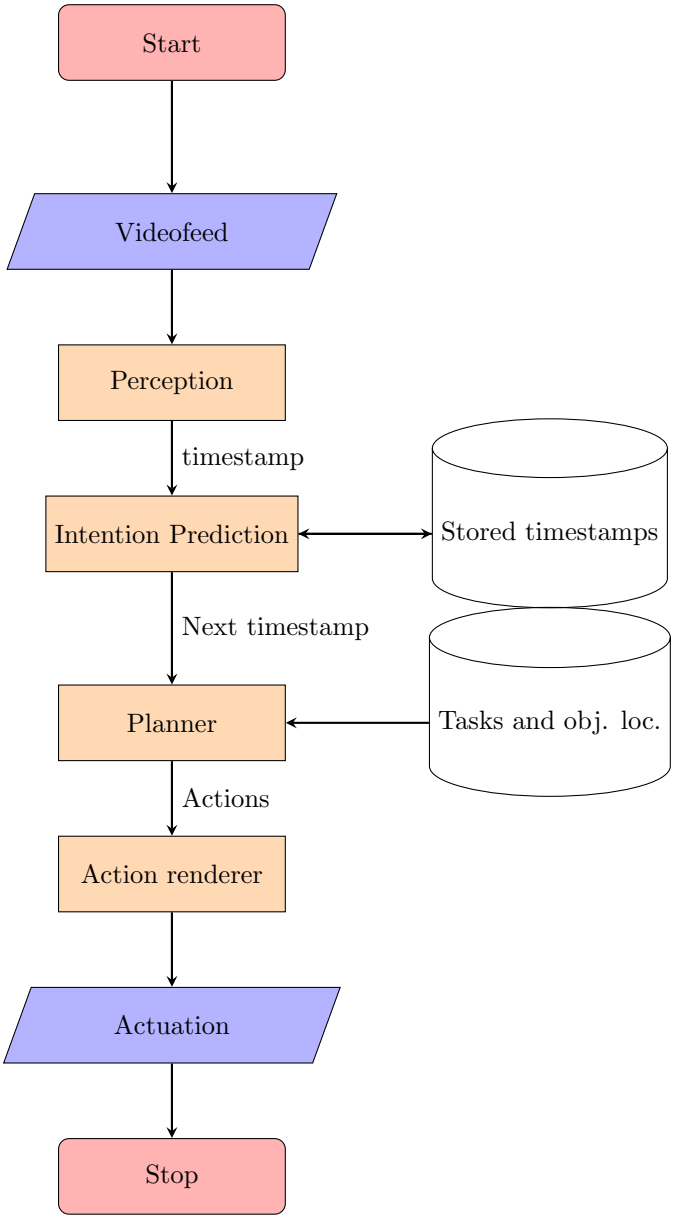
4.2.3 Planner



The objective of this module is to plan the actions until human requires robot's assistance.

The input is the predicted timestamp, it is passed to *Find actions to optimise Tasks*, which upon getting data from Knowledge base plans a series of actions to be rendered.

4.3 Architecture



5 Milestones

Schedule Planning	
Date	Expected Work
2^{nd} February, 2017	Implementation of Multimodal Perception in Python
9^{th} February, 2017	Implementation of Intention Prediction/Evaluation in Python
16^{th} February, 2017	Implementation of Planner in Python
23^{rd} February, 2017	Implementation of Action Renderer in Python
9^{th} March, 2017	Integrating all components and Testing
16^{th} March, 2017	Rendering actions using ROS/SWI-Prolog/Robot Studio for a simple task
23^{th} March, 2017	First Draft Submission

References

[1] Yumi - creating an automated future together. `http://new.abb.com/products/robotics/industrial-robots/yumi`. Accessed: 2017-01-11.

[2] Sandra Devin, Grégoire Milliez, Michelangelo Fiore, Aurélie Clodic, and Rachid Alami. Some essential skills and their combination in an architecture for a cognitive and interactive robot. *arXiv preprint arXiv:1603.00583*, 2016.

[3] Sylvie Pesty. Social human-robot interaction: A new cognitive and affective interaction-oriented architecture. In *Social Robotics: 8th International Conference, ICSR 2016, Kansas City, MO, USA, November 1-3, 2016 Proceedings*, volume 9979, page 253. Springer, 2016.

[4] Yong Tao, Tianmiao Wang, Hongxing Wei, and Peijiang Yuan. A behavior adaptation method for an elderly companion robot-—rui. In *International Conference on Social Robotics*, pages 141–150. Springer, 2010.