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Stabilization of Dynamical Peer to Peer Networks

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Abstract*— The analysis of wireless network exhibits that network maintenance system is the major problem. In wireless networks computational methods degrade the performance and stability of the network. Architecture of Wireless Control Network (WCN) is an interconnection of nodes where each node maintains its position details and gets frequent updates from other nodes in linear combination of neighbour plant outputs. In previous structural system have less computation overhead and beneficial scheduling with compositionality properties. In our proposed system defines basic characteristics of topological conditions which allow us to stabilize the network. To achieve this by analyse the coupling between plant's and nodes in dynamic changing nature of network structure. Our system stabilizes the control inputs even though vertex connectivity of the network is very larger than the geometric multiplicity of unstable eigen values of the plant. The condition is alternative for typical min-cut condition is required in traditional information distribution problem. To overcome this by topological conditions regulates the network communication through plant's sensors and decentralized controllers at actuators with traditional code employed on it.

Keywords*— Networked control systems, decentralized control, wireless sensor networks, structured systems, in-network control, network coding, cooperative control.

I. INTRODUCTION

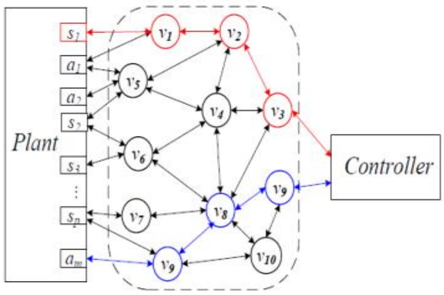
In wireless communication, sensor and actuator are available with updated features to compete with present technologies. Embedded these with reasonable price to bring multi-hop wireless networks becomes a disruptive technology. Wireless multi-hop mesh network replaces the earlier interconnection of plant sensors, controllers and actuators to save cost and space require to perform necessary computation on plants and to make it as more efficient and robust communication. These provide incredible assurance to wireless communication while introducing feedback loops checks to direct accurate and safe route but it gives several challenges to feedback control. Before transmitting information through multi-hop network route should be schedule carefully depends on feedback decisions to reduce packets dropouts due to collisions between neighbour nodes. Collision degrades the stability of interconnected system if not identified in mean time. So, research forecast these damages in earlier stages to avoid it by adopting some more dedicated controllers or state estimators in specified locations observe closed loop interconnection of sensor-estimator and/or controller-actuator communication channels.

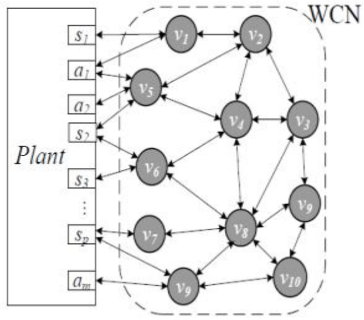
For a standard Architecture dedicated controllers are defined with powerful check points in one or more fixed paths to transmit information along that path to overcome end to end delay within the network. These delays are optimized by appending control loops to controllers. Scheduled computations in controller checks and regulates the communication at runtime to establish flexible transmissions without affecting the original one. In some situations paths are in congestion state at that time we need a clever routing approach to direct the correct path for information carried over the network. For this an effective routing approach defined with all possible routes within the wireless network. With Wide spread of wireless technology for communication and feedback process causes some delays because of multi-hop and packet dropouts occur collision due to confusion will transmitting. Our goal is to detect collisions and maintain stabled system with the help of distributed algorithm for resource constrains contain collective control laws in the network.

II. WIRELESS CONTROL NETWORK

WCN Architecture is a combination of sensor, controller/estimator and actuator are interconnected through channels and control laws are defined to control the network for flexible processes. There is a question raised while re-examining this system, how come the network itself acts as controller as well as stabilizer to control the plant communication by using distributed algorithm. While kept all these things in mind to introduce a new setup of wireless nodes are deployed in proxy of plant in which few nodes directly access sensor outputs and some other few nodes are placed in listening range of plants actuators.

In this model resources have some constraints, for example a node can able to kept limited no.of internal states updated to arrange the nodes in linear combination to its immediate neighbourhood. Actuators in the plant can also do the same thing to get linear plant according to network topology by applying linear iterative strategy.





We developed a feasible approach to get coefficients of each node connected in linear passion to stabilize the network by applying actuator. With this we can see low rate of packet dropouts. By using this approach we have lot of benefits like easy way of scheduling the route to carry the information within compeatable path, ability to separate the sensors and actuators of the network according to required geographically way.

III. MULTI HOP WCM

The start our analysis by initially disregard the effects of the actuators on the plant; i.e., we assume that at each time-step the plant actuators do not use transmissions from the nodes in the set VA to actuate the plant (via (5)). This allows us to consider the plant £ = (A;B;C) and the WCN together as a linear system where the outputs of the plant are injected into the WCN If we view the transmissions of the nodes in VA as the output of the £ system can be specified as.

$$\hat{x}[k+1] = \begin{bmatrix} x[k+1] \\ z[k+1] \end{bmatrix} = \underbrace{\begin{bmatrix} A & 0 \\ HC & W \end{bmatrix}}_{\tilde{A}} \begin{bmatrix} x[k] \\ z[k] \end{bmatrix} + \underbrace{\begin{bmatrix} B \\ 0 \end{bmatrix}}_{\tilde{B}} u[k],$$

$$\hat{y}[k] = \underbrace{\begin{bmatrix} 0 & E_{\mathcal{V}_A} \end{bmatrix}}_{\tilde{C}} \begin{bmatrix} x[k] \\ z[k] \end{bmatrix}.$$

Here EVA = [ei1, ei2….eit]. Recall that X is the set of state vertices (corresponding to the states of the plant), U is the set of P input vertices (corresponding to the actuators), and V is the set of vertices corresponding to the network nodes. The set EA represents the edges between state vertices (given by the matrix A), and EB represents edges from the plant inputs to the states (given by the matrix B). The set E represents the topology of the network, and the set EO captures how the state vertices influence the vertices in the wireless network. Specifically, the states of the plant affect the outputs of the plant (via the edge set EC), and each plant output connects to one or more nodes (via the edge set E out defined in (2)). As the output vertices simply pass the information about the state vertices through to the wireless network, we can remove the output vertices from the representation and introduce connections directly from the state vertices to the wireless vertices as follows:

EO = f(xi; vj) 2 X _ VSj9yk 2 Y; (xi; yk) 2 EC; (yk; vj) 2 Eoutg:

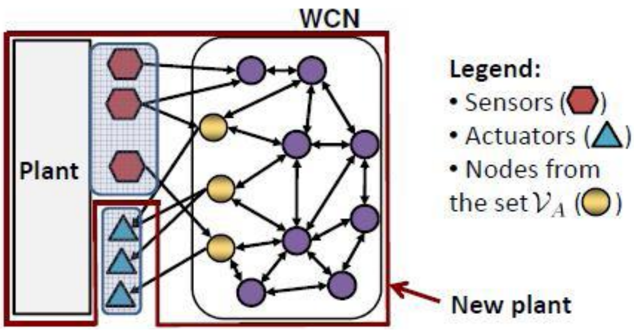


Fig 1.1 system architecture

To model resource constrained nodes, assumed that each node is capable of maintaining only a limited internal state. Then presented a distributed algorithm in the form of a linear iterative strategy for each node to follow, where each node periodically updates its state to be a linear combination of the states of the nodes in its immediate neighborhoods. The actuators of the plant also apply linear combinations of the states of the nodes in their neighborhoods. Given a linear plant model and the network's topology, Devised a design-time procedure to derive the coefficients of the linear combinations for each node and actuator to apply in order to stabilize the plant. The method could also handle a sufficiently low rate of packet dropouts in the network to maintain mean square stability. Referred to this paradigm, where the computation of the control law is done in-network as a Wireless Control Network (WCN). The scheme has several benefits, including easy scheduling of wireless transmissions, compositional design, and the ability to handle geographically separated sensors and actuators. Then illustrated the use of the WCN in industrial process control applications

Advantage of the system architecture for the wireless network system model in the model.

1. WCN in industrial process control applications
2. Less time should be taken and cost will be low saving place
3. Easy scheduling of wireless transmissions

A fixed mode will be introduced with Each WCN state vertex zi that does not belong to a strong component in the graph g~_in= (v~_; e~_ [ein) with an edge from ein (this might happen if the network is disconnected).However, by setting to zero all the weights associated with the links outgoing from zi, this WCN state vertex is effectively. Removed from the network. In this case, due to the state vertex zi the system has a structured fixed mode in the origin. Thus, In both cases the closed-loop system does not have structured fixed-modes outside of zero, meaning that almost every system with this structure will be stabilizable using the WCN.

For instance, delays may be introduced if a multi-hop wireless network is used to route furthermore, transmissions in the network must be scheduled carefully information between the plant sensors, actuators and controllers. To avoid packet dropouts due to collisions between neighbouring nodes. These issues can be detrimental to the goal of maintaining stability of the closed loop system if not explicitly accounted for, and substantial research has been devoted to understanding the performance limitations in such settings.
These works typically adopt the convention of having one or more dedicated controllers or state estimators located in the system, and study the stability of the closed loop system assuming that the sensor estimator and/or controller-actuator communication channels are unreliable dropping packets with a certain probability, For this standard architecture the use of dedicated controllers imposes a routing requirement along one or more fixed paths through the network, along with strict end-to-end delay constraints to ensure stability.

IV. EXTENSION OF PEER TO PEERS NETWORK

Wireless Control Network our analysis can be extended in a straightforward manner for control over networks with wired communication links. We consider the problem of network synthesis for the case where network coding over point-to-point communication links is use. Our goal is to provide topological conditions that guarantee that there exist linear dynamical controllers (at the actuators) that can stabilize the plant. We focus on two scenarios. We start with the case when the network delay (over each link in the network) is equal to the sampling period of the plant. We then investigate the case when an idealized, delay-free network is used. It is worth noting that this scenario can be used to model closed-loop systems where the speed of the network is much higher than the sampling period of the plant.

Suppose that Gc = (Vc;Ec [Y1:p [U1:m) is a network with point-to-point links, where Y1:p = [pi=1Yi represents the links coming into the network from the plant's sensors, andU1:m = [mj=1Uj represents the set of links coming out of the network into the plant's actuators. As is standard in linear network coding, the information sent on each outgoing edge from a given network node is a linear combination of information carried on the edges entering that node. Note that in the wired communication model, the linear combinations on each outgoing edge are allowed to be different. As shown in [12],from the graph Gc we can obtain the (unique) directed labeled line graph B = (VB; EB), where VB = Ec [Y1:p [U1:m,and for all ei; ej 2 VB, (ei; ej) 2 EB if and only if there exist v1; v2; v3 2 Vc such that ei = (v1; v2) and ej =(v2; v3)(i.e., head(e1) = tail(e2)). Each link (ei; ej) 2 EB is labeled With the coefficient (i.e., weight) assigned to the information received over edge ei in the linear combination that is used to produce information over ej .An illustration of this procedure is shown in where the labeled line graph is given for the network from Note that each link in the initial graph corresponds to a unique vertex in the labeled line graph .If each link in the initial network introduces a fixed.

Similar results can be obtained in the case with delay-free communication networks, where the information injected in the network by the plant's sensors is expected to be instantaneously available at the actuators. In this case, as described in [12], for the directed labeled graph of the initial network we can define W – the adjacency matrix of the labeled graph .Here, wij is the weight assigned to the edge ei in the linear combination used to derive ej (if head(ei) 6= tail(ej) then wij = 0).9 Using the matrix W, as in [12] it can be shown that for any set I _ M, EF (WI)1H is the transfer matrix of the network, from the input edges to the output edges10 This is equal to the WCN transfer function, evaluated at _ = 1, which is used in the proof of Theorem 8. Therefore, by using the same approach from the proof of Theorem 8, we can formulate theorem equivalent this means that, even for delay-free networks that use network coding over point-to-point links, Theorem 10specifies sufficient conditions for the existence of network coding parameters for which the plant can be stabilized via controllers at the actuators.

The conditions for a given system to not have structural fixed modes when controlled using a WCN, where each node in the network maintains only a scalar state, and the actuator nodes maintain vector states. Start analysis by initially disregarding the effects of the actuators on the plant; i.e., assume that at each time-step the plant actuators do not use transmissions from the nodes in the set VA to actuate the plant. In decentralized control systems, a set of non-interacting local controllers is used to control a dynamical system (plant); each of the controllers generates the appropriate plant inputs by observing only a subset of the plant's outputs. Due to these limitations imposed on each of the local controllers, it is possible that even a controllable and observable system cannot be stabilized with the aforementioned setup. As shown in the problem of decentralized control can be formulated as a static output feedback control problem, where the feedback matrix potentially has some sparsity constraints. Furthermore, introduced the notion of fixed modes to derive conditions for the existence of a stabilizing set of decentralized controllers. The concept of fixed modes was generalized in to handle arbitrary feedback patterns, and to enable a graph-theoretic analysis of the problem.

V. CONCLUSION

Stabilizing a network is a critical problem with devices mobility and dynamic changes in infrastructure. Our conventional approaches completely concentrate on routing mechanism to regulate transmission through controllers with some dynamic strategies to get accurate inputs to actuators. Our proposed scheme regulates the communication in plants with end to end connection requests the neighbour nodes to transmit the information to nearest node in desired timestamp. Distributive algorithm maintains this by network dynamics. Along with this, topological condition stabilizes the network by auto correcting the nodes and actuators are arranged in linear passion with iterative strategy chosen appropriate weights to stabilize the plant network in dynamic manner, rather than no of source nodes.

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